

**EUROPEAN CREDIT TRANSFER SYSTEM  
INFORMATION PACKAGE**

**DEPARTMENT OF CHEMICAL ENGINEERING**

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**DEPARTMENT**

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**ECTS COORDINATION**

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## GENERAL INFORMATION

Each year, 100 new undergraduate students and 45 new graduate students, on the average, enter our department.

Chemical Engineering Department program not only covers the basic principles of Chemical Engineering but also provides industrial applications and research opportunities.

Chemical Engineering program provides basic concepts, and their synthesis and applications in process design, and deals with various industrial problems and solutions.

One third of the courses are offered in English. A total of 133 credits (240 ECTS) is required to get a B. S. degree. The 4 year undergraduate program includes courses from many fields such as momentum, heat and mass transfer, chemical engineering thermodynamics, mathematical modeling, reactor design, engineering economics and process control in addition to basic engineering courses. A graduation project is assigned to each student in the last semester in order to give opportunities of applying basic Chemical Engineering knowledge into practice.

After the first four semesters, undergraduate students perform a summer practice lasting 50 working days, 25 days for laboratory training and 25 days for process/plant training.

### Research and Laboratories

Analytical Chemistry Laboratory. Organic Chemistry Laboratory. Chemical Engineering Laboratory I. Chemical Engineering Laboratory II. Chemical Engineering Laboratory III. Water and Wastewater Laboratory. Chemical Reaction Engineering and Catalyst Laboratory. Corrosion Laboratory.

### Degrees Granted

|                                                               |                       |
|---------------------------------------------------------------|-----------------------|
| Bachelor of Science in Chemical Engineering                   | 4 years (8 semesters) |
| Master of Science in Chemical Engineering (thesis option)     | 2 years (4 semesters) |
| Master of Science in Chemical Engineering (non-thesis option) | 2 years (4 semesters) |
| Doctor of Philosophy in Chemical Engineering                  | 4 years (8 semesters) |

**Academic Staff and Researches**

| <b>Academic Staff</b>         | <b>Department</b>       | <b>Researches</b>                                                                                                                                                    |
|-------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Prof.Dr.<br>Ahmet ALICILAR    | Chemical<br>Engineering | Synthesis and Applicability of Dyes,<br>Water Pollution, Packed Columns                                                                                              |
| Prof.Dr.<br>İrfan AR          | Chemical<br>Engineering | Chemical Reaction Engineering, Air<br>Pollution, Adsorption, Catalyst<br>Synthesis, Fuel Cell, Biogas                                                                |
| Prof.Dr.<br>Suna BALCI        | Chemical<br>Engineering | Chemical Reaction Engineering,<br>Synthesis/Characterization/Application<br>of Porous Materials, Heterogeneous<br>Reactions, Mass Transfer,<br>Adsorption/Desorption |
| Prof.Dr.<br>Ahmet BİÇER       | Chemical<br>Engineering | Trickle Bed Reactors, Mass Transfer,<br>Inorganic Technology, Unit Operations                                                                                        |
| Prof.Dr.<br>H. Canan CABBAR   | Chemical<br>Engineering | Chemical Reaction Engineering,<br>Absorption, Diffusion and Adsorption<br>Environmental Pollution, Catalysts                                                         |
| Prof.Dr.<br>Müjgan ÇULFAZ     | Chemical<br>Engineering | Ion Exchange and Its Thermodynamics,<br>Synthesis of Zeolite Type Materials                                                                                          |
| Prof.Dr.<br>Nursel DİLSİZ     | Chemical<br>Engineering | Composite Materials, Polymer Science<br>and Technology, Sol-Jel Technology,<br>Plasma Chemistry and Surface<br>Modification                                          |
| Prof.Dr.<br>Murat DOĞAN       | Chemical<br>Engineering | Energy, Fluidized Beds, Heat and Mass<br>Transfer, Fluid Mechanics, Combustion<br>of Oil Shale and Coal, Flue Gas<br>Desulphurization, Hydrogen Storage              |
| Prof.Dr.<br>Gülşen DOĞU       | Chemical<br>Engineering | Chemical Reaction Engineering, Mass<br>Transfer, Adsorption and Diffusion,<br>Catalysis, Air Pollution Control<br>Technologies                                       |
| Prof.Dr.<br>Sebahat ERDOĞAN   | Chemical<br>Engineering | Control of Polymerization Reactor,<br>Process Dynamics, Heat Transfer                                                                                                |
| Prof.Dr.<br>Mübeccel ERGUN    | Chemical<br>Engineering | Corrosion, Biochemical Reaction<br>Engineering, Biotechnology, Material<br>Synthesis, Design                                                                         |
| Prof.Dr.<br>F. Çiğdem GÜLDÜR  | Chemical<br>Engineering | Chemical Reaction Engineering,<br>Catalysts, Porous Materials, Control of<br>Air Pollution, Fuel Cell, Hydrogen<br>Energy                                            |
| Prof.Dr.<br>Ufuk GÜNDÜZ ZAFER | Chemical<br>Engineering | Chemical and Biochemical Separation,<br>Biotechnology, Thermodynamics, Phase<br>Equilibrium, Energy, Hydrogen<br>Production                                          |
| Prof.Dr.<br>Metin GÜRÜ        | Chemical<br>Engineering | Energy Technologies, Biotechnology,<br>Organic Technology, Material,<br>Thermodynamics, Environment, Water                                                           |

|                                   |                         |                                                                                                                                                                     |
|-----------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                   |                         | Technology                                                                                                                                                          |
| Prof.Dr.<br>Ayşe MURATHAN         | Chemical<br>Engineering | Water Technologies, Total Quality Management, Environmental Management, Synthesis and Applicability of Dyes                                                         |
| Prof.Dr.<br>Atilla M. MURATHAN    | Chemical<br>Engineering | Packed Beds, Water Pollution and Its Control, Supercritical Fluid Extraction, Synthesis and Applicability of Dyes                                                   |
| Prof.Dr.<br>Kırali MÜRTEZAOĞLU    | Chemical<br>Engineering | Chemical Reaction Engineering, Environment, Material, Porous Media and Its Modelling                                                                                |
| Prof.Dr.<br>İskender ÖKSÜZ        | Chemical<br>Engineering | Atom Physics, Electronic Energy Level of Atom and Molecules, Numerical Methods in Quantum Chemistry, Computer Aided Education and Computer Application in Education |
| Prof.Dr.<br>H. Vecihi PAMUK       | Chemical<br>Engineering | Supercritical Fluid Extraction, Thermochemical Liquefaction, Fossil Fuels, Advanced Materials                                                                       |
| Prof.Dr.<br>Nurdan SARAÇOĞLU      | Chemical<br>Engineering | Chemical Reaction Engineering, Ion Exchange in Zeolites ve Adsorption, Biotechnology, Biochemical Reaction Engineering                                              |
| Prof.Dr.<br>B. Zühtü UYSAL        | Chemical<br>Engineering | Heat and Mass Transfer, Design, Fluidized Beds, Fluid Mechanics, Combustion, Flue Gas Desulphurization                                                              |
| Assoc.Prof.Dr.<br>Ayla ALTINTEN   | Chemical<br>Engineering | Control of Polymerization Reactors, Genetic Algorithm, Fuzzy Control                                                                                                |
| Assoc.Prof.Dr.<br>Nuray OKTAR     | Chemical<br>Engineering | Chemical Reaction Engineering, Catalyst, Transport Phenomena in Porous Media                                                                                        |
| Assoc.Prof.Dr.<br>Göksel ÖZKAN    | Chemical<br>Engineering | Catalytic Converters, Supercritical Extraction, Controls of Air Pollution, Fuel Cell and Actuators                                                                  |
| Assoc.Prof.Dr.<br>Nail YAŞYERLİ   | Chemical<br>Engineering | Adsorption in Porous Solids and Diffusion, Catalytic and Noncatalytic Reactions, NO <sub>x</sub> Reduction                                                          |
| Assoc.Prof.Dr.<br>Sena YAŞYERLİ   | Chemical<br>Engineering | Gas- Solid Reactions, Adsorption, Synthesis and Characterization of Catalysts and Adsorbents, H <sub>2</sub> S Removal                                              |
| Asst.Prof.Dr.<br>Muzaffer BALBAŞI | Chemical<br>Engineering | Synthesis and Characterization of Zeolites, Materials, Dyes                                                                                                         |
| Asst.Prof.Dr.<br>Meltem DOĞAN     | Chemical<br>Engineering | Membranes, Transport Phenomena in Porous Media, Chemical Reaction Engineering                                                                                       |

|                                     |                         |                                                                                                       |
|-------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------|
| Asst.Prof.Dr.<br>S. Ferda MUTLU     | Chemical<br>Engineering | Environmental Technologies,<br>Biotechnology, Fermentation<br>Technology, Energy Technology           |
| Asst.Prof.Dr.<br>Niyazi Alper TAPAN | Chemical<br>Engineering | Reaction and Surface Kinetics , Direct<br>Methanol, Ethanol Fuel Cell,<br>Electrochemical Engineering |

| KM501 WATER AND WASTE WATER TECHNOLOGY |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                               | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     | Credits      |             |
|                                        | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                    | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -      | -    | 22  | 75                 | 48                              | 188                 | 3            | 7.5         |
| Language                               | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                  | Compulsory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                          | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Course Contents                        | Preparation of drinking and industrial water. Classification of waste water from houses and industry.Physical,chemical and biological water purification methods. Legal limitations and regulations.                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                      | <ul style="list-style-type: none"><li>Learning of drinking water and industrial water preparing methods</li><li>Understanding of domestic and industrial water and wastewater topic with theoretical and practical samples</li></ul>                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences      | <ul style="list-style-type: none"><li>Development of knowledge and skills about drinking and industrial water preparing.</li><li>Development of oral and writing communication skills</li><li>Learning of advanced concepts at domestic and industrial wastewater applications</li></ul>                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References            | <ol style="list-style-type: none"><li>Metcalf &amp; Eddy, Inc., Wastewater Engineering Treatment, Disposal and Reuse, 3<sup>rd</sup> ed., McGraw-Hill, Inc., 1991.</li><li>Eckenfelder, W.W., Industrial Water Pollution Control, 3<sup>rd</sup> ed., McGraw-Hill Inc., 2000.</li><li>Tchobanoglous G. &amp; Burton F.L., Wastewater Engineering, Treatment, Disposal and Reuse, 3<sup>rd</sup> ed., Mc. Graw Hill, 1991.</li><li>McGhee T.J.,” Water Supply and Sewerage”, McGraw-Hill Inc. 6<sup>th</sup> ed., 1991.</li><li></li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                        | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | X                   | 25           |             |
|                                        | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | -                   | -            |             |
|                                        | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | X                   | 10           |             |
|                                        | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                        | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 25           |             |
|                                        | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | -                   | -            |             |
|                                        | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | -                   | -            |             |
| Final Exam                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    | X                               | 40                  |              |             |
| Prepared by                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Week                                   | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 1-2                                    | Preparation of drinking and industrial water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 3                                      | Classification of waste water from houses and industry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| 4-10                                   | Physical,chemical and biological water purification methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 11-12                                  | Legal limitations and regulations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| 13-14                                  | Project                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM504 CORROSION                   |                                                                                                                                                                                                                                                   |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                           | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                | =      | =    |     |                    |                                 | 188                 | 3            | 7.5         |
| Language                          | Turkish/ English                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Optional                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Basic Principles of Corrosion theory. Pourbaix diagrams. Experimental Methods in corrosion. Passivity. Forms of corrosion. Corrosion control; Coatings Anodic and cathodic Protection and inhibitors.                                             |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | To have information in advaced level about the basic principles, types, the reasons for the occurence and also the methods of controlling for the corrosion reactions encountered very often in chemical processes and industries                 |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | Gaining the corrosion theory, reasons for the occurence and forms of corrosion and the ability to apply this knowledge to control corrosion problems encountered in industry.                                                                     |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | 1.Uhlig, H. H., R. W. Revie(1993) “ Corrosion and corrosion Control” 3rd Edn. John Wiley and Sons.<br>2.Sastri V. S. (1998) “Corrosion Inhibitors” John Wiley and Sons.<br>3. Trethewey, K. R. ,J. Chamberlain(1998) “Corrosion” 2nd Edn. Longman |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                           |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Term Paper                                                                                                                                                                                                                                        |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                   |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                        |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof.Dr. Mübeccel Ergun                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 1-3                               | Thermodynamics and Kinetics of Corrosion Reactions                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 4-5                               | Polarisation, Diffusion Processes and Mixed Potential Model of Corrosion                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| 6-7                               | Pourbaix Diagrams                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 8                                 | Polarization Curves , Electrochemical impedance                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 9-10                              | Forms of Corrosion                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 10-12                             | Anodic and Cathodic Protection, Inhibitors and Plating                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 12-14                             | 2 Midterms and Presentation of Special Topics                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
|                                   |                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM507 Numerical Methods in Chemical Engineering |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                            |              |             |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|----------------------------|--------------|-------------|
| Semester                                        | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                            | Credits      |             |
|                                                 | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total                      | Credit       | ECTS credit |
| 1-2                                             | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | -      | -    | 75  | -                  | 71                              | 188                        | 3            | 7.5         |
| Language                                        | Turkish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                            |              |             |
| Compulsory / Elective                           | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                            |              |             |
| Prerequisites                                   | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                            |              |             |
| Course Contents                                 | Iterative methods for solution of ordinary and partial differential equations. Solution methods of some engineering problems by Matlab and standart libraries.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                            |              |             |
| Course Objectives                               | <ul style="list-style-type: none"> <li>In this course, students learn how to apply knowledge of mathematics, science, and engineering to analyze and solve numerically problems encountered in chemical engineering.</li> <li>The course gives the student the opportunity to analyze and interpret data, to identify, formulate, and solve engineering problems</li> <li>To teach modern engineering tools necessary for engineering practice.</li> <li>To give the student an understanding of professional and ethical responsibility.</li> <li>To teach the concepts and methods of numerical analysis as applied to the solution of chemical engineering problems.</li> <li>To familiarize with the strengths and weaknesses of various numerical methods, and give criterions for selecting methods to be used for solving of a particular problem.</li> <li>To give opportunity to use of the available computational tools in solving engineering problems.</li> </ul> |        |      |     |                    |                                 |                            |              |             |
| Learning Outcomes and Competences               | Students will achieve the educational objectives that include: <ul style="list-style-type: none"> <li>an ability to apply knowledge of mathematics, science and engineering;</li> <li>an ability to analyze and interpret data;</li> <li>an ability to identify, formulate, and solve engineering problems;</li> <li>an understanding of professional and ethical responsibility;</li> <li>an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                            |              |             |
| Textbook and /or References                     | 1. Constantinides and N. Mostoufi, <i>Numerical Methods for Chemical Engineers with MATLAB Applications</i> , Prentice Hall PTR, Upper Saddle River, NJ, 1999.<br>2. Mathews, J.H. and Fink, K.D., <i>Numerical Methods Using Matlab</i> , Prentice Hall, 3 <sup>rd</sup> ed. NJ, 1999.<br>3. D. Hanselman and B. Littlefield, <i>Mastering MATLAB 7</i> , Prentice Hall PTR, Upper Saddle River, NJ, 2005.<br>4. <b>Software (required, if you will be using your own computer to do the homeworks):</b> MATLAB & Simulink Student Version Release 14 with Service Pack 3, The Math Works.                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                            |              |             |
| Assessment Criteria                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | <i>If any, mark as (X)</i> | Percentage % |             |
|                                                 | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | X                          | 40           |             |
|                                                 | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 | -                          | -            |             |
|                                                 | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                          | 20           |             |
|                                                 | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | -                          | -            |             |
|                                                 | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                          | -            |             |
|                                                 | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | -                          | -            |             |
|                                                 | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                          | -            |             |
|                                                 | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                          | 40           |             |
|                                                 | Assist. Prof. Dr. Muzaffer BALBAŞI, Prof. Dr. Canan Cabbar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                            |              |             |
| Prepared by                                     | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                            |              |             |
| Week                                            | Introduction to MATLAB, Algorithms, and Software                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                            |              |             |
| 1-3                                             | Solution of Nonlinear Equations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                            |              |             |
| 3-4                                             | Solution of Linear Algebraic Equations, Midterm Examination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                            |              |             |
| 5-6                                             | Difference Methods and Interpolation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                            |              |             |
| 7-8                                             | Numerical Differentiation and Integration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                            |              |             |
| 9                                               | Solution of Ordinary Differential Equations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                            |              |             |
| 10-11                                           | Solution of Partial Differential Equations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                            |              |             |
| 12-13                                           | Midterm Examination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                            |              |             |

