

| MM 302E Fluid Mechanics II               |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      | DEPARTMENT of MECHANICAL ENGINEERING |          |                            |                       |         |             |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|--------------------------------------|----------|----------------------------|-----------------------|---------|-------------|
| Semester                                 | Methods of Education                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |                                      |          |                            |                       | Credits |             |
|                                          | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                              | Recit. | Lab. | Project / Field Study                | Homework | Other                      | Total                 | Credit  | ECTS Credit |
| 6                                        | 42                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -      | 15   | -                                    | 43       | 25                         | 125                   | 3       | 5.0         |
| <b>Language</b>                          | English                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |      |                                      |          |                            |                       |         |             |
| <b>Compulsory / Elective</b>             | Compulsory                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |                                      |          |                            |                       |         |             |
| <b>Prerequisites</b>                     | MM 301 E                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |      |                                      |          |                            |                       |         |             |
| <b>Course Contents</b>                   | Introduction to differential analysis of fluid motion. Continuity, momentum and energy equations. Incompressible inviscid flow. Velocity potential. Stream function. Elementary plane flows. Dimensional analysis and similitude. Incompressible viscous flow, Navier-Stokes equations. Boundary layer in laminar and turbulent flow. Fluid flow about immersed bodies. Introduction to compressible flow. Steady one-dimensional compressible flow. |        |      |                                      |          |                            |                       |         |             |
| <b>Course Objectives</b>                 | To teach derivation and application of basic equations in differential form governing the fluid motion, calculation of forces exerted by flows on bodies.                                                                                                                                                                                                                                                                                            |        |      |                                      |          |                            |                       |         |             |
| <b>Learning Outcomes and Competences</b> | Understanding and usage of basic approached employed for detailed analysis of flow fields and their applications to engineering flow problems.                                                                                                                                                                                                                                                                                                       |        |      |                                      |          |                            |                       |         |             |
| <b>Textbook and / or Reference</b>       | 1. Introduction to Fluid Mechanics, R. W. Fox, P. J. Pritchard and A. T. MacDonald, John Wiley & Sons, Inc., Seventh Edition.<br>2. Mechanics of Fluids, M. C. Potter and D. C. Wiggert, Prentice Hall, Second Edition.<br>3. Fundamentals of Fluid Mechanics, B. R. Munson, D. F. Young and T. H. Okiishi, John Wiley & Sons, Inc., Third Edition.                                                                                                  |        |      |                                      |          |                            |                       |         |             |
| <b>Assessment Criteria</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |                                      |          | <b>If any, mark as (x)</b> | <b>Percentage (%)</b> |         |             |
|                                          | <b>Midterm Exams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |      |                                      |          | X                          | 45                    |         |             |
|                                          | <b>Quizzes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |                                      |          | X                          | 5                     |         |             |
|                                          | <b>Homeworks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |      |                                      |          | X                          | 5                     |         |             |
|                                          | <b>Projects</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |                                      |          |                            |                       |         |             |
|                                          | <b>Term Paper</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |                                      |          |                            |                       |         |             |
|                                          | <b>Laboratory Work</b>                                                                                                                                                                                                                                                                                                                                                                                                                               |        |      |                                      |          | X                          | 5                     |         |             |
|                                          | <b>Other</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |      |                                      |          |                            |                       |         |             |
|                                          | <b>Final Exam</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |      |                                      |          | X                          | 40                    |         |             |
| <b>Instructors</b>                       | Prof. Nuri YUCEL, Prof. Hasmet TURKOGLU, Asst. Prof. Nureddin DINLER                                                                                                                                                                                                                                                                                                                                                                                 |        |      |                                      |          |                            |                       |         |             |
| <b>Week</b>                              | <b>Subject</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |                                      |          |                            |                       |         |             |
| 1                                        | DIFFERANSIYEL ANALYSIS OF FLUID MOTION: Derivation of continuity equation. Stream function for two-dimensional incompressible flows.                                                                                                                                                                                                                                                                                                                 |        |      |                                      |          |                            |                       |         |             |
| 2                                        | DIFFERANSIYEL ANALYSIS OF FLUID MOTION: Motion of fluid elements (kinematics), derivation of momentum equation.                                                                                                                                                                                                                                                                                                                                      |        |      |                                      |          |                            |                       |         |             |
| 3                                        | INCOMPRESSIBLE INVISCID FLOW: Derivation and application of Euler's equation. Derivation and application of Bernoulli equation. Static, stagnation and dynamic pressure.                                                                                                                                                                                                                                                                             |        |      |                                      |          |                            |                       |         |             |
| 4                                        | INCOMPRESSIBLE INVISCID FLOW: Irrotational flow. Bernoulli equation for irrotational flow. Velocity potential and stream function.                                                                                                                                                                                                                                                                                                                   |        |      |                                      |          |                            |                       |         |             |
| 5                                        | INCOMPRESSIBLE INVISCID FLOW: Elementary plane flows. Superposition of plane flows.                                                                                                                                                                                                                                                                                                                                                                  |        |      |                                      |          |                            |                       |         |             |
| 6                                        | DIMENSIONAL ANALYSIS AND SIMILITUDE: Introduction. Buckingham Pi theorem. Determination of Pi groups.                                                                                                                                                                                                                                                                                                                                                |        |      |                                      |          |                            |                       |         |             |
| 7                                        | DIMENSIONAL ANALYSIS AND SIMILITUDE: Dimensionless groups of significance in fluid mechanics. Flow similarity and model studies.                                                                                                                                                                                                                                                                                                                     |        |      |                                      |          |                            |                       |         |             |
| 8                                        | MIDTERM EXAM I and EXPERIMENT I                                                                                                                                                                                                                                                                                                                                                                                                                      |        |      |                                      |          |                            |                       |         |             |
| 9                                        | BOUNDARY LAYER: The boundary layer concept, boundary layer thicknesses.                                                                                                                                                                                                                                                                                                                                                                              |        |      |                                      |          |                            |                       |         |             |
| 10                                       | BOUNDARY LAYER: Laminar flat-plate boundary layer: Exact solution. Momentum integral equations.                                                                                                                                                                                                                                                                                                                                                      |        |      |                                      |          |                            |                       |         |             |
| 11                                       | FLOW ABOUT IMMERSED BODIES: Drag and lift on surfaces parallel and normal to flow. EXPERIMENT II                                                                                                                                                                                                                                                                                                                                                     |        |      |                                      |          |                            |                       |         |             |
| 12                                       | FLOW ABOUT IMMERSED BODIES: Flow over cylinder and sphere: Drag and lift forces. Flow over different geometrical shapes.                                                                                                                                                                                                                                                                                                                             |        |      |                                      |          |                            |                       |         |             |
| 13                                       | MIDTERM EXAM II and solution of exam problems.                                                                                                                                                                                                                                                                                                                                                                                                       |        |      |                                      |          |                            |                       |         |             |
| 14                                       | COMPRESSIBLE FLOW: Introduction. Analysis of steady one-dimensional compressible flow. Fanno line and Rayleigh line.                                                                                                                                                                                                                                                                                                                                 |        |      |                                      |          |                            |                       |         |             |