B.TECH/CE/4TH SEM/CIVL 2204/2019
FLUID MECHANICS
(CIVL 2204)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) For a submerged curved surface, the horizontal component of the hydrostatic force is
(a) mass of the liquid supported by the curved surface
(b) weight of the liquid supported by the curved surface
(c) the total pressure force on the projected area of the curved surface on vertical plane
(d) equal to the pressure acting on the centroid.

(ii) A vertical wall is subjected to a pressure due to one kind of liquid on one of its sides of dimension 'h'. The total pressure on the wall acts at a distance _____ from the liquid surface
(a) h/3 (b) h/2 (c) 2h/3 (d) 3h/4.

(iii) A timber platform of size 4m × 2m × 0.5m and specific gravity of 0.5 floats in water. When the load on the platform is 9.81 kN, it will be submerged to a depth of
(a) 0.2 m (b) 0.375 m (c) 0.4 m (d) 0.5 m.

(iv) The ratio of the inertia and viscous forces acting in any flow ignoring other forces is called
(a) Euler number (b) Froude number
(c) Reynolds number (d) Weber number.

(v) If the same fluid is used both in the model and prototype, and if it is desired to have equal Reynolds number and Froude number in the model and prototype, the scale of the model is
(a) 3.5 (b) 2.0 (c) 1.0 (d) -6.0.

(vi) The boundary layer takes place for
(a) ideal fluids (b) real fluids
(c) pipe flow only (d) flow over flat plate only.

(vii) The discharge through a trapezoidal channel is maximum when
(a) m = d/3 (b) m = d/2 (c) m = 2d (d) m = 1.5.

(viii) Cipoletti weir is a trapezoidal weir having side slope of
(a) 1H:2V (b) 1H:4V (c) 4H:1V (d) 1H:3V.

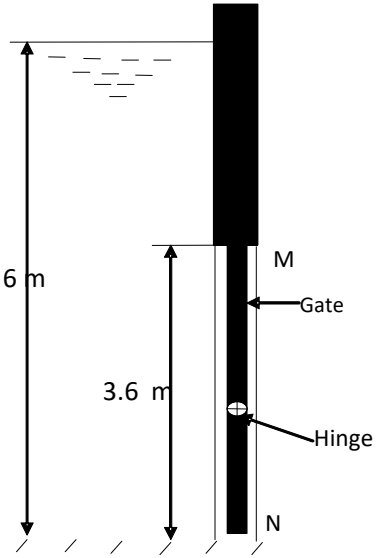
(ix) If the head on the turbine is more than 300 m, the type of turbine used should be
(a) Kaplan (b) propeller (c) Pelton (d) Francis.

(x) The specific speed (N_s) of a pump is the speed at which a pump runs when
(a) head developed is unity and discharge is one cubic metre
(b) head developed is unity and shaft horse power is also unity
(c) discharge is one cubic metre and shaft horse power is unity
(d) discharge is unity and shaft horse power is unity.

Group – B

2. (a) Find the volume of water displaced and position of centre of buoyancy for a wooden block of width 3 m, depth 2 m, when it floats horizontally in water. The density of wooden block is 600 kg/m^3 and length is 8 m.

(b) A 3.6 m by 1.5 m wide rectangular gate MN is vertical and is hinged at point 0.15 m below the centre of gravity of the gate. The total depth of water is 6 m. What horizontal force must be applied at the bottom of the gate to keep the gate closed?



6 + 6 = 12

3. (a) A most economical trapezoidal section is required to give a maximum discharge of 21.5 m^3/s of water. The slope of the channel bottom is 1 in 2500. Taking Chezy's coefficient C = $70m^{1/2}/s$, determine the dimension of the channel. Also determine value of Manning's "n", taking the value of velocity of flow as obtained for the channel by Chezy's equation.

(b) For most efficient trapezoidal channel section half of the top width must be equal to one of the sloping sides of the channel. Derive the necessary expressions to support the above statement.

8 + 4 = 12

Group – C

4. (a) Define with the help of diagram an ogee weir.

(b) Derive an equation for discharge over a rectangular weir.

(c) A sharp edged triangular notch is inserted at the side of a rectangular tank, 4 m long and 1.5 m wide. Find the time required to reduce the head in the tank from 0.5 m to 0.05 m, if the water discharges freely over the notch. Take C_d=0.6 and θ = 90°.

3+ 4 + 5 = 12

5. (a) Find the head loss due to friction in a pipe 1 m in diameter and 1.5 m long when the water is flowing with a velocity of 1 m/s by using
(i) Darcy-Weisbach equation with f = 0.005
(ii) Chezy's equation with C = 64.

(b) List out the minor losses in pipes. Define Moody's diagram and boundary layer.

6 + (3 ×2)= 12

Group – D

6. (a) Water flows from under a sluice gate into a very wide rectangular channel. The channel has a bed slope of 1 in 1000. The sluice is regulated to discharge 6 m^3/s per m width of channel, the depth at vena contracta being 0.5 m. Will a hydraulic jump form? If so determine its depth and location. Use Manning's constant n as 0.015.

(b) Prove that in a rectangular channel section, for a given specific energy 'E', the discharge per unit width 'q' is maximum when the depth of flow 'y' is equal to critical depth 'y_c'.

6+6 = 12

7. (a) Find the form of the equation for discharge Q through a sharp edge triangular notch assuming Q depends on the central angle α of the notch, head H, gravitational acceleration g and on the density ρ, viscosity μ and surface tension σ of the fluid.

(b) A shallow river is 1500 m wide and the maximum depth of flow in it is 5 m. It carries a discharge of 3000 m^3/s, and the velocity of flow being 1.5 m/s. The model of river is constructed to the horizontal scale of 1:800 and the vertical scale of 1:40. If Manning's coefficient n for the bed material in the river is 0.025, find the value of n for the bed material of the model. The hydraulic mean depth may be assumed to be equal to mean depth of flow.

6 + 6 =12

Group – E

8. (a) Define hydraulic, mechanical, volumetric and overall efficiency of a turbine. Define cavitation. What are the effects of cavitation? Give the necessary precautions against cavitation.

(b) A Francis turbine has been manufactured to develop 15000 horse power at the head of 81 m and speed 375 r.p.m. The mean atmospheric pressure at the site is 1.03 kgf/cm^2 and vapour pressure 0.03 kgf/cm^2. Calculate the maximum permissible height of the runner above the tail water level to ensure cavitation free operation. The critical cavitation factor for Francis turbine is given by

$$\sigma_c = 317\times10^{-8}\times N_s^2$$

where N_s is the specific speed of the turbine in M.K.S. units.

(3 + 5) + 4 = 12

9. (a) Draw a neat sketch of a centrifugal pump indicating its different parts. Find the number of pumps required to take water from a deep well under a total head of 89 m. All the pumps are identical and are running at 800 r.p.m. The specific speed of each pump is given as 25 while the rated capacity of each pump is 0.16 m^3/s.

(b) Differentiate between :
(i) Centrifugal pumps and reciprocating pumps
(ii) Kaplan and propeller turbines.

(3 + 4) + (2.5 + 2.5) = 12