| KM509 Optimization                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |          |  | Name of the Programme:<br>Chemical Engineering |       |                            |             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|----------|--|------------------------------------------------|-------|----------------------------|-------------|
| Semester                          | Teaching Methods(Student Workload/Hour)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |          |  |                                                |       | Credits                    |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Recite | Lab. | Homework |  | Other                                          | Total | Local Credit               | ECTS Credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -      | -    | 90       |  | 56                                             | 188   | 3                          | 7.5         |
| Language                          | Turkish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |          |  |                                                |       |                            |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |          |  |                                                |       |                            |             |
| Prerequisites                     | None (ChE-377, ChE-306 and ChE-507 highly recommended)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |          |  |                                                |       |                            |             |
| Course Contents                   | <p>Formulation of objective functions; nature and organization of optimization problems to data; optimization of unconstrained functions; unconstrained multivariable optimization; linear programming and application nonlinear programming with constraints; optimization of staged and discrete processes; applications of optimization to engineering processes.</p> <p>This course will focus on the fundamentals of optimization and applications of mathematical optimization in engineering systems. The first part of the course will address optimization theory, solution algorithms and implementation software. Topics to be covered include nonlinear optimization, linear programming, linear and nonlinear optimization. Emphasis will be placed on understanding the logic of the methods, the key assumptions that underlie them, their comparative merits and shortcomings, and how they can be applied for solving engineering problems. In the solution of problems will be used the specialized optimization solvers such as Matlab Optimization Toolbox.</p> <p>This course will provide the student with the ability to efficiently formulate and solve engineering optimization problems. Also students will gain an understanding of different numerical techniques to solve linear and nonlinear optimization problems. Relevant engineering examples will be discussed, which will emphasize the use of computational software, such as MATLAB and MicroSoft Excel to solve optimization problems.</p> |        |      |          |  |                                                |       |                            |             |
| Course Objectives                 | <p>The basic aim is to develop the practical mastery of optimization thinking for the engineer with applications in engineering. This leads to the following objectives for the participants:</p> <ul style="list-style-type: none"> <li>• To recognize and formulate optimization problems in engineering practice</li> <li>• To select appropriate algorithms and software packages to solve optimization problems</li> <li>• To analyze and interpret the solution of an optimization problem</li> <li>• To understand the basic mathematical considerations</li> <li>• To learn to use and appreciate tools to solve these problems</li> <li>• To apply optimization techniques to moderately complex case studies.</li> <li>• To equip participants with a range of tools for solving optimisation problems.</li> <li>• The applicability and limitations of these tools will be highlighted</li> <li>• To use various software packages, in particular Matlab ve MicroSoft Excel.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |          |  |                                                |       |                            |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>• Have a basic understanding of numerical optimization algorithms.</li> <li>• Formulate engineering design problems as mathematical optimization problems.</li> <li>• Use mathematical software for the solution of engineering problems.</li> <li>• Reinforce numerical skills learned in class with several homework assignments.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |          |  |                                                |       |                            |             |
| Textbook and /or References       | <ul style="list-style-type: none"> <li>• Edgar, T.F., Himmelblau, D.M., and Laston, L.S., Optimization of Chemical Processes, SE, McGrawHill.,2001.</li> <li>• Rao, S.S., Optimization: Theory and Application, Wiley , NY, 1984.</li> <li>• Bunday, B.D., Basic Optimization Methods, Edward Arnold Publ., 1985.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |          |  |                                                |       |                            |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |          |  |                                                |       | <i>If any, mark as (X)</i> | Percent (%) |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |          |  |                                                |       | X                          | 40          |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |          |  |                                                |       |                            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |          |  |                                                |       |                            |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |          |  |                                                |       |                            |             |

|             |                                               |   |    |
|-------------|-----------------------------------------------|---|----|
|             | Term Paper                                    | X | 20 |
|             | Laboratory Work                               |   |    |
|             | Other                                         |   |    |
|             | Committee Exam                                |   |    |
|             | Final Exam                                    | X | 40 |
| Instructors | Assit. Prof. Dr. Muzaffer BALBAŞI             |   |    |
| Week        | Subject                                       |   |    |
| 1           | Fundamental concepts                          |   |    |
| 2           | One-dimensional search                        |   |    |
| 3-4         | Unconstrained optimization                    |   |    |
| 5-6         | Linear Programming, Midterm examination       |   |    |
| 7-8         | Nonlinear programming                         |   |    |
| 9           | Penalty Functions for Handling Constraints    |   |    |
| 10-11       | Constrained Optimization                      |   |    |
| 12-13       | Matlab Optimization Toolbox (if time permits) |   |    |
| 14          | Midterm examination                           |   |    |

| KM 511 TRANSPORT PHENOMENA        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     | CHEMICAL ENGINEERING DEPARTMENT |       |       |                     |              |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-----|---------------------------------|-------|-------|---------------------|--------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |     |                                 |       |       | Credits             |              |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Recit | Lab. | Hw. | Term Paper/Project              | Other | Total | Credit              | ECTS Credit  |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -     | -    | 20  | 40                              | 86    | 188   | 3                   | 7.5          |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     |                                 |       |       |                     |              |
| Compulsory / Elective             | Compulsory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       |                     |              |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |      |     |                                 |       |       |                     |              |
| Course Contents                   | Transport properties. Analogy in transport phenomena. Unified approach for solutions of momentum, energy and mass transport. Velocity, temperature and concentration profiles in laminar and turbulent flows. Interphase momentum, heat and mass transfer.                                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       |                     |              |
| Course Objectives                 | Evaluation of transport properties. To teach unified approach in transport phenomena. To study and learn the development of basic equations of transport phenomena. Modelling in transport phenomena and solution of the equations developed.                                                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       |                     |              |
| Learning Outcomes and Competences | The knowledge and ability of modeling the transport phenomena problems related to research and engineering applications, solving the equations developed and assessment of the results will be gained.                                                                                                                                                                                                                                                                                                                                          |       |      |     |                                 |       |       |                     |              |
| Text Book and/or References       | 1. Bird, R.B., Stewart, W.E, Lightfoot, E.N., Transport Phenomena, 2 <sup>nd</sup> ed., Wiley, Inc., New York, 2002.<br>2. Slattery, J.C., Momentum, Energy and Mass Transfer in Continua, McGraw-Hill Book Co., New York, 1972.<br>3. Tosun, İ., Modelling in Transport Phenomena, Elsevier, Amsterdam, 2002.<br>4. Brodkey, R.S., Hershey, H.C., Transport Phenomena - A Unified Approach McGraw-Hill Book Co., New York, 1988.<br>5. Thomson, W.J., Introduction to Transport Phenomena, Prentice Hall, New Jersey, 2000.<br>6. Periodicals. |       |      |     |                                 |       |       |                     |              |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     |                                 |       |       | If any, mark as (X) | Percentage % |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       | X                   | 30           |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |      |     |                                 |       |       | X                   | 5            |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |      |     |                                 |       |       | X                   | 5            |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                                 |       |       | -                   | -            |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       | X                   | 20           |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     |                                 |       |       | -                   | -            |
|                                   | Other                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |      |     |                                 |       |       | -                   | -            |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       | X                   | 40           |
| Prepared by                       | Prof. Dr. B. Zühtü UYSAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                                 |       |       |                     |              |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |      |     |                                 |       |       |                     |              |
| 1                                 | Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |      |     |                                 |       |       |                     |              |
| 2                                 | Momentum transfert mechanism                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |      |     |                                 |       |       |                     |              |
| 3                                 | Energy transfert mechanism                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       |                     |              |
| 4                                 | Mass transfer mechanism                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |      |     |                                 |       |       |                     |              |
| 5-6                               | Velocity profiles in laminar flows                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |     |                                 |       |       |                     |              |
| 7-8                               | Temperature profiles in solids and in laminar flows                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |      |     |                                 |       |       |                     |              |
| 9-10                              | Concentration profiles in solids and in laminar flows                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |      |     |                                 |       |       |                     |              |
| 11                                | Equations of change (Equations of Continuity,motion and energy); applications for isothermal systems                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |      |     |                                 |       |       |                     |              |
| 12                                | Equations of change (Equations of Continuity,motion and energy); applications for non-isothermal systems                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                                 |       |       |                     |              |
| 13                                | Equations of change (Equations of Continuity,motion and energy); applications for multicomponent systems                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                                 |       |       |                     |              |
| 14                                | Unsteady state transport phenomena                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |     |                                 |       |       |                     |              |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 513 CHEMICAL ENGINEERING MATHEMATICS |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                                | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     | Credits      |             |
|                                         | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                     | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -      | -    |     |                    |                                 | 188                 | 3            | 7.5         |
| Language                                | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                   | Compulsory                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                           | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Course Contents                         | Vectors and tensors. Determinants and matrices. Methods for solving ordinary and partial differential equations. Applications to chemical engineering problems                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                       | <ul style="list-style-type: none"><li>To give certain mathematical knowledge and methods to solve chemical engineering problems</li><li>ability to apply mathematical methods to chemical engineering problems</li></ul>                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences       | <ul style="list-style-type: none"><li>To get mathematical solution of chemical engineering problems using different methods.</li></ul>                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References             | <ol style="list-style-type: none"><li>Loney, N.W., Applied Mathematical Methods for Chemical Engineers, CRC Pres, NewYork, 2001.</li><li>Lopez, R.J., Advanced Engineering Mathematics, Addison-Wesley, NewYork, 2001.</li><li>Wylie, C.R. and Barrett, L.C., Advanced Engineering Mathematics, 5<sup>th</sup> Edition, McGraw Hill, NewYork, 1987.</li><li>Bird, R.B.,Steward, E.W., Lightfoot E.N., Transport Phenomena, Wiley, NewYork, 2002.</li><li>Periodicals.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                         | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | X                   | 30           |             |
|                                         | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
|                                         | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | X                   | 10           |             |
|                                         | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
|                                         | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 20           |             |
|                                         | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
|                                         | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
|                                         | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                             | Prof. Dr.Sebahat Erdoğan ,Prof. Dr. Ahmet Alıcılar                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Week                                    | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 1-4                                     | Vector and tensors                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 5-7                                     | Determinants and matrices                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 8-10                                    | Ordinary Differential Equations                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 11-13                                   | Partial Differential Equations                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
|                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 515 Advanced Chemical Reaction Engineering |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                                      | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     | Credits      |             |
|                                               | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                           | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | -      | -    | 48  | 48                 | 50                              | 188                 | 3            | 7.5         |
| Language                                      | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                         | Compulsary Elective for PhD Program                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                                 | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Course Contents                               | Kinetics of complex homogeneous and heterogeneous reactions. Batch, ideal flow and semi-batch reactors. Laminar flow reactors. Non-ideal flow reactors. Axial and radial dispersion in tubular reactors. Temperature effects and stability in chemical reactors. Axial and radial temperature variations in tubular reactors. Design principles of multiphase reactors.                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                             | <ul style="list-style-type: none"><li>To Investigate homogeneous and heterogeneous reactions in ideal and nonideal reactors at advanced level.</li><li>To Improve the theoretical background in chemical reaction engineering and their applications.</li><li>To follow the recent developments in chemical reaction engineering.</li></ul>                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences             | <ul style="list-style-type: none"><li>Gaining advanced knowledge on theoretical and applied basis, in chemical reaction engineering.</li><li>Improvements in the oral and written communications.</li></ul>                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References (*)               | <ol style="list-style-type: none"><li>Smith, J.M., Chemical Engineering and Kinetics, 3<sup>rd</sup> ed., Mc Graw Hill, 1981.</li><li>Missen, R.W., Mims, C.A. and Saviie, B.A., Introduction to Chemical Reaction Engineering and Kinetics, Wiley, 1999.</li><li>Levenspiel, O., Chemical Reaction Engineering, 3<sup>rd</sup> ed., Wiley, 1999.</li><li>Fogler, H.S., Elements of Chemical Reaction Engineering, Prentice Hall Inc., 1992.</li><li>Hill, C.G. Jr., An Introduction to Chemical Engineering and Reactor Design, Wiley, 1977.</li><li>Periodicals.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                               | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 30           |             |
|                                               | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | -                   | -            |             |
|                                               | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | X                   | 10           |             |
|                                               | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 30           |             |
|                                               | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | -                   | -            |             |
|                                               | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 | -                   | -            |             |
|                                               | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | -                   | -            |             |
|                                               | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | X                   | 30           |             |
| Prepared by                                   | Prof.Dr. Gülşen DOĞU, Prof.Dr. Canan CABBAR, Prof.Dr. Kırallı MÜRTEZAOĞLU, Prof.Dr. Suna BALCI, Prof.Dr. Çiğdem GÜLDÜR, Doç.Dr. İrfan AR, Doç.Dr. Nail YAŞYERLİ, Yrd.Doç.Dr. Meltem DOĞAN, Yrd.Doç.Dr. Nuray OKTAR, Yrd.Doç.Dr. Sena YAŞYERLİ                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Week                                          | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 1-2                                           | Kinetics of complex homogeneous and heterogeneous reactions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 3-5                                           | Batch, ideal flow and semi-batch reactors. Laminar flow reactors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 6-9                                           | Non-ideal flow reactors. Axial and radial dispersion in tubular reactors. Temperature effects in chemical reactors and stability.                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 10-14                                         | Modelling of noncatalytic gas-solid reactions. Axial and radial temperature variations in tubular reactors. Design principles in multiphase reactors.                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |

+ Recommended as reference books.

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM516 CATALYSIS                   |                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                        | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                             | -      | -    | 36  | 55                 | 55                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Compulsary Elective for PhD Program                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Physical and chemical properties of catalysts. Catalyst preparation and characterization techniques. Heat and mass transfer effects in catalytic reaction systems. Diffusion in porous solids, effectiveness factor concept. Mechanism of catalytic reactions. Selectivity in catalytic reactions. Deactivation and regeneration of catalysts. |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>To gain knowledge on various techniques in the preparation and characterization of catalysts used chemical reactions.</li><li>To investigate transport phenomena and reaction mechanisms in porous catalysts</li></ul>                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Knowledge and skills in the preparation of catalysts for the reactions of interests.</li><li>The concept of transport phenomena in porous catalysts.</li><li>Improvements in written and oral communication skills.</li></ul>                                                                            |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References (*)   | 1. Gates, B., Catalytic Chemistry: An Introductory Text, Wiley, 1991.<br>2. Smith, J.M., Chemical Engineering and Kinetics, 3 <sup>rd</sup> ed., Mc Graw Hill Book Co., 1981.<br>3. Carberry, J.J., Chemical and Catalytic Reaction Engineering, Dover Publications, 2001.<br>4. Periodicals                                                   |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 30           |             |
| Prepared by                       | Prof.Dr. Gülşen DOĞU, Prof.Dr. Kırallı MÜRTEZAOĞLU, Prof.Dr. Suna BALCI, Prof.Dr. Çiğdem GÜLDÜR, Doç.Dr. İrfan AR, Doç.Dr. Nail YAŞYERLİ, Yrd.Doç.Dr. Nuray OKTAR, Yrd.Doç.Dr. Sena YAŞYERLİ, Yrd.Doç.Dr. Meltem DOĞAN                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| 1                                 | Physical and chemical properties of catalysts.                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 2-5                               | Catalyst preparation and characterization techniques. Heat and mass transfer effects in catalytic reaction systems.                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 6-8                               | Diffusion in porous solids, effectiveness factor concept.                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 9-14                              | Selectivity in catalytic reactions. Deactivation and regeneration of catalysts.                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
|                                   |                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
|                                   |                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
|                                   |                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |

+ Recommended as reference books.

