Code: 20A01302T

R20

B.Tech II Year I Semester (R20) Supplementary Examinations August/September 2023

FLUID MECHANICS & HYDRAULIC MACHINES

(Common to CE & ME)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

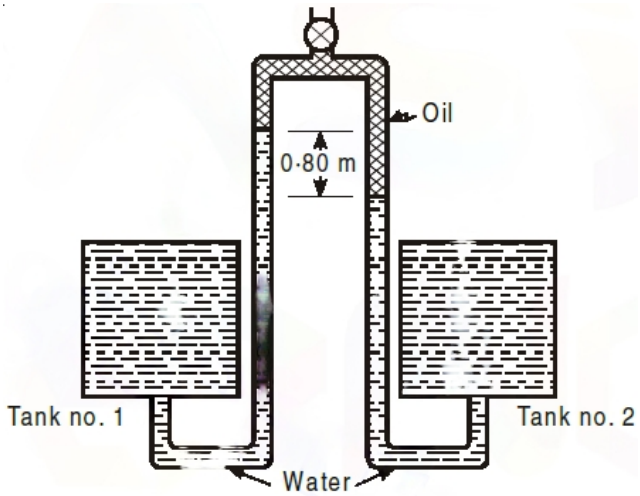
1 Answer the following: (10 X 02 = 20 Marks)

(a) (i) Write the expression for the magnitude of pressure (p)at any point if F represents the total force uniformly distributed over an area A. 2M

(ii) How do you express the pressure in SI units and in metric gravitational units?

(b) As shown in figure below, two tanks are filled with water of specific weight $9.81\frac{kN}{m^3}$. The bottoms of the tanks are connectedto an inverted $U-$tubecontaining oil weighing $8.85\frac{kN}{m^3}$. Find the difference in pressure between the two tanks when the manometer gives a reading of $0.80\ m$. 2M

$\left[\text{Hint: Use } \frac{p_1}{w}-\frac{p_2}{w}=x(S_1-S_2)\right]$



(c) Explain flow-nets and equipotential lines with neat sketches. 2M

(d) Define velocity potential and stream function. Write the expressions. 2M

(e) Differentiate between hydraulic grade line and energy grade line. 2M

(f) What are the different energy losses in pipe flow? 2M

(g) What is Chezy's equation? 2M

(h) Define critical depth and critical flow. 2M

(i) A jet of water $75mm$ diameter having a velocity of $20\frac{m}{sec}$, strikes normally a flat smoothplate. Determine the thrust on the plate if the plate is moving in the same direction as the jet with a velocity of $5\frac{m}{sec}$ and the work done. 2M

(j) List the different losses occurring during the operation of centrifugal pumps. 2M

Contd. In page 2

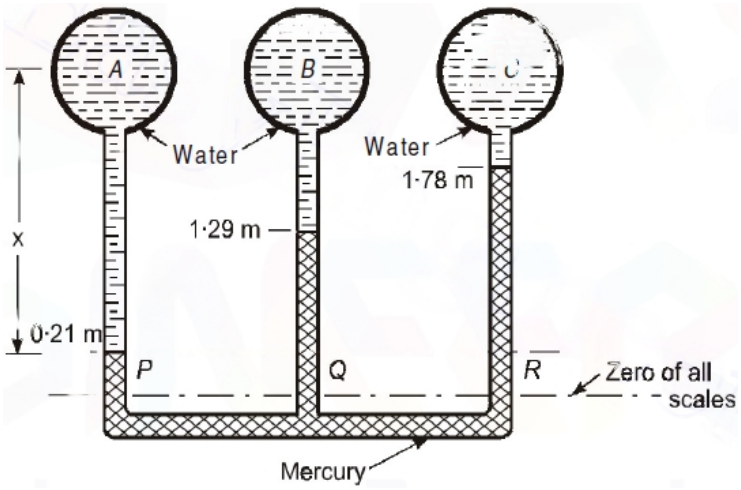
PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 (a) Sketch the diagrammatic representation of the Newtonian, non-Newtonian, plastic and ideal fluids. 4M

(b) For the multiple differential manometer shown in figure below, if points A, B and C are at the same elevation, what is the difference in pressure heads in termsof water column between A and B,between A and C and between B and C? 6M

