UCE305 FLUID MECHANICS

Tutorial No. 3 and 4

FLUID STATICS (Hydrostatic Forces on Surfaces and Floatation)

Q1: A rectangular plate 3 m wide and 5 m deep is placed vertically in water such that 3 m side is parallel to the water surface. Determine the total pressure and its location when upper edge (i) coincides with the free surface and (ii) 2 m below the free surface.

Q2: Determine the total pressure and its location on an isosceles triangular plate of base 3.5 m and altitude 3.5 m when it is submerged vertically in an oil of specific gravity 0.85. The base of plate coincides with the free surface of oil.

Q3: **Figure 1** shows a tank containing water and oil (**S** = 0.90). Calculate the total pressure on one of the sides of the tank and its position. Take width of the tank as 2.5 m.

Q4: A canal of bed width 8 m and sides slope 1.5H: 1V is closed by means of vertical wall of height 2.5 m above the canal bed. If depth of water in the canal is 2 m, find the water pressure on the wall and its location.

Q5: An opening in a wall is covered by a vertical sluice gate. The opening is 2 m wide and 1.2 m high. On one side of the wall, a liquid of specific gravity 1.45 lies up to a height of 1.5 m above the top of the gate, whereas on the other side, water is up to the top of the gate. Find (i) the resultant force acting on the gate and its position and (ii) the force acting at the top of the gate, which is capable of opening it. Assume that the gate is hinged at the bottom.

Q6: A pipeline 4 m in diameter contains a gate valve. The pressure at the centre of pipe is 200 kPa. If pipe is full of oil of specific gravity 0.87, find the force exerted by oil on the gate and its location.

Q7: A circular plate 2.5 m in dia. is submerged in water. The greatest and least depth of plate below the free surface is 3 m and 1 m, respectively. Find the total pressure and its location on the face of the plate.

Q8: There is an opening in a container shown in **Figure 2**. Find force **P** and the reaction at the hinge.

Q9: A slab **AB**, 4 m × 2 m supports water as shown in **Figure 3**. The slab is hinged as the bottom. At the middle of slab, a prop is connected. The slab is at 60^o to the horizontal and prop is at 45^o with the slab. Determine the total pressure and its location. Also, determine the reaction at the prop.

Q10: A gate **AB** having a shape of a quadrant of circle of radius 2 m has to resist water force as shown in **Figure 4**. Find the resultant water pressure and its direction. Take width of gate as unity.

Q11: A radial gate shown in **Figure 5** is 0.50 m in length. Find (a) the total horizontal pressure of water on the gate (b) the total vertical pressure of water on the gate and (c) the resultant water pressure and its location.

Q12: **Figure 6** shows a gate whose profile is given by $\mathbf{x = y^{1/2}}$. It holds water to a depth of 1 m behind it. Determine the moment **M** required to hold the gate in position. The width of gate is 5 m.

Q13: An iceberg floats in an ocean so that one-eight of its volume is above the surface. Find the specific gravity of iceberg.

Q14: A stone weighs 400 N in air and when it is immersed in water; it weighs 225 N. Calculate volume and relative density of stone.

Q15: An object which has a volume of 0.18 m^3 requires a force of 270 N to keep it immersed in water. If 160 N force is required to keep it immersed in another liquid, determine specific gravity of this liquid.

Q16: A cylinder of diameter 300 mm and height 150 mm is floating in a vessel containing mercury, the depth of immersion being 80 mm. Find the metacentric height. If water is now poured into the vessel till the whole of the cylinder is immersed partly in mercury and partly in water, find the depth of immersion in mercury and water.

Q17: A wooden block (**S = 0.7**) and size 2 m × 1 m × 0.8 m is floating horizontally on the surface of water. Find metacentric height of block and comment on its stability. Also, determine angular moment for tilt of 5°.

Q18: A rectangular pontoon 12 m × 8 m × 3 m weighs 800 kN and is floating in sea water (S = 1.02). It carries a boiler of diameter 5 m and weight 500 kN. The center of gravity of the boiler and the pontoon may be assumed at their geometrical centers and on the same vertical line. Find the metacentric height and comment on the stability of the system.

