IM343
HOMEWORK-7 (Due on 06.12.2019)

1) Water exerts pressure on the upstream face of a dam as shown in Fig. P24.23. The pressure can be characterized by

$p(z) = \rho g(D - z)$ (1)

where $p(z)$ = pressure in pascals (or N/m^2) exerted at an elevation z meters above the reservoir bottom; ρ = density of water, which for this problem is assumed to be a constant 1000 kg/m^3; g=acceleration due to gravity (9.81 m/s^2); and D = elevation (in m) of the water surface above the reservoir bottom. According to Eq. (1) pressure increases linearly with depth, as shown in Fig. *a*. Omitting atmospheric pressure (because it works against both sides of the dam face and essentially cancels out), the total force *ft* can be determined by multiplying pressure times the area of the dam face (as shown in Fig.b). Because both pressure and area vary with elevation, the total force is obtained by evaluating

$$f_t = \int_0^D \rho g w(z)(D - z)\, dz$$

where $w(z)$=width of the dam face (m) at elevation z (Fig. *b*). The line of action can also be obtained by evaluating

$$d = \frac{\int_0^D \rho g z w(z)(D - z)\, dz}{\int_0^D \rho g w(z)(D - z)\, dz}$$

Use Simpson's 3/8 rule to compute the total hydrostatic force and its line of action.

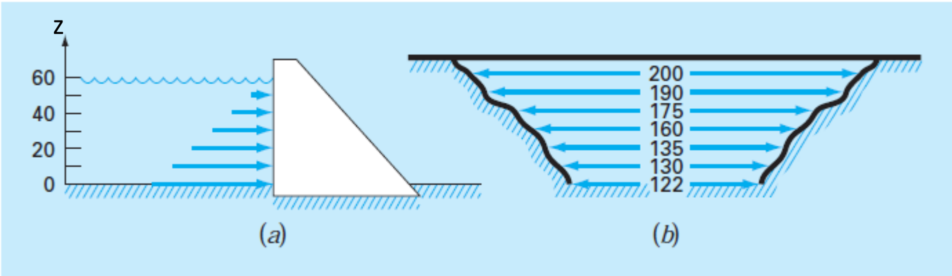

Figure 1. Water exerting pressure on the upstream face of a dam: (a) side view showing force increasing linearly with depth; (b) front view showing width of dam w(z) in meters.

2) Evaluate the following double integral:

$$\int_{-2}^{2} \int_{0}^{4} (x^2 - 3y^2 + xy^3)\, dx\, dy$$

(a) analytically;
(b) using a multiple-application trapezoidal rule, with n = 3, compute the percent relative error with analytical solution
(c) using Simpson's 1/3 rule with n=2, compute the percent relative error with analytical solution