$\left[Hint: Calculate \frac{p_A}{w} - \frac{p_B}{w}, \quad \frac{p_A}{w} - \frac{p_C}{w}, \quad \frac{p_B}{w} - \frac{p_C}{w}\right]$



OR

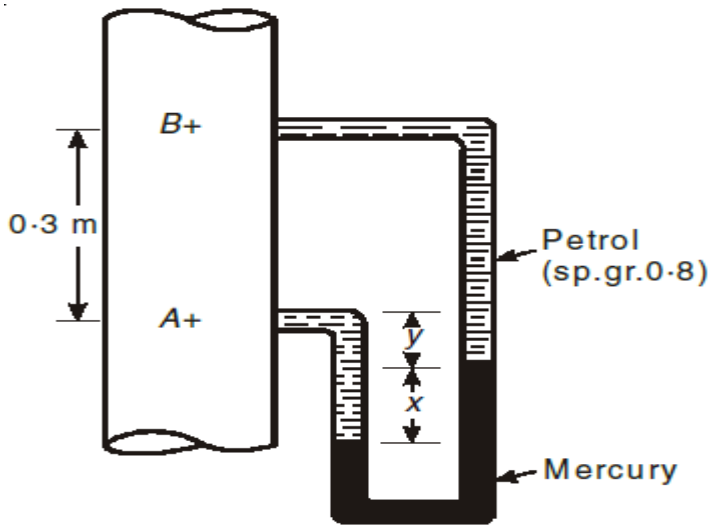
3 (a) Explain the following briefly: 4M

(i) Pascal's Law,

(ii) Relationship between absolute, gage and vacuum pressures,

(iii) Common types of simple manometers.

(b) Petrol of specific gravity 0.8 flows upwards though a vertical pipe as shown in Figure below. A and B are twopoints in the pipe, B being $0.3m$ higher than A. Connections are led from A and B to a U –tube containingmercury. If the difference of pressure between $A$and B is $0.19 \frac{kg(f)}{cm^2}$, find x, the reading shown by the differential mercury manometer gage. 6M



Contd. In page3

4 (a) (i) With a neat sketch, explain the vortex motion clearly. 4M

(ii) Derive the expressions for the flow characteristics in vortex motion.

(b) The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as: 6M

$$u = \frac{y^3}{3} + 2x - x^2y$$

$$v = xy^2 - 2y - \frac{x^3}{3}$$

(i) Show that these functions represent a possible case of an irrotational flow.

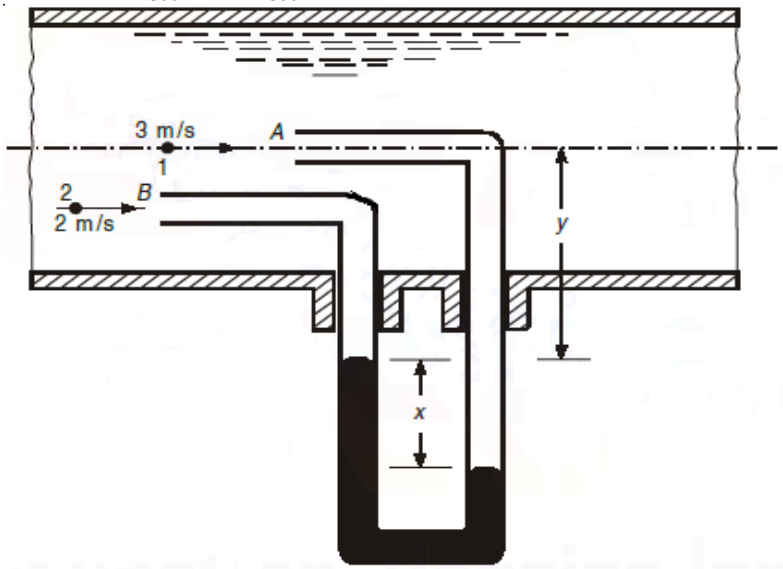
(ii) Obtain an expression for stream function (ψ).

(iii) Obtain an expression for velocity potential $(\emptyset)$.