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 517 ADVANCED THERMODYNAMICS    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -      | -    | 45  | 40                 | 61                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Compulsory for Ph.D. program                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Laws of thermodynamics. Thermodynamic properties of fluids. Thermodynamical analysis of chemical engineering processes                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>To teach advanced thermodynamic processes and analysis</li> </ul>                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>Improvements of written and oral skills.</li> <li>Breadth and depth in the theory and applications in thermodynamics</li> </ul>                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | 1. Sandler, S.I., Chemical and Engineering Thermodynamics, 3 <sup>rd</sup> ed., Wiley, 1999.<br>2. Eliot, J.R., Lira, C.T., Introductory Chemical Engineering Thermodynamics, Prentice Hall PTR, 2001.<br>3. Tester, J.W., Model, M., Thermodynamics and Its Applications, 3 <sup>rd</sup> ed., Prentice Hall, 1996.<br>4. Prausnitz, J.M., Lichtenthaler, R.N., de Azevedo, E.G., Molecular Thermodynamics of Fluid-Phase Equilibria, Prentice Hall, 1997.<br>5. Periodicals |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof.Dr. Nurdan SARAÇOĞLU, Prof.Dr. Ufuk G. ZAFER, Prof.Dr. Metin GÜRÜ, Assoc. Prof. Dr. Ö.Murat DOĞAN, Asst. Prof. Dr. S.Ferda MUTLU                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 1-2                               | Basic concepts and definitions (review)                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 3                                 | Thermodynamic properties of pure substances. Tables and diagrams.                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 4-5                               | First law of thermodynamics. Applications of first law to closed and open systems.                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 6-7                               | Second law of thermodynamics. Entropy, entropy balances and thermodynamic analysis.                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 8-9                               | Volume properties, real gases and state equations. MIDTERM 1                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 10-11                             | Power cycles                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 12                                | Gas and air cycles                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 13-14                             | Refrigeration and liquefaction. MIDTERM 2                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |

| KM 519 ADVANCED FLUID MECHANICS    |                                                                                                                                                                                                                                                                                                                                                                                                                   |        |    |      | CHEMICAL ENGINEERING DEPARTMENT |       |            |              |             |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----|------|---------------------------------|-------|------------|--------------|-------------|
| Semester                           | Teaching and Learning Methods (Hours per Semester)                                                                                                                                                                                                                                                                                                                                                                |        |    |      |                                 |       |            | Credits      |             |
|                                    | Lecture                                                                                                                                                                                                                                                                                                                                                                                                           | Recit. | HW | Lab. | Project                         | Other | Total      | Local Credit | ECTS Credit |
| 1                                  | 42                                                                                                                                                                                                                                                                                                                                                                                                                | -      | -  | -    | 46                              | 100   | 188        | 3            | 7.5         |
| <b>Language</b>                    | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                   |        |    |      |                                 |       |            |              |             |
| <b>Compulsory / Elective</b>       | Elective                                                                                                                                                                                                                                                                                                                                                                                                          |        |    |      |                                 |       |            |              |             |
| <b>Prerequisites</b>               | None. (Transport phenomena is recommended.)                                                                                                                                                                                                                                                                                                                                                                       |        |    |      |                                 |       |            |              |             |
| <b>Catalog Description</b>         | Viscous and inviscous flow. Solution of Navier-Stokes equations. Boundary layer. Fluid kinematics. Draft, dynamics of circulating fluids and tork. Stream separation. Rheology.                                                                                                                                                                                                                                   |        |    |      |                                 |       |            |              |             |
| <b>Course Objectives</b>           | To give the basic knowledge about the behaviour of the fluids, basic approaches (Lagrange and Euler perspectives) related with the basic problems of fluid mechanics, and to teach the combined analytical and experimental solutions and to show the relationships between the properties of fluids such as density, viscosity and the reflectence of these properties to the behaviour of the fluid properties. |        |    |      |                                 |       |            |              |             |
| <b>Course Outcomes</b>             | Basic concepts on the fluid flow. Ability to solve problems for flow systems in different flow regimes and for different fluid types.                                                                                                                                                                                                                                                                             |        |    |      |                                 |       |            |              |             |
| <b>Textbook and /or References</b> | 1. Shapiro, A.H., Sonin, A.A., Advenced Fluid Mechanics Problems, MIT Pres, 1994.<br>2. Biswas, G., Turbulent Flows :Fundamentals, Experiments and Modeling, Alpha Science, Pangbourne, 2002.<br>3. Panton, L. Ronald, Incompressible Flow, 3 <sup>rd</sup> ed., Wiley, 2005.<br>1. White, F.M., Viscous Fluid Flow, 2 <sup>nd</sup> ed., Mc Graw Hill, New York, 1991.<br>2. Periodicals.                        |        |    |      |                                 |       |            |              |             |
| <b>Assessment Criteria</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                   |        |    |      | Quantity                        |       | Percentage |              |             |
|                                    | <b>Midterm Exams</b>                                                                                                                                                                                                                                                                                                                                                                                              |        |    |      | x                               |       | 40         |              |             |
|                                    | <b>Quizzes</b>                                                                                                                                                                                                                                                                                                                                                                                                    |        |    |      | -                               |       | -          |              |             |
|                                    | <b>Homeworks</b>                                                                                                                                                                                                                                                                                                                                                                                                  |        |    |      | x                               |       |            |              |             |
|                                    | <b>Projects</b>                                                                                                                                                                                                                                                                                                                                                                                                   |        |    |      | -                               |       | -          |              |             |
|                                    | <b>Term Paper</b>                                                                                                                                                                                                                                                                                                                                                                                                 |        |    |      | x                               |       | 20         |              |             |
|                                    | <b>Laboratory Work</b>                                                                                                                                                                                                                                                                                                                                                                                            |        |    |      | -                               |       | -          |              |             |
|                                    | <b>Other</b>                                                                                                                                                                                                                                                                                                                                                                                                      |        |    |      | -                               |       | -          |              |             |
|                                    | <b>Final Exam</b>                                                                                                                                                                                                                                                                                                                                                                                                 |        |    |      | x                               |       | 40         |              |             |
| <b>Prepared by</b>                 | Assoc.Prof.Dr. İrfan AR                                                                                                                                                                                                                                                                                                                                                                                           |        |    |      |                                 |       |            |              |             |
| <b>Week</b>                        | <b>Subject</b>                                                                                                                                                                                                                                                                                                                                                                                                    |        |    |      |                                 |       |            |              |             |
| 1. Week                            | Introduction, basic concepts.                                                                                                                                                                                                                                                                                                                                                                                     |        |    |      |                                 |       |            |              |             |
| 2. Week                            | Basic problems related with fluid mechanics.                                                                                                                                                                                                                                                                                                                                                                      |        |    |      |                                 |       |            |              |             |
| 3. Week                            | Fluid flow regimes: viscous flow.                                                                                                                                                                                                                                                                                                                                                                                 |        |    |      |                                 |       |            |              |             |
| 4. Week                            | Fluid flow regimes: no-viscous flow                                                                                                                                                                                                                                                                                                                                                                               |        |    |      |                                 |       |            |              |             |
| 5. Week                            | Analytical and empirical approaches: Lagrange approach                                                                                                                                                                                                                                                                                                                                                            |        |    |      |                                 |       |            |              |             |
| 6. Week                            | Analitik ve empirik yaklaşımlar :Euler yaklaşımı                                                                                                                                                                                                                                                                                                                                                                  |        |    |      |                                 |       |            |              |             |
| 7. Week                            | I. Midterm                                                                                                                                                                                                                                                                                                                                                                                                        |        |    |      |                                 |       |            |              |             |
| 8. Week                            | Fluid properties; Rheology                                                                                                                                                                                                                                                                                                                                                                                        |        |    |      |                                 |       |            |              |             |
| 9. Week                            | Fluid kinetics and deformation.                                                                                                                                                                                                                                                                                                                                                                                   |        |    |      |                                 |       |            |              |             |
| 10. Week                           | Boundary layer                                                                                                                                                                                                                                                                                                                                                                                                    |        |    |      |                                 |       |            |              |             |
| 11. Week                           | Turbulent bursts                                                                                                                                                                                                                                                                                                                                                                                                  |        |    |      |                                 |       |            |              |             |
| 12. Week                           | Drag, dynamics of rotating objects and torque.                                                                                                                                                                                                                                                                                                                                                                    |        |    |      |                                 |       |            |              |             |
| 13. Week                           | II. Midterm                                                                                                                                                                                                                                                                                                                                                                                                       |        |    |      |                                 |       |            |              |             |
| 14. Week                           | Flow separation.                                                                                                                                                                                                                                                                                                                                                                                                  |        |    |      |                                 |       |            |              |             |