Q19: A body has cylindrical upper portion of diameter 3 m and depth 1.8 m. The lower portion is a curved one which displaces a volume of 0.6 m^3 of water. The centre of buoyancy of curved portion is at a distance of 1.95 m below the top of cylinder. The centre of gravity of whole body is 1.2 m below the top of cylinder. The total displacement of water by the body is 38.3 kN. Find metacentric height of the body.

Q20: : A cone of dia. 240 mm and height 200 mm is floating in water with its vertex downward. The specific gravity of the cone is 0.80. Determine the metacentric height of cone and comment on its stability.

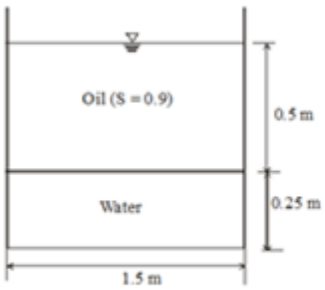

Figure 1

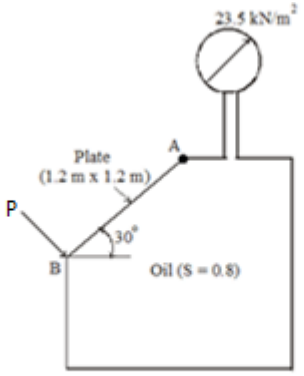

Figure 2

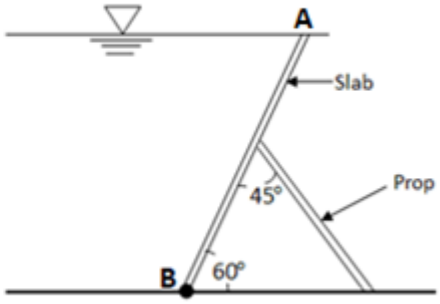

Figure 3

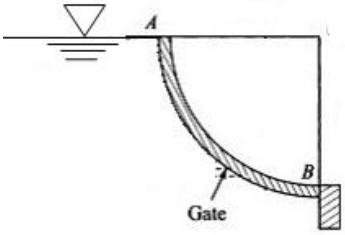

Figure 4

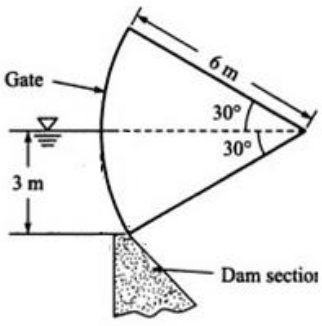

Figure 5

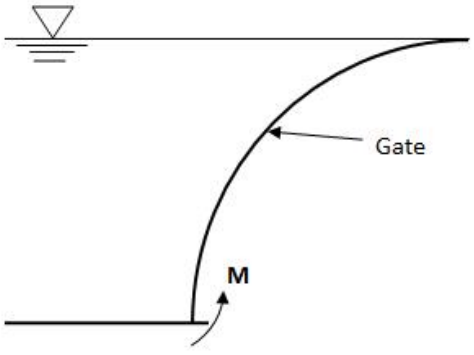

Figure 6

Answers:
Q1: 367.8 kN, 3.33 m; 662.2 kN, 4.96 m **Q2:** 59.6 kN, 1.75 m **Q3:** 6.28 kN, 0.50 m **Q4:** 196.2 kN, 1.27 m **Q5:** 57.57 kN, 0.578 m; 27.73 kN **Q6:** 2512.9 kN, 0.043 m **Q7:** 96.3 kN, 2.12 m **Q8:** 19.3 kN, 18 kN **Q9:** 67.97 kN, 1.155 m; 64.05 kN **Q10:** 36.53 kN, 57.52° **Q11:** 22.07 kN, 8, 19.92° **Q12:** 12.25 kN m **Q13:** 0.875 **Q14:** 0.0178 m^3, 2.3 **Q15:** 0.94 **Q16:** 0.035 m, 0.074 m, 0.076 m **Q17:** 0.03 m, 28.84 N m **Q18:** 1.575 m **Q19:** 0.595 m **Q20:** 0.04 m