OR

5 (a) Derive Bernoulli's equation from Euler's equation of motion. 4M

(b) Consider that the water flows in a $300mm$ pipe. As shown in Figure below, two pitot tubes are installed in the pipe, one on the centerline and the other $75mm$ from the centreline. Calculate the reading on the differential mercury manometer connected to the two tubes if the velocities at the two points are $3\frac{m}{sec}$ and $2\frac{m}{sec}$, respectively. 6M



6 (a) Laminar flow of an oil having dynamic viscosity $\mu = 1.766Pa - second$ in a $0.3\,m$ diameterpipe, the velocity distribution is parabolic with a maximum point velocity of $3\frac{m}{sec}$ at the centre of the pipe. Calculate the shearing stresses at the pipe wall and within the fluid $50\,mm$ from the pipe. 5M

(b) A liquid of specific gravity 0.88 and absolute viscosity $6.533 \times 10^{-4}\frac{N-sec}{m^2}$ flows through apipe of diameter $0.15\,m$ at the rate of $60\frac{litres}{sec}$. Determine whether the pipe is rough or smooth if the loss of head in$100m$ length of pipe is $4.56\,m$. 5M

OR

Contd. In page4

7 (a) Derive the drag coefficient for a sphere based on the Stoke's Law. 4M

(b) Water flows from a reservoir through a pipe of $0.15\ m$ diameter and $180\ m$ long to a point $13.5\ m$ below the open surface of the reservoir. Here it branches into two pipes, each of $0.1m$ diameter, one ofwhich is $48m$ long discharging to atmosphere at a point $18m$ below reservoir leveland the other $60\ m$ long discharging to atmosphere $24\ m$ below reservoir level. Calculate the discharge from each pipe assuming a constant friction coefficient of 0.032. Neglect any losses at the junction. 6M

8 (a) Show that the head loss in a hydraulic jump formed in a rectangular channel is: 5M

$$\Delta E = \frac{(V_1 - V_2)^3}{2g(V_1 + V_2)}$$

(b) A rectangular channel which is laid on a bottom slope of 0.0064 is to carry $20\frac{m^3}{sec}$ of water. Determine the width of the channel when the flow is in critical condition. Take Manning's $n = 0.015$. 5M

OR

9 (a) Write short notes on specific energy. 4M

(b) A most efficient trapezoidal section is required to give a maximum discharge of $21.5\frac{m^3}{sec}$ ofwater. The slope of the channel bottom is $1\ in\ 2500$. Taking $C = 70\ \frac{\sqrt{m}}{sec}$ in Chezy's equation, determine: 6M

(i) Dimensions of the channel,

(ii) Value of Manning's (n), taking the value of velocity of flow asobtained for the channel by Chezy's equation.

10 A centrifugal pump has an impeller $0.5\ m$ outer diameter and when running at $600\ rpm$ discharges water at the rate of $8000\frac{litres}{minute}$ against a head of $8.5\ m$. The water enters the impeller without whirl and shock. The inner diameter is $0.25\ m$ and the vanes are set back at outlet at an angle of 45^0 and the areaof flow which is constant from inlet to outlet of the impeller is $0.06\ m^2$. Determine: 10M

(i) Manometric efficiency of the pump.

(ii) Vane angle at inlet.

(iii) Least speed at which the pump commences to work.

OR

11 (a) Explain draft tube. 4M

(b) A jet of water moving at $20\frac{m}{sec}$ impinges on a symmetrical curved vane shaped to deflectthe jet through 120^0 (that is the vane angles θ and $\emptyset$ are each equal to 30^0). If the vane is moving at $5\frac{m}{sec}$, find: 6M

(i) Angle of the jet so that there is no shock at inlet,

(ii)Absolute velocity of exit in magnitude and direction.

*****

Code: 20A01302T **R20**

B.Tech II Year I Semester (R20) Supplementary Examinations April/May 2024

FLUID MECHANICS & HYDRAULIC MACHINES

(Common to CE & ME)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Define the phenomenon of Capillarity. 2M

(b) Define Metacentre and Metacentric height. 2M

(c) Describe briefly different methods of drawing flow nets. 2M

(d) Differentiate between the Eulerian and Lagrangian methods of representing fluid flow. 2M

(e) What do you mean by compound pipe, pipes in parallel and equivalent pipe? 2M

(f) State practical applications of Moody's diagram. 2M

(g) What is meant by conveyance as applied to an open channel? Write an equation for conveyance in terms of Manning's 'N'. 2M

(h) Sketch and name different drawdown curves that are formed in mild and steep channel slopes by stating the condition. 2M

(i) Define hydraulic and mechanical efficiencies as applied to hydraulic turbines. 2M