| KM 520 PETROCHEMICAL TECHNOLOGY          |                                                                                                                                                                                                                                                                                   |       |      |     | CHEMICAL ENGINEERING DEPARTMENT |       |       |                           |                     |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-----|---------------------------------|-------|-------|---------------------------|---------------------|
| Semester                                 | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                |       |      |     |                                 |       |       | Credits                   |                     |
|                                          | Lecture                                                                                                                                                                                                                                                                           | Recit | Lab. | Hw. | Term Paper/Project              | Other | Total | Credit                    | ECTS Credit         |
| 1-2                                      | 42                                                                                                                                                                                                                                                                                | -     | -    | 48  | -                               | 98    | 188   | 3                         | 7,5                 |
| <b>Language</b>                          | Turkish/English                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       |                           |                     |
| <b>Compulsory / Elective</b>             | Elective                                                                                                                                                                                                                                                                          |       |      |     |                                 |       |       |                           |                     |
| <b>Prerequisites</b>                     | None                                                                                                                                                                                                                                                                              |       |      |     |                                 |       |       |                           |                     |
| <b>Course Contents</b>                   | Raw Materials, side product and products in petrochemical industry. Production methods.                                                                                                                                                                                           |       |      |     |                                 |       |       |                           |                     |
| <b>Course Objectives</b>                 | To be informed about petrochemical technology.To study production techniques and state of industry.                                                                                                                                                                               |       |      |     |                                 |       |       |                           |                     |
| <b>Learning Outcomes and Competences</b> | To be informed about petrochemical manufacture and state of industry.                                                                                                                                                                                                             |       |      |     |                                 |       |       |                           |                     |
| <b>Textbook and /or References</b>       | 1. Austin, G. T. Shreve's Chemical Proces Industries, 5 <sup>th</sup> ed., McGraw-Hill, Newyork, 1984.<br>2. Kent, J. A., Riegels Handbook of Industrial Chemistry, 10 <sup>th</sup> ed., Kluwer/Plenum, 2003.<br>3. Petrokimya, DPT-ÖİK Raporu, Ankara, 2001.<br>4. Periodicals. |       |      |     |                                 |       |       |                           |                     |
| <b>Assessment Criteria</b>               |                                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       | <i>If any,mark as (X)</i> | <b>Percentage %</b> |
|                                          | <b>Midterm Exams</b>                                                                                                                                                                                                                                                              |       |      |     |                                 |       |       | X                         | 50                  |
|                                          | <b>Quizzes</b>                                                                                                                                                                                                                                                                    |       |      |     |                                 |       |       | -                         | -                   |
|                                          | <b>Homeworks</b>                                                                                                                                                                                                                                                                  |       |      |     |                                 |       |       | -                         | -                   |
|                                          | <b>Projects</b>                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       | -                         | -                   |
|                                          | <b>Term Paper</b>                                                                                                                                                                                                                                                                 |       |      |     |                                 |       |       | X                         | 10                  |
|                                          | <b>Laboratory Work</b>                                                                                                                                                                                                                                                            |       |      |     |                                 |       |       | -                         | -                   |
|                                          | <b>Other</b>                                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       | -                         | -                   |
|                                          | <b>Final Exam</b>                                                                                                                                                                                                                                                                 |       |      |     |                                 |       |       | X                         | 40                  |
| <b>Prepared by</b>                       | Prof. Dr. H. Vecihi PAMUK                                                                                                                                                                                                                                                         |       |      |     |                                 |       |       |                           |                     |
| <b>Week</b>                              | <b>Subject</b>                                                                                                                                                                                                                                                                    |       |      |     |                                 |       |       |                           |                     |
| 1                                        | Naphtha cracker                                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       |                           |                     |
| 2                                        | Vinyl chloride monomer (VCM)                                                                                                                                                                                                                                                      |       |      |     |                                 |       |       |                           |                     |
| 3                                        | Styrene                                                                                                                                                                                                                                                                           |       |      |     |                                 |       |       |                           |                     |
| 4                                        | Acrylonitrile                                                                                                                                                                                                                                                                     |       |      |     |                                 |       |       |                           |                     |
| 5                                        | Aromatics                                                                                                                                                                                                                                                                         |       |      |     |                                 |       |       |                           |                     |
| 6                                        | Phthalic anhydride                                                                                                                                                                                                                                                                |       |      |     |                                 |       |       |                           |                     |
| 7 - 8                                    | Carbon black, I. Midterm                                                                                                                                                                                                                                                          |       |      |     |                                 |       |       |                           |                     |
| 9                                        | Low density polyethylene (LDPE)                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       |                           |                     |
| 10                                       | High density polyethylene (HDPE)                                                                                                                                                                                                                                                  |       |      |     |                                 |       |       |                           |                     |
| 11                                       | Polyvinyl chloride (PVC)                                                                                                                                                                                                                                                          |       |      |     |                                 |       |       |                           |                     |
| 12-13                                    | Polypropylene (PP), II. Midterm                                                                                                                                                                                                                                                   |       |      |     |                                 |       |       |                           |                     |
| 14                                       | Polystyrene                                                                                                                                                                                                                                                                       |       |      |     |                                 |       |       |                           |                     |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM521                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     | CHEMICAL ENGINEERING DEPARTMENT |       |                     |              |             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|---------------------------------|-------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                                 |       |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Recit. | Lab. | HW. | Term Paper/Project              | Other | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | =      | =    | 35  | 50                              | 61    | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                                 |       |                     |              |             |
| Compulsory / Elective             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                                 |       |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                                 |       |                     |              |             |
| Course Contents                   | Equilibrium between phases. Various methods to calculate fugacity and activity coefficients. Experimental methods in phase equilibrium. Computer applications.                                                                                                                                                                                                                                                                                                                  |        |      |     |                                 |       |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>Study of phase equilibrium</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                                 |       |                     |              |             |
| Learning Outcomes and Competences | To provide the students with the necessary background so as to follow the phase equilibrium calculations for systems they will encounter in their M. S. and Ph. D. works.                                                                                                                                                                                                                                                                                                       |        |      |     |                                 |       |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>Orbey, H., Sandler, S.I., Modeling Vapour-Liquid Equilibria : Cubic Equations of State and Their Mixing Rules, Cambridge University Press, New York, 1998.</li><li>Walas, S.M., Phase Equilibria in Chemical Engineering, Butterworth Publishers, Stoneham, 1984.</li><li>Prausnitz, J.M., Lichtenthaler, R.N., de Azeredo, E.G., Molecular Thermodynamics of Fluid-Phase Equilibria, Prentice Hall, 1997.</li><li>Periodicals.</li></ol> |        |      |     |                                 |       |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                                 |       | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                                 |       |                     | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                                 |       |                     |              |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                                 |       |                     | 20           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                                 |       |                     | -            |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                                 |       |                     | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                                 |       |                     | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                                 |       |                     | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                                 |       |                     | 40           |             |
| Prepared by                       | Prof. Dr. Ufuk GÜNDÜZ ZAFER (2005/2006 1.Yarıyıl) , Doç. Dr. Ö. Murat DOĞAN , Dr. Alper TAPAN                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                                 |       |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                                 |       |                     |              |             |
| 1                                 | Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                                 |       |                     |              |             |
| 2                                 | Equations of state                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                                 |       |                     |              |             |
| 3                                 | Thermodynamic functions and Equilibrium                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                                 |       |                     |              |             |
| 4-6                               | Fugacity, fugacity and activity coefficients                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                                 |       |                     |              |             |
| 7                                 | Phase diagrams                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                                 |       |                     |              |             |
| 8                                 | Vapor-liquid Equilibrium                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                                 |       |                     |              |             |
| 9                                 | Liquid-liquid Equilibrium                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                                 |       |                     |              |             |
| 10-11                             | Liquid-solid Equilibrium                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                                 |       |                     |              |             |
| 12                                | Other Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                                 |       |                     |              |             |
| 13-14                             | Oral presentations by students                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                                 |       |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 522 FUEL TECHNOLOGY            |                                                                                                                                                                                                                                                                                                                     |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching Methods                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                             | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                  | -      | -    | 47  | 45                 | 54                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Formation of fuels, their compositions and properties. Coal carbonization. Products and properties of petroleum. Synthetic gas and liquid fuels. Natural gas. Transport, storage and combustion of fuels.                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>To investigate fuel preparation in industrial processes</li><li>To explain some applications in combustion processes.</li></ul>                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>To learn to investigate the fuel type</li><li>To learn some applications on fossil fuels.</li><li>To learn the used fuels in industry</li><li>To know the specifications of petroleum products</li><li>To learn basic knowledge of fuel transportation and storage.</li></ul> |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>Speight, J.G., Fuel Science and Technology Handbook, Marcel Dekker, 1990.</li><li>Borman, Gary L., Combustion Engineering, McGraw-Hill, Boston, 1998.</li><li>Periodicals.</li></ol>                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | X                   | 40           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | -                   | -            |             |
| Final Exam                        |                                                                                                                                                                                                                                                                                                                     |        |      |     |                    | X                               | 40                  |              |             |
| Instructors                       | Prof. Dr. Vecihi PAMUK, Assoc. Prof. Dr. Ö. Murat DOĞAN                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 1-2                               | Formation of fossil fuels, their compositions, properties and types                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 3-4                               | Fossil fuel carbonisation                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 5-6                               | Fossil fuel gasification                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 7-8                               | Fossil fuel liquifuction                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 9                                 | Formation of liquid fuels, their compositions and properties                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| 10                                | Petroleum products and theis specifications                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 11                                | Formation of gaseous fuels, their compositions and properties                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 12-13                             | Fuels transportaion and storage                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 14                                | Oral presentation                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 524 AIR POLLUTION and CONTROL                 |                                                                                                                                                                                                                                                                                                                          |        |              |            | CHEMICAL ENGINEERING DEPARTMENT |       |                            |                    |             |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------|------------|---------------------------------|-------|----------------------------|--------------------|-------------|
| Semester                                         | Teaching Methods                                                                                                                                                                                                                                                                                                         |        |              |            |                                 |       |                            | Credits            |             |
|                                                  | Lecture                                                                                                                                                                                                                                                                                                                  | Recite | Library Work | Term Paper |                                 | Other | Total                      | Credit             | ECTS Credit |
| 1-2                                              | 42                                                                                                                                                                                                                                                                                                                       |        | 80           | 50         |                                 | 16    | 188                        | 3                  | 7.5         |
| <b>Language</b>                                  | Turkish                                                                                                                                                                                                                                                                                                                  |        |              |            |                                 |       |                            |                    |             |
| <b>Compulsory / Elective</b>                     | Elective                                                                                                                                                                                                                                                                                                                 |        |              |            |                                 |       |                            |                    |             |
| <b>Prerequisites</b>                             | None                                                                                                                                                                                                                                                                                                                     |        |              |            |                                 |       |                            |                    |             |
| <b>Course Contents</b>                           | Air pollutants, their sources, formation, their effects on the human and environment, distribution models in atmosphere. Air pollution control technology and its design. Standards and regulations. Project studies.                                                                                                    |        |              |            |                                 |       |                            |                    |             |
| <b>Course Objectives</b>                         | To give the students the knowledge of pollutants formed on pollutants arises from natural and man made activities and their formation. Measurement, control and prevention of these pollutants.                                                                                                                          |        |              |            |                                 |       |                            |                    |             |
| <b>Learning Outcomes and Competences</b>         | Formation of air pollution, measurement, and precautions which must be taken for the prevention of air pollution, air pollution and related technologies and to gain the basic environmental consciousness to the students are the important outcomes of the course.                                                     |        |              |            |                                 |       |                            |                    |             |
| <b>Textbook and /or References</b>               | 1. Wayne, T.D.(editor), Air Pollution; Engineering Manual, Amazon Book Co., 2004.<br>2. Colls, J., Air Pollution :An Introduction, E & FN Spon., London, 1997.<br>Godish, T., Air Quality, Lewis Publishers, Boca Raton, 2004.<br>Rao, Gandikota V., Air Quality, Birkhauser Verlag Basel, Boston, 2003.<br>Periodicals. |        |              |            |                                 |       |                            |                    |             |
| <b>Assessment Criteria</b>                       |                                                                                                                                                                                                                                                                                                                          |        |              |            |                                 |       | <i>If any, mark as (X)</i> | <b>Percent (%)</b> |             |
|                                                  | <b>Midterm Exams</b>                                                                                                                                                                                                                                                                                                     |        |              |            |                                 |       | X                          |                    |             |
|                                                  | <b>Quizzes</b>                                                                                                                                                                                                                                                                                                           |        |              |            |                                 |       |                            |                    |             |
|                                                  | <b>Homeworks</b>                                                                                                                                                                                                                                                                                                         |        |              |            |                                 |       |                            |                    |             |
|                                                  | <b>Projects</b>                                                                                                                                                                                                                                                                                                          |        |              |            |                                 |       |                            |                    |             |
|                                                  | <b>Term Paper</b>                                                                                                                                                                                                                                                                                                        |        |              |            |                                 |       | X                          |                    |             |
|                                                  | <b>Laboratory Work</b>                                                                                                                                                                                                                                                                                                   |        |              |            |                                 |       |                            |                    |             |
|                                                  | <b>Other</b>                                                                                                                                                                                                                                                                                                             |        |              |            |                                 |       |                            |                    |             |
|                                                  | <b>Final Exam</b>                                                                                                                                                                                                                                                                                                        |        |              |            |                                 |       | X                          |                    |             |
| <b>Instructors</b>                               | Doç.Dr. Çiğdem Güldür                                                                                                                                                                                                                                                                                                    |        |              |            |                                 |       |                            |                    |             |
| <b>Week</b>                                      | <b>Subject</b>                                                                                                                                                                                                                                                                                                           |        |              |            |                                 |       |                            |                    |             |
| 1<br>2<br>3-4<br>5<br>6-7<br>8-10<br>11-13<br>14 | <b>Giriş</b><br>Exponential Expansion and Ecology<br>Limitations of Air Pollution<br>Types of Pollutants<br>Atmospheric Chemicals, Transportation and Reactions<br>Pollutions and Control in Combustion systems<br>Methods of removal of the gas and steam<br>Particulates and Removal of the particulates               |        |              |            |                                 |       |                            |                    |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 526 ADVANCED PROCESS CONTROL   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Recit. | Lab. | HW. | Term Paper/Project | Other (personel study)          | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | -      | -    | 50  | 50                 | 46                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Analysis and design of advanced control systems. Cascade control systems, Feed-forward control, ratio control and Internal Model Control (IMC). Design of multivariable control systems, discrete-time systems, Z-transforms. Computer aided process control.                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>Ability to analysis and design of automatic control systems of chemical processes.</li></ul>                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Learning how to analyse and design the automatic control systems in chemical processes</li></ul>                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>Seborg, D.E, Edgar, T.F., Mellichamp, D.A., Process Dynamics and Control, Wiley, 2<sup>nd</sup> ed., 2004.</li><li>Shahian, B., Hasul, M., Control System Design Using Matlab, Prentice Hall, 1993.</li><li>Coughanowr, D.R., Process Systems Analysis and Control, McGraw Hill, 2<sup>nd</sup> ed., 1991.</li><li>Bequette, B.W., Process Control: Modeling, Design and Simulation, Prentice Hall, 2003.</li><li>Periodicals.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 30           |             |
| Prepared by                       | Prof.Dr. Sebahat ERDOĞAN, Prof.Dr. Müjgan ÇULFAZ, Asst.Prof.Dr. Ayla ALTINTEN                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| 1-3                               | Analysis of advanced control systems                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 4-5                               | Cascade and Feed-Forward Control                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 6-8                               | Internal Model Control (IMC)                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 9-11                              | Design of multivariable systems                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 12-14                             | Computer Aided Process Control                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 528 QUALITY CONTROL IN CHEMICAL INDUSTRY |                                                                                                                                                                                                                                                    |        |      |     | CHEMICAL ENGINEERING DEPARTMENT |       |              |         |             |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|---------------------------------|-------|--------------|---------|-------------|
| Semester                                    | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                 |        |      |     |                                 |       |              | Credits |             |
|                                             | Lecture                                                                                                                                                                                                                                            | Recit. | Lab. | Hw. | Term Paper/Project              | Other | Total        | Credit  | ECTS Credit |
| 1-2                                         | 42                                                                                                                                                                                                                                                 | -      | -    | 15  | 50                              | 81    | 188          | 3       | 7.5         |
| Language                                    | Turkish/English                                                                                                                                                                                                                                    |        |      |     |                                 |       |              |         |             |
| Compulsory / Elective                       | Elective                                                                                                                                                                                                                                           |        |      |     |                                 |       |              |         |             |
| Prerequisites                               | None                                                                                                                                                                                                                                               |        |      |     |                                 |       |              |         |             |
| Course Contents                             | Basic concepts.Types of quality control, statistical techniques, sampling and tolerances. Cost and accuracy. Organization. Standards and regulations.                                                                                              |        |      |     |                                 |       |              |         |             |
| Course Objectives                           | Importance of quality in production, teaching of quality control applications.                                                                                                                                                                     |        |      |     |                                 |       |              |         |             |
| Learning Outcomes and Competences           | Quality control techniques, and learning rules related to the subject.                                                                                                                                                                             |        |      |     |                                 |       |              |         |             |
| Textbook and /or References                 | 1. Logothesis, N., Managing For Total Quality, From Deming to Taguchi and SPC, Prentice-Hall, New York, 1992.<br>2. Noori, Hamid and Russell Radford, Production and Operations Management, McGraw- Hill, Inc., New York, 1995.<br>3. Periodicals. |        |      |     |                                 |       |              |         |             |
| Assessment Criteria                         |                                                                                                                                                                                                                                                    |        |      |     | If any,mark as (X)              |       | Percentage % |         |             |
|                                             | Midterm Exams                                                                                                                                                                                                                                      |        |      |     | X                               |       | 25           |         |             |
|                                             | Quizzes                                                                                                                                                                                                                                            |        |      |     | -                               |       | -            |         |             |
|                                             | Homeworks                                                                                                                                                                                                                                          |        |      |     | X                               |       | 10           |         |             |
|                                             | Projects (Oral Presentation)                                                                                                                                                                                                                       |        |      |     | X                               |       | 25           |         |             |
|                                             | Term Paper (Project Report)                                                                                                                                                                                                                        |        |      |     | -                               |       | -            |         |             |
|                                             | Laboratory Work                                                                                                                                                                                                                                    |        |      |     | -                               |       | -            |         |             |
|                                             | Other                                                                                                                                                                                                                                              |        |      |     | X                               |       | -            |         |             |
|                                             | Final Exam *                                                                                                                                                                                                                                       |        |      |     | X                               |       | 40           |         |             |
| Prepared by                                 | Assoc.Prof. Dr. Ayşe MURATHAN, Assoc. Prof. Dr. Atilla MURATHAN                                                                                                                                                                                    |        |      |     |                                 |       |              |         |             |
| Week                                        | Subject                                                                                                                                                                                                                                            |        |      |     |                                 |       |              |         |             |
| 1-4                                         | Basic concepts.Types of quality control,statistical techniques of sampling and tolerances                                                                                                                                                          |        |      |     |                                 |       |              |         |             |
| 5-8                                         | Cost and accuracy                                                                                                                                                                                                                                  |        |      |     |                                 |       |              |         |             |
| 9                                           | Organization.                                                                                                                                                                                                                                      |        |      |     |                                 |       |              |         |             |
| 10-12                                       | Standards and regulations                                                                                                                                                                                                                          |        |      |     |                                 |       |              |         |             |
| 12-14                                       | Presentation                                                                                                                                                                                                                                       |        |      |     |                                 |       |              |         |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 529 COMBUSTION                 |                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching Methods                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                             | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                  | -      | -    | -   | -                  | 42                              | 3                   | 7,5          | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Properties of fuels and selection. Principles of combustion and its thermochemical kinetics. Flame progression and stability. Homogenous and heterogenous combustion. Designs of brulars, furnaces and other combustion systems. Stack design.                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>To investigate combustion phenomena in industrial processes</li> <li>To explain combustion applications.</li> </ul>                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>To learn combustion phenomena in industrial processes and combustion applications.</li> <li>To know combustion and thermochemical principles.</li> <li>To learn the used fuels in industry.</li> <li>To know the basic principles of homogenous and heterogenous combustion.</li> <li>To desing the combustion systems and stack.</li> </ul> |        |      |     |                    |                                 |                     |              |             |
| Textbook and/or References        | 1. Borman, G. L., Ragland, K. W., Combustion Engineering, McGraw-Hill, 1998.<br>2. Conforth J.R. Combustion Engineering and Gas Utilisation, E and FN Spon, London, 1992.<br>3. Smoot, L.D., Smith, P.J., Coal Combustion and Gasification, Plenum Press, 1985.<br>4. Periodicals.                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzs                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 | X                   | 5            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | X                   | 5            |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 40           |             |
| Instructors                       | Assoc. Prof. Dr. Ö. Murat Doğan                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 1-2                               | Properties of fuels and selectivity                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 3-4                               | Principles of combustion and its thermochemical kinetics                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 5-6                               | Flame progression and stability                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 7-9                               | Homogenous and heterogenous combustion                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 10-11                             | Designs of brulars, furnaces and other combustion systems                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 12-14                             | Stack design                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |

|                                                                   |                                                                                                                                                                                                                                                                                                                                                                |        |      |          |                                             |       |       |                    |             |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|----------|---------------------------------------------|-------|-------|--------------------|-------------|
| Course Title-Course Code:Energy and Energy Technology KM 531      |                                                                                                                                                                                                                                                                                                                                                                |        |      |          | Name of the Programme: Chemical Engineering |       |       |                    |             |
| Semester                                                          | Teaching Methods(Student Workload/Hour)                                                                                                                                                                                                                                                                                                                        |        |      |          |                                             |       |       | Credits            |             |
|                                                                   | Lecture                                                                                                                                                                                                                                                                                                                                                        | Recite | Lab. | Homework | Term paper/Project                          | Other | Total | Local Credit       | ECTS Credit |
| 1-2                                                               | 42                                                                                                                                                                                                                                                                                                                                                             | -      | -    | -        | 40                                          | 106   | 188   | 3                  | 7.5         |
| Language                                                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                |        |      |          |                                             |       |       |                    |             |
| Compulsory / Elective                                             | Elective                                                                                                                                                                                                                                                                                                                                                       |        |      |          |                                             |       |       |                    |             |
| Prerequisites                                                     | None                                                                                                                                                                                                                                                                                                                                                           |        |      |          |                                             |       |       |                    |             |
| Course Contents                                                   | Energy and energy types. Energy technology based on fossil fuels, environmental effects of energy cycle, biological carbon equilibrium. Nuclear energy. New and renewable energy sources. Thermodynamic and economical analyses of energy conservation systems.                                                                                                |        |      |          |                                             |       |       |                    |             |
| Course Objectives                                                 | Introducing industrial processes and analysis of the applications of material and energy balances in these systems.                                                                                                                                                                                                                                            |        |      |          |                                             |       |       |                    |             |
| Learning Outcomes and Competences                                 | Studying new and renewable energy sources and learning thermal and thermodynamical analysis of processes.                                                                                                                                                                                                                                                      |        |      |          |                                             |       |       |                    |             |
| Textbook and /or References                                       | 1. El-Nakil, M.M., Powerplant Technology, 1 <sup>st</sup> ed., Mc Graw Hill, 2002.<br>2. Petrecca, G., Industrial Energy Management: Principles and Applications, Kluwer Academic Pub., 1993.<br>Periodicals                                                                                                                                                   |        |      |          |                                             |       |       |                    |             |
| Assessment Criteria                                               |                                                                                                                                                                                                                                                                                                                                                                |        |      |          |                                             |       |       | If any,mark as (X) | Percent (%) |
|                                                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                  |        |      |          |                                             |       |       | x                  | 50          |
|                                                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                        |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                      |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Projects                                                                                                                                                                                                                                                                                                                                                       |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                     |        |      |          |                                             |       |       | x                  | 10          |
|                                                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Other                                                                                                                                                                                                                                                                                                                                                          |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Committee Exam                                                                                                                                                                                                                                                                                                                                                 |        |      |          |                                             |       |       | -                  | -           |
|                                                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                     |        |      |          |                                             |       |       | x                  | 40          |
| Instructors                                                       | Prof.Dr. Metin GÜRÜ, Assoc.Prof.Dr. Ö. Murat DOĞAN                                                                                                                                                                                                                                                                                                             |        |      |          |                                             |       |       |                    |             |
| Week                                                              | Subject                                                                                                                                                                                                                                                                                                                                                        |        |      |          |                                             |       |       |                    |             |
| 1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>9-10<br>11-12<br>13<br>14 | Energy<br>Energy types<br>Energy technology based on fossil fuels,<br>Environmental effects of energy cycle,<br>Biological carbon equilibrium. Nuclear energy.<br>Midterm-I<br>New energy sources.<br>Renewable energy sources.<br>Thermodynamic analysis of energy conversation systems.<br>Economical analysis of energy conversation systems.<br>Midterm-II |        |      |          |                                             |       |       |                    |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 533 ADVANCED MEMBRANE TECHNOLOGY |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                            | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     | Credits      |             |
|                                     | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                 | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -      | -    | 30  | 28                 | 88                              | 188                 | 3            | 7.5         |
| Language                            | Turkish/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective               | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                       | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Course Contents                     | Basic concepts, types of membranes, membrane synthesis (methods and related theories) and charecterization, theories for transportation through the porous, nonporous and ionic membranes, Donnan equilibrium, expanded Nernst-Plank equation, application areas of the membranes.                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                   | <ul style="list-style-type: none"><li>To give the students the ability of the understanding and to solve the problems related with membranes by means of</li><li>to gain the knowledge on the membrane separation mechanisms,transport models, permeability calculations in membranes, types and modulus of membranes, membrane reactors etc.</li></ul>                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences   | <ul style="list-style-type: none"><li>To learn the basic concepts related with membranes, basic priciplesof the membrane used systems and</li><li>To gain the ability to understand anl solve the problems related with these systems,</li><li>To learn to make the literature survey and examination of a scientific manuscript on a specific subject via the homeworks related with the applications of membranes.</li></ul>                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References         | 6. Mulder, M., "Basic Principles of Mmembrane Technology", Kluwer Academic Publisher, (1996).<br>7. Konttturi, K., Murtomaki, L., "Transport Processes at Electrodes and in Membranes", Helsinki University of Technology Edition, (2003).<br>8. Ho, L., Sirkar, W. (Editors), "Membrane Handbook", Chapman Hall Book Co., (1992).<br>9. Noble, R.D., Stern, S.A., "Membrane Seperation Technology: Principles and Applications", Elsevier 1995. Noble, R.D., Stern, S.A., "Membrane Seperation Technology: Principles and Applications", Elsevier 1995. |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                     | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | X                   | 30           |             |
|                                     | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                     | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 10           |             |
|                                     | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | -                   | -            |             |
|                                     | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | X                   | 10           |             |
|                                     | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
|                                     | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
| Final Exam                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    | X                               | 50                  |              |             |
| Prepared by                         | Assoc. Prof. Dr. İrfan Ar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Week                                | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 1. Week                             | Introduction: Definitions and membrane applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 2. Week                             | Membrane Materials                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 3. Week                             | Membrane Synthesis : Thermodynamic theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 4. Week                             | Membrane Syntesis : Solubility parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 5. Week                             | Memebrane Synthesis: Method and related theories                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 6. Week                             | Membrane Charekterization: Pore size and structure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 7. Week                             | Membrane Charekterization: Surface charge distribution and appearance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| 8. Week                             | Transport Theories for Non-porous Membranes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 9. Week                             | Transport Theories for Porous Membranes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 10. Week                            | Transport Theories for Ion Exchange Membranes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 11. Week                            | Transport in Membranes: Donnan equilibrium                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 12. Week                            | Transport in Membranes: Extended Nernst-Plank Equation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 13. Week                            | Application: Separation of natural organic materials by using Membrane                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 14. Week                            | Application: Removal of ions by using membrane                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |

| KM 535 POLYMER BASED COMPOSITES   |                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                            | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                 | -      | -    |     |                    |                                 | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | -                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Properties of high performance polymers. Polymerization mechanisms. Classification of polymer composites. Matrix-reinforced interface mechanism. Thermal and mechanical behaviors of polymer composite materials. The production methods of polymer composite materials.                                                           |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>Teaching how to prepare polymer and composite materials and their uses in engineering application.</li></ul>                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Fundamental knowledge necessary to understand important concepts in polymer and polymer composite materials.</li><li>Concepts related to engineering design and manufacturing of polymer composites</li></ul>                                                                                |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>Dostal, C.A., Engineered Materials Handbook: Composites, Vol 1, ASM Intl, 1987.</li><li>Talreja, R., Manson, A.E., Polymer matrix composites, Pergamon, 2001.</li><li>Fried, J., Polymer Science and Technology, Prentice Hall, 2<sup>nd</sup> ed., 2003.</li><li>Süreli yayınlar.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof. Dr. Nursel Dilsiz                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 1                                 | Properties of high performance polymers                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 2-3                               | Polymerization mechanisms                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| 4-5                               | Classification of polymer composites                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 6-7                               | Matrix-reinforced interface mechanism . Midterm Exam I                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 8-9                               | The thermal behaviors of polymer composite materials                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 10-11                             | The mechanical behaviors of polymer composite materials                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 11-12                             | The production methods of polymer composite materials                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 13                                | Thermoset polymer composites                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 14                                | Thermoplastic composites. Midterm Exam II                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 536 FLUIDIZATION AND FLUIDIZED BED TECHNOLOGY |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       | CHEMICAL ENGINEERING DEPARTMENT |                            |                     |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-----|--------------------|-------|---------------------------------|----------------------------|---------------------|
| Semester                                         | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                             |       |      |     |                    |       |                                 | Credits                    |                     |
|                                                  | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Recit | Lab. | Hw. | Term Paper/Project | Other | Total                           | Credit                     | ECTS Credit         |
| 1-2                                              | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | -     | -    | 20  | 40                 | 86    | 188                             | 3                          | 7.5                 |
| <b>Language</b>                                  | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 |                            |                     |
| <b>Compulsory / Elective</b>                     | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |      |     |                    |       |                                 |                            |                     |
| <b>Prerequisites</b>                             | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |      |     |                    |       |                                 |                            |                     |
| <b>Course Contents</b>                           | Basic principles of gas and liquid fluidization, regimes and characterization. Mixing and transport of solid particles. Bubbling and circulating fluidized beds. Spouted beds. Three-phase fluidized beds. Heat and mass transfer, chemical reactions in fluidized beds. Industrial applications. Modelling techniques.                                                                                                                                                        |       |      |     |                    |       |                                 |                            |                     |
| <b>Course Objectives</b>                         | To teach basic principles of fluidization. To examine solid particle motion in fluidized beds. To explain some applications in different industrial-scale fluidized beds. To learn how to design a fluidized bed.                                                                                                                                                                                                                                                              |       |      |     |                    |       |                                 |                            |                     |
| <b>Learning Outcomes and Competences</b>         | The knowledge of the principles of fluidized beds and industrial applications will be gained.                                                                                                                                                                                                                                                                                                                                                                                  |       |      |     |                    |       |                                 |                            |                     |
| <b>Text Book and/or References</b>               | <ol style="list-style-type: none"> <li>Kunii, D. and Levenspiel, O., Fluidization Engineering, 2<sup>nd</sup> ed., Butterworth-Heinemann, 1991.</li> <li>Geldart, D., Gas Fluidization Technology, Wiley, 1986.</li> <li>Grace, J.R., Avidan, A.A. and Knowlton, T.M., Circulating Fluidized Beds, 1<sup>st</sup> ed., Blackie Academic &amp; Professional, 1997.</li> <li>Mathur, K.B. and Epstein, N., "Spouted Beds", Academic Pres, 1974.</li> <li>Periodicals.</li> </ol> |       |      |     |                    |       |                                 |                            |                     |
| <b>Assessment Criteria</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 | <i>If any, mark as (X)</i> | <b>Percentage %</b> |
|                                                  | <b>Midterm Exams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |      |     |                    |       |                                 | X                          | 30                  |
|                                                  | <b>Quizzes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     |                    |       |                                 | X                          | 5                   |
|                                                  | <b>Homeworks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |      |     |                    |       |                                 | X                          | 5                   |
|                                                  | <b>Projects</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 | -                          | -                   |
|                                                  | <b>Term Paper</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |     |                    |       |                                 | X                          | 20                  |
|                                                  | <b>Laboratory Work</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |      |     |                    |       |                                 | -                          | -                   |
|                                                  | <b>Other</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |      |     |                    |       |                                 | -                          | -                   |
|                                                  | <b>Final Exam</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |     |                    |       |                                 | X                          | 40                  |
| <b>Prepared by</b>                               | Prof. Dr. B. Zühtü UYSAL, Assoc. Prof. Dr. Ö. Murat DOĞAN                                                                                                                                                                                                                                                                                                                                                                                                                      |       |      |     |                    |       |                                 |                            |                     |
| <b>Week</b>                                      | <b>Subjects</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 |                            |                     |
| 1                                                | Introduction and basics of fluidization                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                    |       |                                 |                            |                     |
| 2                                                | General behaviour of fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |      |     |                    |       |                                 |                            |                     |
| 3                                                | Bubble phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |      |     |                    |       |                                 |                            |                     |
| 4                                                | Emulsion phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |      |     |                    |       |                                 |                            |                     |
| 5                                                | Behaviours of gas and and solids in fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                             |       |      |     |                    |       |                                 |                            |                     |
| 6                                                | Slugging                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |      |     |                    |       |                                 |                            |                     |
| 7                                                | Heat transfer in fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 |                            |                     |
| 8                                                | Mass transfer in fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                    |       |                                 |                            |                     |
| 9                                                | Chemical reactions in fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |      |     |                    |       |                                 |                            |                     |
| 10                                               | Fast fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |      |     |                    |       |                                 |                            |                     |
| 11                                               | Circulating fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |      |     |                    |       |                                 |                            |                     |
| 12                                               | Spouted beds                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |      |     |                    |       |                                 |                            |                     |
| 13                                               | Three phase fluidized beds                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |      |     |                    |       |                                 |                            |                     |
| 14                                               | Industrial applications                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |      |     |                    |       |                                 |                            |                     |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 537 PROCESS SIMULATION         |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                               | Recit. | Lab. | HW. | Term Paper/Project | Other (Computing or Laboratory) | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                    | =      | =    | 50  | 76                 | 20                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Basic principles of process analysis. Modelling and simulation in chemical engineering. Computer based application in classical chemical engineering problems. Classification of transport phenomena and population equivalence models.                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>• Application of chemical engineering principles.</li> <li>• Solving open-ended chemical engineering problems.</li> <li>• Designing of process and determination of equipment size.</li> <li>• Shortcut methods and their place in design calculations.</li> <li>• Economic analysis.</li> <li>• Environmental and safety factors.</li> <li>• Improvement in written and oral communication skills.</li> </ul> |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>• Criticizes design.</li> <li>• Uses technical and non-technical issues in problem solving effectively.</li> <li>• Communicates effectively.</li> <li>• Uses Chemcad, Excell, Matcad, Matlab softwares.</li> </ul>                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Textbook and/or References        | 1. Peters, M.S., Timmerhaus, K.D., West, R.E., Plant Design and Economics for Chemical Engineers, McGraw-Hill, 5 <sup>th</sup> ed., 2002.<br>2. Turton, R., Bailie, R.C., Whiting, W.B., Shaeiwitz, J.A., Analysis, Synthesis, and Design of Chemical Processes, Prentice-Hall, 2 <sup>nd</sup> ed., 2003.<br>3. Periodicals.                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Dr. N.Alper TAPAN                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 1-3                               | Basic principles of process analysis.                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 4-8                               | Modelling and simulation in chemical engineering. Computer based application in classical chemical engineering problems.                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 9-12                              | Classification of transport phenomena.                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| 13-14                             | Population equivalence models.                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |

| KM 538 Advanced Heat Transfer     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -      | -    | 35  | 50                 | 61                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None (Transport phenomena is recommended).                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Multi dimensional conduction. Natural and forced convection. Boiling and condensation. Thermal radiation. Thermal boundary layer analysis.                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>To give the basic principles of heat transfer mechanisms.</li><li>To study the problems related with the systems in which different heat transfer mechanisms take place.</li><li>To show the relationships between the heat transfer and the other transfer mechanisms.</li></ul>                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Basic concepts of the heat transfer.</li><li>Ability of solving problems involving different heat transfer mechanisms.</li></ul>                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ul style="list-style-type: none"><li>Bejan, A., Heat Transfer Handbook, Wiley, 2003.</li><li>John H. Lienhard IV, John H. Lienhard V, A Heat Transfer Textbook, 3<sup>rd</sup> ed., 2005.</li><li>Kakaç, S.,Yener, Y., Heat Conduction, 3<sup>rd</sup> ed., Taylor and Francis, 1993.</li><li>Özışık, M.N., Boundary Value Problems of Heat Conduction, Int. Textbook Co.,1968.</li><li>Bird, R.B., Stewart, W.E., Lightfoot, E.N., Transport Phenomena, Wiley, 2002.</li><li>Periodicals.</li></ul> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof. Dr. Ufuk GÜNDÜZ ZAFER, Assoc. Prof. Dr. İrfan AR,<br>Asst. Prof. Dr. Göksel ÖZKAN (2005/2006 S.S.; 2006/2007 S.S.), Dr. Alper TAPAN                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 1                                 | Introduction to conduction, convection, radiation and review of the basic relations. Initial and boundary conditions                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 2-4                               | Conduction. One-dimensional, two-dimensional and three-dimensional conduction equations with steady state and unsteady state conditions                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 5-6                               | Analytical solution methods of steady state and transient heat conduction problems                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| 7-9                               | Heat transfer with convection, forced convection and free convection                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 10-11                             | Thermal radiation, condensation and boiling                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 12-13                             | Boundary layer equations                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 14                                | Finite- difference methods for solving heat conduction problems                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 539 ADVANCED MASS TRANSFER     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -      | -    | 40  | 60                 | 46                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None (Transport Phenomena is recommended)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Mechanism and theory of mass transfer. Basic Principles and mechanism of multicomponent systems. Mass transfer and simultaneous chemical reactions                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>To give basic principles of the mass transfer and mechanisms in multicomponent mass transfer</li><li>To study mass transfer and simultaneous chemical reaction in multicomponent systems</li></ul>                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Learning Fundamentals of multicomponent mass transfer and simultaneous mass chemical reaction</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>Bird, R.B., Steward, E.W., Lightfoot E.N., Transport Phenomena, Wiley, New York, 2002.</li><li>Slattery, J.C., Advanced Transport Phenomena, Cambridge Univ. Pr., New York, 1999.</li><li>Anthony, L.H., Robert, N.M., Mass Transfer: Fundamentals and Applications, Prentice-Hall, Englewood Clift, 1985.</li><li>Griskey, R.G., Transport Phenomena and Unit Operations: A Combined Approach, Wiley, New York, 2002.</li><li>Cussler, E.L., Arvind, V., Diffusion: Mass Transfer in Fluid Systems, Cambridge, 1989.</li><li>Periodicals</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     | 20           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof. Dr.Sebahat Erdoğan, Assoc.Prof.Dr.Ayşe Murathan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 1-4                               | Mechanism and theory of mass transfer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 5-9                               | Basic Principles and mechanism of multicomponent system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 10-13                             | Mass transfer and simultaneous chemical reactions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 542 Computer Aided Design      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -      | -    | 40  | 60                 | 46                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Basic principles and techniques used in computer aided design of chemical processes. Models of thermodynamic properties. Parameter estimation and regression. Modeling of unit operations and reactors. Development of flow sheets. Use of chemical engineering softwares. Case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | Computer aided chemical process design.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>• The use of modern and various computer programs in chemical process design.</li><li>• Development of chemical process flow sheets</li><li>• The use of models of thermodynamic properties of chemical components on computer.</li><li>• Computer aided design of equipments in chemical proseses</li><li>• Improvements in written and oral communication skills.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"><li>1. Peters M.S, Timmerhaus K.D., West, R.E., "Plant Design and Economics For Chemical Engineers", Fifth ed., McGraw-Hill, New York, (2003).</li><li>2. Turton, R., Bailie, R.C., Whiting, W.B., Shaeiwitz, J.A., "Analysis Synthesis and Design of Chemical Processes", Prentice Hall, New Jersey, (2003).</li><li>3. J.M. Coulson, J.F. Richardson and R.K. Sinnott, Chemical Engineering Volume &amp; Design, Pergamon Press, Oxford, (1999).</li><li>4. Wiley-VCH (Editör), "Ullmann's Chemical Engineering and Plant Design", Wiley, (2004).</li><li>5. Alexandre, C.,D., "Integrated Design and Simulation of Chemical Processes: Computer Aided Chemical Engineering", Elsevier Sci&amp;Tech.Books., (2003).</li><li>6. Michael B. Cutlip, Mordechai Shacham, "Problem Solving In Chemical Engineering with Numerical Methods", Prentice Hall PTR Intn Series, Upper Saddle River, NJ,1999.</li><li>7. Periodicals.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | X                   | 20           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Prof. Dr. Bekir Zühtü Uysal (2005/2006 2nd Semester), Assoc.Prof.Dr. Nail YAŞYERLİ, Asst.Prof.Dr. Ayla ALTINTEN, Asst.Prof.Dr. Sena YAŞYERLİ                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 1                                 | Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 2                                 | Parameter Estimation and Regression                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 3-4                               | Modeling of Thermodynamic Properties                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 5                                 | ChemCAD Simulation Program Basics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| 6-13                              | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 14                                | Presentations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 545 BIOCHEMICAL PROCESSES ENGINEERING |                                                                                                                                                                                                                                                                                                                                                                                     |       |      |     | CHEMICAL ENGINEERING DEPARTMENT |       |              |         |             |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-----|---------------------------------|-------|--------------|---------|-------------|
| Semester                                 | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                  |       |      |     |                                 |       |              | Credits |             |
|                                          | Lecture                                                                                                                                                                                                                                                                                                                                                                             | Recit | Lab. | Hw. | Term Paper/Project              | Other | Total        | Credit  | ECTS Credit |
| 1-2                                      | 42                                                                                                                                                                                                                                                                                                                                                                                  | -     | -    | 15  | 50                              | 81    | 188          | 3       | 7.5         |
| Language                                 | Turkish/English                                                                                                                                                                                                                                                                                                                                                                     |       |      |     |                                 |       |              |         |             |
| Compulsory / Elective                    | Elective                                                                                                                                                                                                                                                                                                                                                                            |       |      |     |                                 |       |              |         |             |
| Prerequisites                            | None                                                                                                                                                                                                                                                                                                                                                                                |       |      |     |                                 |       |              |         |             |
| Course Contents                          | Structure of microbiological systems , transfer processes and reaction kinetics. Fermentation, waste treatment and applications to other biochemical processes.                                                                                                                                                                                                                     |       |      |     |                                 |       |              |         |             |
| Course Objectives                        | Teaching fundamental information about biochemicals and understanding cellular metabolism. Applying chemical engineering analysis to the design and operation of industrial bioreactors and bioseparation processes.                                                                                                                                                                |       |      |     |                                 |       |              |         |             |
| Learning Outcomes and Competences        | Familiarity with basic microbiology and biochemistry concept. Setting up and solving enzyme and cell kinetic expressions. Setting up fermentor design expressions. Discussing available downstream processing for recovery and /or purification of a product produced via a biochemical reaction. Making a clear oral presentation on a biochemical engineering related topic.<br>• |       |      |     |                                 |       |              |         |             |
| Textbook and /or References              | 1. Shuler, M.L., Kargı, F., Bioprocess Engineering : Basic Concepts , Prentice Hall, NJ, 2002.<br>2. Bailey , J.E., Ollis, D.F., Biochemical Engineering Fundamentals , 2 <sup>nd</sup> ed. McGraw Hill, 1986.<br>3. Türker M., Biyoreaksiyon Mühendisliği, Su Vakfı Yayınları,Kocaeli, 2005.<br>4. Periodicals.                                                                    |       |      |     |                                 |       |              |         |             |
| Assessment Criteria                      |                                                                                                                                                                                                                                                                                                                                                                                     |       |      |     | If any, mark as (X)             |       | Percentage % |         |             |
|                                          | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                       |       |      |     | X                               |       | 30           |         |             |
|                                          | Quizzes                                                                                                                                                                                                                                                                                                                                                                             |       |      |     | -                               |       | -            |         |             |
|                                          | Homeworks                                                                                                                                                                                                                                                                                                                                                                           |       |      |     | X                               |       | 15           |         |             |
|                                          | Projects                                                                                                                                                                                                                                                                                                                                                                            |       |      |     | -                               |       | -            |         |             |
|                                          | Term Paper                                                                                                                                                                                                                                                                                                                                                                          |       |      |     | X                               |       | 15           |         |             |
|                                          | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                     |       |      |     | -                               |       | -            |         |             |
|                                          | Other                                                                                                                                                                                                                                                                                                                                                                               |       |      |     | -                               |       | -            |         |             |
|                                          | Final Exam                                                                                                                                                                                                                                                                                                                                                                          |       |      |     | X                               |       | 40           |         |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 550 PROCESS ANALYSIS           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | -      | -    | 50  | 76                 | 20                              | 188                 | 3            | 7.5         |
| Language                          | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Computer based application in chemical engineering education, and principles of computer based application. Process analysis. Chemical engineering application in technical softwares. Numerical methods and engineering programming. Database programming. Spread sheet analysis and application to chemical engineering design.                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>To synthesize and model a chemical process.</li><li>To provide experience with commercial process simulation software.</li><li>To get trained in written and oral technical communication.</li><li>To work in teams.</li><li>To integrate the knowledge of previous chemical engineering courses for the open ended chemical engineering problems.</li></ul>                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>Acquire chemical technical knowledge.</li><li>Criticize on the technical subjects in written language.</li><li>Improvements in written and oral communication skills.</li><li>Assemble a logical sequence of interconnected unit operations for an effective chemical process.</li><li>Using, understanding, and interpreting results from a commercial chemical process simulation software package.</li><li>Evaluate the advantages of chemical process.</li><li>Determining sizes, materials and costs of equipments commonly used in the chemical processing industries.</li></ul> |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | 1. Douglas, James M., Conceptual Design of Chemical Processes, New York, McGraw-Hill, 1988.<br>2. Peters, Max S. and Timmerhaus, Klaus D., Plant Design and Economics for Chemical Engineers, 4 <sup>th</sup> ed., New York, McGraw-Hill, 1991.<br>3. Periodicals.                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 30           |             |
|                                   | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 1-2                               | Principles of computer based application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| 3-6                               | Process analysis. Chemical engineering application in technical softwares.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 7-10                              | Numerical methods and engineering programming.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 11-14                             | Database programming. Spread sheet analysis and application to chemical engineering design.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constatin (%60), the percentages among them may change.

| KM 556 ADVANCED MATERIALS TECHNOLOGY |                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                             | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     | Credits      |             |
|                                      | Lecture                                                                                                                                                                                                                                                                                                                                                                                     | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                  | 42                                                                                                                                                                                                                                                                                                                                                                                          | -      | -    | -   | 96                 | 50                              | 188                 | 3            | 7.5         |
| Language                             | Turkish/English                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                | Elective                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                        | None                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Course Contents                      | A general introduction to polymer, ceramic and metal materials, the production methods of particulate and fiber based metal and ceramic composite materials, surface preparation techniques, the production technologies of particulate and reinforced systems, and their applications to composite materials, the applications of bio, nano and smart materials.                           |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                    | <ul style="list-style-type: none"><li>Teaching technological advanced developments in the fields of materials, manufacturing and their applications</li></ul>                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences    | <ul style="list-style-type: none"><li>Fundamental knowledge necessary to understand important concepts in advanced materials.</li><li>Concepts related to engineering design and manufacturing.</li></ul>                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Textbook and/or References           | <ol style="list-style-type: none"><li>Dostal C.A., Composites (Engineered Materials Handbook, Vol 1), ASM Intl, 1987.</li><li>Schneider S. J., Ceramics and Glasses (Engineered Materials Handbook, Vol 4), ASM Intl, 1991.</li><li>High Performance Synthetic Fibers for Composites, Edited by National Research Council, National Academy Press, 1992.</li><li>Süreli yayınlar.</li></ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                  |                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                      | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | X                   | 30           |             |
|                                      | Quizzes                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | -                   | -            |             |
|                                      | Homeworks                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | X                   | 10           |             |
|                                      | Projects                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | X                   | 20           |             |
|                                      | Term Paper                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                      | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | -                   | -            |             |
|                                      | Other (.....)                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 | -                   | -            |             |
| Final Exam                           |                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    | X                               | 40                  |              |             |
| Prepared by                          | Prof. Dr. Nursel DİLSİZ                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| Week                                 | Subject                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 1                                    | A general introduction to polymer, ceramic and metal materials and their structural, mechanical and thermal properties                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 2-3                                  | The production technologies of particulate systems                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| 4-5                                  | The production technologies of reinforced systems                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 6-7                                  | Sol-gel technology. Midterm Exam I                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| 8                                    | The application of plasma and sol-gel Technologies as surface preparation techniques.                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 9-10                                 | Particulate based metal and ceramic composite materials                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 11-12                                | Fiber based metal and ceramic composite materials                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 13                                   | The applications of particulate and fiber reinforced systems to composite materials                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 14                                   | The applications of bio, nano and smart materials. Midterm Exam II                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |

\* The total contribution of midterm exams, homeworks, term paper and projects to the overall grade being constant (%60), the percentages among them may change.

| KM 570 ADVANCED SEPARATION OPERATIONS |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                              | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     | Credits      |             |
|                                       | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                   | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      | 30  | 50                 | 66                              | 188                 | 3            | 7.5         |
| Language                              | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                 | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                         | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Course Contents                       | Flow sheet development in separation processes. Separations in multicomponent systems. Adsorption, desorption, membrane separation, chemical separation, other separation techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                     | <ul style="list-style-type: none"> <li>Teaching of advanced separation techniques</li> <li>Teaching separation principles and design approach.</li> <li>Flow sheet development.</li> <li>Recent developments in separation techniques and following the application methods.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences     | <ul style="list-style-type: none"> <li>Gains the ability of separation processes and application to novel separation techniques</li> <li>Gains the ability of flowsheet development in separation processes and doing equipment design</li> <li>Improvements in written and oral communication skills.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References           | <ol style="list-style-type: none"> <li>Do, D.D., Adsorption Analysis: Equilibrium and Kinetics", Series on Chem. Eng., Vol. 2, Imperial College Press, Signapore, 1998.</li> <li>Froment, G.F., Bischoff, K.B., Chemical Reactor Analysis and Design, 2<sup>nd</sup> ed., Wiley, Newyork, 1992.</li> <li>Issac, H.J., Century of Separation Science, Marcel Deccer, Newyork, 2001.</li> <li>Levenspiel, O, Chemical Reaction Engineering, 3<sup>rd</sup> ed. Wiley, 1999.</li> <li>Mulder, M., Basic Principles of Membrane Technology, Kluwer, Newyork, 1996.</li> <li>Rouguerol, J., Rouguerol, F., Sing, K., "Adsorption by Powder Porous Solids", Academic Press, Newyork, 1999.</li> <li>Ruthven, D.M., Principles of Adsorption and Adsorption Processes, Wiley, Newyork, 1984.</li> <li>Yang, R.T., Adsorbents: Fundamentals and Applications, Wiley, 2003</li> <li>Periodicals.</li> </ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                       | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | X                   | 30           |             |
|                                       | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 | -                   | -            |             |
|                                       | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 10           |             |
|                                       | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | X                   | 20           |             |
|                                       | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | -                   | -            |             |
|                                       | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | -                   | -            |             |
|                                       | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 | -                   | -            |             |
|                                       | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| Week                                  | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 1                                     | Separation principles in multicomponent system and flow sheet development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| 2-8                                   | Mass transfer in porous media and separation processes application                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 8-11                                  | Membrane separation processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 12-14                                 | Mass transfer between phases and separation processes with chemical reactions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |

| KM 571 ADVANCED POROUS MATERIALS  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |           |              | CHEMICAL ENGINEERING DEPARTMENT |                            |                       |             |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----------|--------------|---------------------------------|----------------------------|-----------------------|-------------|
| Semester                          | Teaching and Learning Methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |           |              |                                 |                            | Credits               |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Recite | Lab. | Homeworks | Term Project | Other                           | Total                      | Credit                | ECTS Credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -      | -    | 27        | 35           | 84                              | 188                        | 3                     | 7.5         |
| Language                          | Turkish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |           |              |                                 |                            |                       |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |           |              |                                 |                            |                       |             |
| Prerequisite                      | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |           |              |                                 |                            |                       |             |
| Course Contents                   | Definition of porous materials and classification. Transport mechanisms in porous materials and determination of transport parameters. Synthesis techniques. Characterization techniques. Natural and synthetic zeolites. Materials suchlike MCM. Clay minerals and clay based materials. Ceramic materials and advanced ceramic materials. Industrial applications.                                                                                                                                                                                                                                            |        |      |           |              |                                 |                            |                       |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>To give the knowledge the structure properties of the natural/synthetic porous materials and gain the skill to choice suitable porous materials for industrial applications.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                  |        |      |           |              |                                 |                            |                       |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>Recognizing the porous materials having industrial importance and to be learned application areas.</li> <li>Learning synthesis and characterization techniques of synthetic porous materials.</li> <li>Learning transport mechanisms in porous materials.</li> </ul>                                                                                                                                                                                                                                                                                                     |        |      |           |              |                                 |                            |                       |             |
| Textbook and/or References        | <ul style="list-style-type: none"> <li>Lu, G. Q. Q., Zhao, X. S., Zhao, X. S. "Nanoporous Materials: Science and Engineering, Vol. 4", Imperial College Press, 2004.</li> <li>Karge, H. G., Weitkamp, J., "Synthesis Vol. 1-Molecular Sieves Series", Springer-Verlag, 1998.</li> <li>Occelli, M.L., Kessler, H., "Synthesis of Porous Materials: Zeolites, Clays and Nanostructures, Marcel Dekker, 1996.</li> <li>Kaufmann, E. N., "Characterization of Materials Vol. 1", John Wiley and Sons, 2003.</li> <li>Kaufmann, E. N., "Characterization of Materials Vol. 2", John Wiley and Sons, 2003.</li> </ul> |        |      |           |              |                                 |                            |                       |             |
| Assesment Criteria                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |           |              |                                 | <i>If any, mark as (X)</i> | <b>Percentage (%)</b> |             |
|                                   | <b>Midterm Exams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |           |              |                                 | X                          | <b>30</b>             |             |
|                                   | <b>Quizzes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |           |              |                                 | -                          | <b>-</b>              |             |
|                                   | <b>Homeworks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |           |              |                                 | X                          | <b>15</b>             |             |
|                                   | <b>Project(s)/ Term Project</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |           |              |                                 | X                          | <b>20</b>             |             |
|                                   | <b>Laboratory Work</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |           |              |                                 | -                          | <b>-</b>              |             |
|                                   | <b>Other</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |           |              |                                 | X                          | <b>-</b>              |             |
|                                   | <b>Final Exam</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |           |              |                                 | X                          | <b>35</b>             |             |
| Instructors                       | Prof. Dr. Mùjgan Çulfaz   Prof. Dr. Suna Balcı   Assist. Prof. Dr. Meltem Doğan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |           |              |                                 |                            |                       |             |
| Week                              | Subjects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |           |              |                                 |                            |                       |             |
| 1                                 | Definition of porous materials and classification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |           |              |                                 |                            |                       |             |
| 2-3                               | Transport mechanisms in porous materials and determination of transport parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |           |              |                                 |                            |                       |             |
| 4                                 | Synthesis techniques of porous materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |           |              |                                 |                            |                       |             |
| 5                                 | Characterization techniques of porous materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |           |              |                                 |                            |                       |             |
| 6-7                               | Natural and synthetic zeolites; Synthesis techniques of synthetic zeolites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |           |              |                                 |                            |                       |             |
| 8                                 | MIDTERM EXAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |           |              |                                 |                            |                       |             |
| 9                                 | Materials suchlike MCM.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |           |              |                                 |                            |                       |             |
| 10                                | Clay minerals and clay based materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |           |              |                                 |                            |                       |             |
| 11-12                             | Ceramic materials and advanced ceramic materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |           |              |                                 |                            |                       |             |
| 13-14                             | Presentations of term proiests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |           |              |                                 |                            |                       |             |