(j) Define NPSH. 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 (a) Define the following fluid properties: Density, weight density, specific volume and specific gravity of a fluid. 4M

(b) Calculate the power required to overcome the friction in a journal bearing with the following data. Diameter of shaft = 75 mm; Dia. of sleeve = 76 mm; length of sleeve = 150 mm; speed of the shaft = 500 rpm, viscosity of the lubricant = 1.8 poise. 6M

OR

3 A trapezoidal plate of parallel sides `l' and `2l' and height `h' is immersed vertically in water with its side of length `l' horizontal and topmost. The top edge is at a depth `h' below the water surface. Determine: (i) Total force on one side of the plate, (ii) Location of the centre of pressure. 10M

4 (a) Derive continuity equation in three dimensional cartesian coordinates. 5M

(b) The velocity vector in an incompressible flow is given by $V = (6xt + yz^2)I + (3t + xy^2)j + (xy - 2xyz - 6tz)K$. (i) Verify whether the continuity equation is satisfied, (ii) Determine the acceleration vector at point A (1, 1, 1) at t = 1. 0. 5M

OR

5 (a) Write Euler's equation of motion long a streamline and integrate it to obtain Bernoulli's equation. State all assumptions made. 5M

(b) A 30 cm diameter horizontal pipe terminates in a nozzle with the exit diameter of 7.5 cm. If the water flows through the pipe at the rate of 0.15 m^3/s. What force will be exerted by the fluid on the nozzle? 5M

Contd. in Page 2

6 (a) Define 'Hydraulic gradient line' and 'Total energy line'. The cross section of a pipe carrying a given discharge is suddenly enlarged. What would be the ratio of the two diameters of the pipe if the magnitude of the loss of head at this change of section is same irrespective of the direction of flow? Assume $C_C = 0.64$. 5M

(b) A pipe of diameter 20 cm and length 2000m connects two reservoirs, having difference of water levels as 20 m. Determine the discharge through the pipe. If an additional pipe of diameter 20 cm and length 1200 m is attached to the last 1200 m length of the existing pipe, find the increase in the discharge. Take f = 0.015 and neglect minor losses. 5M

OR

7 (a) Explain how Reynold's experiment is conducted in the lab and bring its practical uses. 4M

(b) In a fully rough turbulent flow in a 15 cm diameter pipe the centre line velocity is 2.50 m/s and the local velocity at mid-radius is 2.28 m/s. Find the discharge and the height of the roughness projections. 6M

8 (a) Derive Chezy's formula. Find the relation between Manning's and Chezy's Constants. 4M

(b) Water flows in a channel of the shape of isosceles triangle of bed width 'a' and sides making an angle of 45^0 with the bed. Find the relations between depth of flow'd' and bed width 'a' for maximum velocity condition and for maximum discharge condition. Use Maning's formula and note that 'd' is less than 0.5 a. 6M

OR

9 (a) Obtain an expression for the depth after the hydraulic jump and the loss of head due to the jump. Write the assumptions made. 5M

(b) A rectangular channel 7.5 m wide has a uniform depth of flow of 2.0 m and has a bed slope of 1 in 3000. If due to weir constructed at the downstream end of the channel, water surface at a section is raised by 0.75 m, determine the water surface slope with respect to horizontal at this section. Assume Maning's n = 0.02. 5M

10 (a) Show that the efficiency of a free jet striking normally on a series of flat plate mounted on the periphery of a wheel can never exceed 50%. 4M

(b) A Pelton wheel has to develop 13230 kW under a net head of 800 m while running at a speed 600 rpm. The coefficient of the jet $C_v = 0.97$, Speed ratio $K_u = 0.46$ and the ratio of jet diameter is 1/16 of wheel diameter. Determine the following: (i) The diameter of the pitch circle, (ii) The diameter of each jet, (iii) The quantity of water supplied to the wheel; and (iv) The number of jets required. 6M

OR

11 (a) What do you understand by characteristics curves of a pump? What is the significance of the characteristic curves? 4M

(b) A centrifugal pump rotating at 1000 rpm delivers 160 liters/s of water against a head of 30 m. The pump is installed at a place where atmospheric pressure is $1x10^5$ Pa(abs.) and vapour pressure of water is 2 kPa (abs.). The head loss is suction pipe is equivalent to 0.2 m of water. Calculate minimum NPSH. 6M

*****