| KM572 HYDROGEN TECHNOLOGY         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                          | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     | Credits      |             |
|                                   | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                               | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -      | -    | 48  | 30                 | 68                              | 188                 | 3            | 7.5         |
| Language                          | Turkish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective             | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                     | None- To take electrochemistry may be suggested                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| Course Contents                   | Properties of hydrogen, hydrogen production techniques, hydrogen production from various energy resources, hydrogen production by biological methods, usage of hydrogen, hydrogen safety, hydrogen storage and transportation, hydrogen energy systems, environmental factors, national and international approaches to hydrogen energy and its future.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>Aim of this course is to give the basic concepts related with the hydrogen energy which is considered as the energy of the 21<sup>st</sup> century, and also</li> <li>to give the hydrogen production methods, hydrogen technology, related safety precautions, development in this technology, and its applications.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>To gain the basic concepts related with hydrogen technology, basic principles that hydrogen technology used systems depend on,</li> <li>ability to understand and to solve the problems related with these processes, and also</li> <li>to gain the literature survey and paper examination skills by means of the homeworks and term papers are the principal course outcomes.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References       | <ol style="list-style-type: none"> <li>Veziroğlu, T.N., Barbir, F., "Hydrogen Energy Technologies", UNIDO, Emerging Technology Series, UNIDO, Vienna(1998).</li> <li>Sperling, D., Cannon, J.S., "The Hydrogen Energy Transition-Moving Toward the Post Petroleum Age in Transportation", Elsevier Academic Press, USA, (2004).</li> <li>Hoffmann, P., Harkin, T., "Tomorrow's Energy:Hydrogen, Fuel Cells and Prospects for a Cleaner Planet", Elsevier Press Co., UK, (2003).</li> <li>Rifkin, J., "The Hydrogen Economy:The Creation of the World-Wide Energy and the Red", The Penquin Inc., NewYork, 2<sup>nd</sup> Edition, (2003).</li> <li>Siblerud, F., "Our Future is Hydrogen:Energy, Environment and Economy", New Science Publication, (2001).</li> <li>Robinson, S.L., "Technologies and Economics of Small Scale Hydrogen Storage (SAND)", National Technical Information Service, USA, (1979).</li> </ol> |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                   | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | X                   | 40           |             |
|                                   | Quizes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 | x                   | 10           |             |
|                                   | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 10           |             |
|                                   | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 | -                   | -            |             |
|                                   | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                       | Assoc. Prof.Dr. İrfan Ar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| Week                              | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 1                                 | Properties of Hydrogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |     |                    |                                 |                     |              |             |
| 2                                 | Hydrogen Production Techniques: Reforming, elektrochemical, thermochemical, photochemical, hydrogen quality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 3-4                               | Hydrogen Production from Different Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| 5-6                               | Hydrogen Production by Biological Methods: Metabolizm, fermentation, Photobiological hydrogen production etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 7                                 | Hydrogen Usage: Advanced materials, Power production technologies, Use of hydrogen in transportation, Hydrogen usage in immobile systems, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |      |     |                    |                                 |                     |              |             |
| 8                                 | Hydrogen safety                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 9                                 | Storage and Transportation of Hydrogen: Storage and transportation at high pressure, Storage and transportation in liquid form, Storage and transportation as Hydrates, in nanotubes, New storage techniques, Born, Other materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |     |                    |                                 |                     |              |             |
| 10                                | Hydrojen Energy Systems: Small sized systems, Large sized systems, Hybrid systems, Hydrogen infrastructure and fuel stations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |     |                    |                                 |                     |              |             |
| 11                                | Devlopment in Fuel Cell Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 12                                | Environmental Factors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |

|    |                                                                              |
|----|------------------------------------------------------------------------------|
| 13 | National/International Perspectives                                          |
| 14 | Recent Developments and Commercial Applications related with hydrogen energy |

| KM 573 Principles of Electrochemical Engineering |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    | CHEMICAL ENGINEERING DEPARTMENT |                     |              |             |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------------------|---------------------------------|---------------------|--------------|-------------|
| Semester                                         | Teaching and Learning Methods (Hours per semester)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     | Credits      |             |
|                                                  | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Recit. | Lab. | HW. | Term Paper/Project | Other                           | Total               | Credit       | ECTS credit |
| 1-2                                              | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | -      | -    | 50  | 76                 | 20                              | 188                 | 3            | 7.5         |
| Language                                         | Turkish/English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| Compulsory / Elective                            | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 |                     |              |             |
| Prerequisites                                    | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |     |                    |                                 |                     |              |             |
| Course Contents                                  | Fundamentals and equations that are needed to analyze electrochemical systems. Thermodynamics, electrode kinetics and mass transfer in electrochemical systems. Experimental electrochemical techniques and their applications, voltammetric methods. Industrial electrochemical applications, electric motors, chlor alkali processes, energy storage, electrolysis and corrosion. Simulation of electrochemical techniques by electrochemical softwares.                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Course Objectives                                | <ul style="list-style-type: none"> <li>• Applications of electrochemical principles.</li> <li>• Acquisition of electrochemical experimental and modeling techniques.</li> <li>• Information about the novel electrochemical industrial applications.</li> <li>• Improvement of written and oral presentation techniques.</li> </ul>                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| Learning Outcomes and Competences                | <ul style="list-style-type: none"> <li>• Improves application of electrochemical techniques</li> <li>• Improves his/her knowledge about electrochemical applications</li> <li>• Application of some electrochemical softwares</li> <li>• Improves his/her written and oral communication skills in electrochemical engineering.</li> </ul>                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |
| Textbook and /or References                      | 1. Bard, J.A., Faulkner, L.R., "Electrochemical Methods: Fundamentals and Applications" John Wiley&Sons, Inc., 2 <sup>nd</sup> Edition., 2002.<br>2. Prentice, G.A., "Electrochemical Engineering Principles", Prentice Hall, 1 <sup>st</sup> Edition, 1991<br>3. Delahay, P., "Advances in Electrochemistry and Electrochemical Engineering" Volume 1-6: Electrochemistry<br>4. Crow, D.R., "Principles and applications of electrochemistry", London: Chapman and Hall, 1988<br>5. Heitz, E., Kreysa, G., "Principles of Electrochemical Engineering: extended version of a DECHEMA experimental course", Newyork: VCH, 1986.<br>6. Periodicals |        |      |     |                    |                                 |                     |              |             |
| Assessment Criteria                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | If any, mark as (X) | Percentage % |             |
|                                                  | Midterm Exams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 30           |             |
|                                                  | Quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 | -                   | -            |             |
|                                                  | Homeworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 | X                   | 10           |             |
|                                                  | Projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |      |     |                    |                                 | X                   | 15           |             |
|                                                  | Term Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 | -                   | -            |             |
|                                                  | Laboratory Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 | -                   | -            |             |
|                                                  | Other (.....)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 | X                   | 5            |             |
|                                                  | Final Exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 | X                   | 40           |             |
| Prepared by                                      | Dr. N. Alper TAPAN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |      |     |                    |                                 |                     |              |             |
| Week                                             | Subject                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |     |                    |                                 |                     |              |             |
| 1-2                                              | Introduction and overview of electrode processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |      |     |                    |                                 |                     |              |             |
| 3                                                | Basic concepts, phase equilibrium, potentials and thermodynamics of cells                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 4-5                                              | Kinetics of electrode reactions, ionic mass transport: Mass transfer by migration and diffusion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |      |     |                    |                                 |                     |              |             |
| 6-7                                              | Experimental methods: Basic potential step methods, potential sweep methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |     |                    |                                 |                     |              |             |
| 8                                                | MIDTERM I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |     |                    |                                 |                     |              |             |
| 9-10                                             | Polarography and pulse voltammetry, controlled-current techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |     |                    |                                 |                     |              |             |
| 11-12                                            | Methods involving forced convection-hydrodynamic methods, techniques based on concepts of impedance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |     |                    |                                 |                     |              |             |
| 13                                               | Electrochemical Instrumentation, electrochemical applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |     |                    |                                 |                     |              |             |
| 14                                               | MIDTERM II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |      |     |                    |                                 |                     |              |             |

| 5980009 SEMINAR                   |                                                                                                                                                                                                               |                 |                      |  |  | CHEMICAL ENGINEERING DEPARTMENT |       |                            |             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------|--|--|---------------------------------|-------|----------------------------|-------------|
| Semester                          | Teaching Methods                                                                                                                                                                                              |                 |                      |  |  |                                 |       | Credits                    |             |
|                                   | Seminar                                                                                                                                                                                                       | Library Studies | Project Presentation |  |  | Other                           | Total | Credit                     | ECTS Credit |
| 1-2                               | 28                                                                                                                                                                                                            | 80              | 80                   |  |  |                                 | 188   | 0                          | 7.5         |
| Language                          | Turkish                                                                                                                                                                                                       |                 |                      |  |  |                                 |       |                            |             |
| Compulsory / Elective             | Compulsory                                                                                                                                                                                                    |                 |                      |  |  |                                 |       |                            |             |
| Prerequisites                     | Assignment of the supervisor                                                                                                                                                                                  |                 |                      |  |  |                                 |       |                            |             |
| Course Contents                   | Presentation of the thesis work                                                                                                                                                                               |                 |                      |  |  |                                 |       |                            |             |
| Course Objectives                 | <ul style="list-style-type: none"> <li>To give the ability of the oral presentation and discussion</li> <li>To decide on the objectives of the thesis work and the strategy</li> </ul>                        |                 |                      |  |  |                                 |       |                            |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>To have the ability of the oral presentation and discussion</li> <li>To have an ability of determining the objectives and the strategy of a scientific work</li> </ul> |                 |                      |  |  |                                 |       |                            |             |
| Textbook and /or References       | All the references related to the study.                                                                                                                                                                      |                 |                      |  |  |                                 |       |                            |             |
| Assessment Criteria               |                                                                                                                                                                                                               |                 |                      |  |  |                                 |       | <i>If any, mark as (X)</i> | Percent (%) |
|                                   | Seminar                                                                                                                                                                                                       |                 |                      |  |  |                                 |       | X                          |             |
|                                   | Quizzes                                                                                                                                                                                                       |                 |                      |  |  |                                 |       |                            |             |
|                                   | Homeworks                                                                                                                                                                                                     |                 |                      |  |  |                                 |       |                            |             |
|                                   | Projects / Presentation                                                                                                                                                                                       |                 |                      |  |  |                                 |       | X                          |             |
|                                   | Term Paper                                                                                                                                                                                                    |                 |                      |  |  |                                 |       |                            |             |
|                                   | Laboratory/ Library Work                                                                                                                                                                                      |                 |                      |  |  |                                 |       | X                          |             |
|                                   | Other                                                                                                                                                                                                         |                 |                      |  |  |                                 |       |                            |             |
|                                   | Final Exam                                                                                                                                                                                                    |                 |                      |  |  |                                 |       |                            |             |
| Instructors                       | The supervisor                                                                                                                                                                                                |                 |                      |  |  |                                 |       |                            |             |

| 5001009 MS Thesis                       |                                                                                                                                                                                                                                         |  |                     |  |  | CHEMICAL ENGINEERING DEPARTMENT |       |                                |                        |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------|--|--|---------------------------------|-------|--------------------------------|------------------------|
| Semester                                | Teaching Methods                                                                                                                                                                                                                        |  |                     |  |  |                                 |       | Credits                        |                        |
|                                         | Meeting                                                                                                                                                                                                                                 |  | Recitation/<br>Lab. |  |  | Other                           | Total | Credit                         | ECTS<br>Credit         |
| 1-2                                     | 14                                                                                                                                                                                                                                      |  | 200                 |  |  | 36                              | 250   | 0                              | 10                     |
| Language                                | Turkish                                                                                                                                                                                                                                 |  |                     |  |  |                                 |       |                                |                        |
| Compulsory /<br>Elective                | Compulsory                                                                                                                                                                                                                              |  |                     |  |  |                                 |       |                                |                        |
| Prerequisites                           | Assignment of the supervisor                                                                                                                                                                                                            |  |                     |  |  |                                 |       |                                |                        |
| Course<br>Contents                      | MS thesis work                                                                                                                                                                                                                          |  |                     |  |  |                                 |       |                                |                        |
| Course<br>Objectives                    | To improve the ability of getting the scientific information, its evaluation and interpretation by<br>conductive scientific research                                                                                                    |  |                     |  |  |                                 |       |                                |                        |
| Learning<br>Outcomes and<br>Competences | <ul style="list-style-type: none"> <li>• To have the ability of getting the scientific and technological information, and engaging in<br/>life-long learning</li> <li>• To have the ability of evaluation and interpretation</li> </ul> |  |                     |  |  |                                 |       |                                |                        |
| Textbook<br>and/or<br>References        | All the references related to the study.                                                                                                                                                                                                |  |                     |  |  |                                 |       |                                |                        |
| Assessment<br>Criteria                  |                                                                                                                                                                                                                                         |  |                     |  |  |                                 |       | <i>If any, mark<br/>as (X)</i> | <b>Percent<br/>(%)</b> |
|                                         | Midterm Exams                                                                                                                                                                                                                           |  |                     |  |  |                                 |       |                                |                        |
|                                         | Quizzes                                                                                                                                                                                                                                 |  |                     |  |  |                                 |       |                                |                        |
|                                         | Homeworks                                                                                                                                                                                                                               |  |                     |  |  |                                 |       |                                |                        |
|                                         | Projects                                                                                                                                                                                                                                |  |                     |  |  |                                 |       |                                |                        |
|                                         | Term Paper                                                                                                                                                                                                                              |  |                     |  |  |                                 |       |                                |                        |
|                                         | Laboratory and Library Work / Applications                                                                                                                                                                                              |  |                     |  |  |                                 |       | X                              |                        |
|                                         | Other ( Report, presentation)                                                                                                                                                                                                           |  |                     |  |  |                                 |       | X                              |                        |
|                                         | Final Exam                                                                                                                                                                                                                              |  |                     |  |  |                                 |       |                                |                        |
| Instructors                             | The supervisor                                                                                                                                                                                                                          |  |                     |  |  |                                 |       |                                |                        |

| 6001009    PhD Thesis                   |                                                                                                                                                                                                                                                                            |  |                     |  | CHEMICAL ENGINEERING DEPARTMENT |       |       |                                |                        |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------|--|---------------------------------|-------|-------|--------------------------------|------------------------|
| Semester                                | Teaching Methods                                                                                                                                                                                                                                                           |  |                     |  |                                 |       |       | Credits                        |                        |
|                                         | Meeting                                                                                                                                                                                                                                                                    |  | Recitation/<br>Lab. |  |                                 | Other | Total | Credit                         | ECTS<br>Credit         |
| 1-2                                     | 14                                                                                                                                                                                                                                                                         |  | 200                 |  |                                 | 36    | 250   | 0                              | 10                     |
| Language                                | Turkish                                                                                                                                                                                                                                                                    |  |                     |  |                                 |       |       |                                |                        |
| Compulsory /<br>Elective                | Compulsory                                                                                                                                                                                                                                                                 |  |                     |  |                                 |       |       |                                |                        |
| Prerequisites                           | Assignment of the supervisor                                                                                                                                                                                                                                               |  |                     |  |                                 |       |       |                                |                        |
| Course<br>Contents                      | PhD thesis work                                                                                                                                                                                                                                                            |  |                     |  |                                 |       |       |                                |                        |
| Course<br>Objectives                    | <ul style="list-style-type: none"> <li>• To give the ability of carrying out independent research,</li> <li>• To give the ability of deducing conclusions scientifically</li> <li>• To give the ability of determining progressive steps to reach new synthesis</li> </ul> |  |                     |  |                                 |       |       |                                |                        |
| Learning<br>Outcomes and<br>Competences | To gain ability for innovations in scientific approach or to develop a new scientific method or to apply obvious method to a new field.                                                                                                                                    |  |                     |  |                                 |       |       |                                |                        |
| Textbook and<br>/or References          | All the references related to the study.                                                                                                                                                                                                                                   |  |                     |  |                                 |       |       |                                |                        |
| Assessment<br>Criteria                  |                                                                                                                                                                                                                                                                            |  |                     |  |                                 |       |       | <i>If any, mark<br/>as (X)</i> | <b>Percent<br/>(%)</b> |
|                                         | Midterm Exams                                                                                                                                                                                                                                                              |  |                     |  |                                 |       |       |                                |                        |
|                                         | Quizzes                                                                                                                                                                                                                                                                    |  |                     |  |                                 |       |       |                                |                        |
|                                         | Homeworks                                                                                                                                                                                                                                                                  |  |                     |  |                                 |       |       |                                |                        |
|                                         | Projects                                                                                                                                                                                                                                                                   |  |                     |  |                                 |       |       |                                |                        |
|                                         | Term Paper                                                                                                                                                                                                                                                                 |  |                     |  |                                 |       |       |                                |                        |
|                                         | Laboratory and Library Work / Applications                                                                                                                                                                                                                                 |  |                     |  |                                 |       |       | X                              |                        |
|                                         | Other ( Report, presentation)                                                                                                                                                                                                                                              |  |                     |  |                                 |       |       | X                              |                        |
|                                         | Final Exam                                                                                                                                                                                                                                                                 |  |                     |  |                                 |       |       |                                |                        |
| Instructors                             | The supervisor                                                                                                                                                                                                                                                             |  |                     |  |                                 |       |       |                                |                        |

| 7001009 TERM PROJECT                    |                                                                                                                |                           |  |  |  | CHEMICAL ENGINEERING<br>DEPARTMENT |                                |                |                |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------|--|--|--|------------------------------------|--------------------------------|----------------|----------------|
| Semester                                | Teaching Methods                                                                                               |                           |  |  |  |                                    | Credits                        |                |                |
|                                         | Meeting                                                                                                        | Recitation/ Lab./ Library |  |  |  | Other                              | Total                          | Credit         | ECTS<br>Credit |
| 1-2                                     | 70                                                                                                             | 300                       |  |  |  | 68                                 | 438                            | 0              | 17.5           |
| Language                                | Turkish                                                                                                        |                           |  |  |  |                                    |                                |                |                |
| Compulsory /<br>Elective                | Compulsory                                                                                                     |                           |  |  |  |                                    |                                |                |                |
| Prerequisites                           | Assignment of the supervisor                                                                                   |                           |  |  |  |                                    |                                |                |                |
| Course<br>Contents                      | A theoretical and practical assay in which technical know how gained in professional discipline are applicable |                           |  |  |  |                                    |                                |                |                |
| Course<br>Objectives                    | To acquaint in a certain field and to teach how to apply.                                                      |                           |  |  |  |                                    |                                |                |                |
| Learning<br>Outcomes and<br>Competences | Getting an ability to apply the knowledge obtained during education                                            |                           |  |  |  |                                    |                                |                |                |
| Textbook and<br>/or References          | All the references related to the study.                                                                       |                           |  |  |  |                                    |                                |                |                |
| Assessment<br>Criteria                  |                                                                                                                |                           |  |  |  |                                    | <i>If any, mark<br/>as (X)</i> | Percent<br>(%) |                |
|                                         | Midterm Exams                                                                                                  |                           |  |  |  |                                    |                                |                |                |
|                                         | Quizzes                                                                                                        |                           |  |  |  |                                    |                                |                |                |
|                                         | Homeworks                                                                                                      |                           |  |  |  |                                    |                                |                |                |
|                                         | Projects / Presentation                                                                                        |                           |  |  |  |                                    | X                              |                |                |
|                                         | Term Paper                                                                                                     |                           |  |  |  |                                    |                                |                |                |
|                                         | Laboratory/ Library Work / Applications                                                                        |                           |  |  |  |                                    | X                              |                |                |
|                                         | Other                                                                                                          |                           |  |  |  |                                    | X                              |                |                |
|                                         | Final Exam                                                                                                     |                           |  |  |  |                                    |                                |                |                |
| Instructors                             | The supervisor                                                                                                 |                           |  |  |  |                                    |                                |                |                |

| 8000009 DOCTORAL QUALIFYING EXAMINATION |                                                                                        |  |  |  | CHEMICAL ENGINEERING DEPARTMENT |       |       |                            |             |
|-----------------------------------------|----------------------------------------------------------------------------------------|--|--|--|---------------------------------|-------|-------|----------------------------|-------------|
| Semester                                | Teaching Methods                                                                       |  |  |  |                                 |       |       | Credits                    |             |
|                                         | Individual work                                                                        |  |  |  |                                 | Other | Total | Credit                     | ECTS Credit |
| I-II                                    | 400                                                                                    |  |  |  |                                 | 38    | 438   | 0                          | 17.5        |
| Language                                | Turkish                                                                                |  |  |  |                                 |       |       |                            |             |
| Compulsory / Elective                   | Compulsory                                                                             |  |  |  |                                 |       |       |                            |             |
| Prerequisites                           | To complete the minimum course credit                                                  |  |  |  |                                 |       |       |                            |             |
| Course Contents                         | The written and oral exams on basic subjects and related fields of the PhD thesis work |  |  |  |                                 |       |       |                            |             |
| Course Objectives                       | To check the qualification on basic subjects and related fields of the PhD thesis work |  |  |  |                                 |       |       |                            |             |
| Learning Outcomes and Competences       | To have the qualification on basic subjects and related fields of the PhD thesis work  |  |  |  |                                 |       |       |                            |             |
| Textbook and /or References             | All the references related to the study.                                               |  |  |  |                                 |       |       |                            |             |
| Assessment Criteria                     |                                                                                        |  |  |  |                                 |       |       | <i>If any, mark as (X)</i> | Percent (%) |
|                                         | Midterm Exams                                                                          |  |  |  |                                 |       |       |                            |             |
|                                         | Quizzes                                                                                |  |  |  |                                 |       |       |                            |             |
|                                         | Homeworks                                                                              |  |  |  |                                 |       |       |                            |             |
|                                         | Projects                                                                               |  |  |  |                                 |       |       |                            |             |
|                                         | Term Paper                                                                             |  |  |  |                                 |       |       |                            |             |
|                                         | Laboratory Work                                                                        |  |  |  |                                 |       |       |                            |             |
|                                         | Other                                                                                  |  |  |  |                                 |       |       |                            |             |
|                                         | Qualifying Exam                                                                        |  |  |  |                                 |       |       |                            |             |
| Instructors                             | Qualification committee                                                                |  |  |  |                                 |       |       |                            |             |

| 8500009 PROGRESS IN THESIS        |                                                                                                                                                                         |                            |  |  |  | CHEMICAL ENGINEERING DEPARTMENT |       |                            |             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--|--|--|---------------------------------|-------|----------------------------|-------------|
| Semester                          | Teaching Methods                                                                                                                                                        |                            |  |  |  |                                 |       | Credits                    |             |
|                                   | Report, Presentation                                                                                                                                                    | Measurement and evaluation |  |  |  | Other                           | Total | Credit                     | ECTS Credit |
| I-II                              | 40                                                                                                                                                                      | 100                        |  |  |  | 48                              | 188   | 0                          | 7.5         |
| Language                          | Turkish                                                                                                                                                                 |                            |  |  |  |                                 |       |                            |             |
| Compulsory / Elective             | Compulsory                                                                                                                                                              |                            |  |  |  |                                 |       |                            |             |
| Prerequisites                     | Passing the qualification exam                                                                                                                                          |                            |  |  |  |                                 |       |                            |             |
| Course Contents                   | Developing the research work                                                                                                                                            |                            |  |  |  |                                 |       |                            |             |
| Course Objectives                 | To analyse the results obtained according to the work plan of PhD studies and make the work plan for the next period and contributing to the direction of the PhD work. |                            |  |  |  |                                 |       |                            |             |
| Learning Outcomes and Competences | To get an ability of making work plans on the basis of research objective and evaluating the results and presentation.                                                  |                            |  |  |  |                                 |       |                            |             |
| Textbook and /or References       | All the references related to the study.                                                                                                                                |                            |  |  |  |                                 |       |                            |             |
| Assessment Criteria               |                                                                                                                                                                         |                            |  |  |  |                                 |       | <i>If any, mark as (X)</i> | Percent (%) |
|                                   | Midterm Exams                                                                                                                                                           |                            |  |  |  |                                 |       |                            |             |
|                                   | Quizzes                                                                                                                                                                 |                            |  |  |  |                                 |       |                            |             |
|                                   | Homework                                                                                                                                                                |                            |  |  |  |                                 |       |                            |             |
|                                   | Projects                                                                                                                                                                |                            |  |  |  |                                 |       |                            |             |
|                                   | Term Paper                                                                                                                                                              |                            |  |  |  |                                 |       |                            |             |
|                                   | Laboratory Work                                                                                                                                                         |                            |  |  |  |                                 |       |                            |             |
|                                   | Report and presentation                                                                                                                                                 |                            |  |  |  |                                 |       | X                          |             |
|                                   | Final Exam                                                                                                                                                              |                            |  |  |  |                                 |       |                            |             |
| Instructors                       | Thesis committee                                                                                                                                                        |                            |  |  |  |                                 |       |                            |             |

| 80*09DD SPECIAL TOPICS in MS      |                                                                                                                                                                   |                       |  |                        |  | CHEMICAL ENGINEERING DEPARTMENT |       |                            |                    |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|------------------------|--|---------------------------------|-------|----------------------------|--------------------|
| Semester                          | Teaching Methods                                                                                                                                                  |                       |  |                        |  |                                 |       | Credits                    |                    |
|                                   | Theory                                                                                                                                                            | Library/Lab./Homework |  | Project / Area studies |  | Other                           | Total | Credit                     | ECTS Credit        |
| 1-2                               | 42                                                                                                                                                                | 150                   |  | 30                     |  | 28                              | 250   | 0                          | 10                 |
| Language                          | Turkish                                                                                                                                                           |                       |  |                        |  |                                 |       |                            |                    |
| Compulsory / Elective             | Compulsory                                                                                                                                                        |                       |  |                        |  |                                 |       |                            |                    |
| Prerequisites                     | Assignment of the supervisor                                                                                                                                      |                       |  |                        |  |                                 |       |                            |                    |
| Course Contents                   | Basic concepts and applications related to the thesis work                                                                                                        |                       |  |                        |  |                                 |       |                            |                    |
| Course Objectives                 | <ul style="list-style-type: none"> <li>To give the general knowledge related to the thesis work</li> <li>To develop the ability of analytical thinking</li> </ul> |                       |  |                        |  |                                 |       |                            |                    |
| Learning Outcomes and Competences | <ul style="list-style-type: none"> <li>To have the general knowledge</li> <li>To have the ability of making plans for the research work</li> </ul>                |                       |  |                        |  |                                 |       |                            |                    |
| Textbook and /or References       | All the references related to the study.                                                                                                                          |                       |  |                        |  |                                 |       |                            |                    |
| Assessment Criteria               |                                                                                                                                                                   |                       |  |                        |  |                                 |       | <i>If any, mark as (X)</i> | <b>Percent (%)</b> |
|                                   | Midterm Exams                                                                                                                                                     |                       |  |                        |  |                                 |       |                            |                    |
|                                   | Quizzes                                                                                                                                                           |                       |  |                        |  |                                 |       |                            |                    |
|                                   | Homeworks                                                                                                                                                         |                       |  |                        |  |                                 |       |                            |                    |
|                                   | Projects / presentation                                                                                                                                           |                       |  |                        |  |                                 |       | X                          |                    |
|                                   | Term Paper                                                                                                                                                        |                       |  |                        |  |                                 |       |                            |                    |
|                                   | Laboratory / Library Work                                                                                                                                         |                       |  |                        |  |                                 |       | X                          |                    |
|                                   | Other                                                                                                                                                             |                       |  |                        |  |                                 |       |                            |                    |
|                                   | Final Exam                                                                                                                                                        |                       |  |                        |  |                                 |       |                            |                    |
| Instructors                       | The supervisor                                                                                                                                                    |                       |  |                        |  |                                 |       |                            |                    |

| 90*09DD SPECIAL TOPICS in PhD     |                                                                                                                                                                                                |                       |  |                        |  | CHEMICAL ENGINEERING DEPARTMENT |                            |             |             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|------------------------|--|---------------------------------|----------------------------|-------------|-------------|
| Semester                          | Teaching Methods                                                                                                                                                                               |                       |  |                        |  |                                 | Credits                    |             |             |
|                                   | Theory                                                                                                                                                                                         | Library/Lab./Homework |  | Project / Area studies |  | Other                           | Total                      | Credit      | ECTS Credit |
| 1-2                               | 42                                                                                                                                                                                             | 150                   |  | 30                     |  | 28                              | 250                        | 0           | 10          |
| Language                          | Turkish                                                                                                                                                                                        |                       |  |                        |  |                                 |                            |             |             |
| Compulsory / Elective             | Compulsory                                                                                                                                                                                     |                       |  |                        |  |                                 |                            |             |             |
| Prerequisites                     | Assignment of the supervisor                                                                                                                                                                   |                       |  |                        |  |                                 |                            |             |             |
| Course Contents                   | Basic concepts and applications related to the thesis work                                                                                                                                     |                       |  |                        |  |                                 |                            |             |             |
| Course Objectives                 | <ul style="list-style-type: none"><li>• To give the general knowledge related to the thesis work</li><li>• To develop the ability of analytical thinking</li></ul>                             |                       |  |                        |  |                                 |                            |             |             |
| Learning Outcomes and Competences | <ul style="list-style-type: none"><li>• To develop the ability of analytical thinking</li><li>• To get the ability of evaluation, data analysis and making written/oral presentation</li></ul> |                       |  |                        |  |                                 |                            |             |             |
| Textbook and /or References       | All the references related to the study.                                                                                                                                                       |                       |  |                        |  |                                 |                            |             |             |
| Assessment Criteria               |                                                                                                                                                                                                |                       |  |                        |  |                                 | <i>If any, mark as (X)</i> | Percent (%) |             |
|                                   | Midterm Exams                                                                                                                                                                                  |                       |  |                        |  |                                 |                            |             |             |
|                                   | Quizzes                                                                                                                                                                                        |                       |  |                        |  |                                 |                            |             |             |
|                                   | Homeworks                                                                                                                                                                                      |                       |  |                        |  |                                 |                            |             |             |
|                                   | Projects / Presentation                                                                                                                                                                        |                       |  |                        |  |                                 | X                          |             |             |
|                                   | Term Paper                                                                                                                                                                                     |                       |  |                        |  |                                 |                            |             |             |
|                                   | Laboratory / Library Work                                                                                                                                                                      |                       |  |                        |  |                                 | X                          |             |             |
|                                   | Other                                                                                                                                                                                          |                       |  |                        |  |                                 |                            |             |             |
|                                   | Final Exam                                                                                                                                                                                     |                       |  |                        |  |                                 |                            |             |             |
| Instructors                       | The supervisor                                                                                                                                                                                 |                       |  |                        |  |                                 |                            |             |             |