Code No: R2021032 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, January - 2023
FLUID MECHANICS & HYDRAULIC MACHINES
(Com to ME, AME)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) A tank 20m deep and 7m wide is layered with 8m of oil, 6 m of water and 4m of mercury. Determine the total hydrostatic force and resultant centre of pressure on the side. Specific gravity of oil is 0.881 and that of mercury is 13.6. [7M]

b) Illustrate the construction and working of U-tube manometer. [7M]

OR

2 a) Analyze the effect of vapour pressure on fluid motion. [7M]

b) A circular plate of diameter 0.75m is immersed in a liquid of relative density 0.80 with its plane making an angle of 30^o with the horizontal. The centre of the plate is at a depth of 1.50m below the free surface. Calculate the total force on one side of the plate and the location of the centre of pressure. [7M]

UNIT-II

3 a) A pipe of diameter 200 mm conveys a discharge of 2250 litres of water per minute and has a pressure of 15.70 kPa at a certain section. Find the total energy head with respect to a datum of 5 metres below the pipe. [7M]

b) Derive an expression for the loss of head due to friction in a pipe line. How is the pipe coefficient f dependent on Reynolds Number [7M]

OR

4 a) In a water supply scheme, it was originally planned to provide 400 mm diameter pipe line. But it was later found that pipes of diameter more than 350 mm were not available. If it is now proposed to provide two parallel mains of the same diameter find the diameter of each parallel main pipe. [7M]

b) A pipe of diameter 500 mm and length 5000 metres connects two reservoirs A and B. The difference of water levels of these reservoirs is 20 metres. Half way along the pipe there is a branch through which water can be discharged to a third reservoir C. Find the rate of flow to the reservoir B when i) no water is discharged to the reservoir C, ii) the discharge to the reservoir C is 0.05 m^3 /sec. Take f = 0.006. [7M]

UNIT-III

5 a) Derive momentum integral equation for boundary layer theory. [7M]

b) Explain dimensional homogeneity and non dimensionalization of equations. [7M]

OR

6 a) Evaluate the parameters involved in separation of boundary layer and control of flow separation? [8M]

b) Analyze bluff body and its applications. [6M]
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UNIT-IV

7 a) Classify various types of turbines in detail. [7M]

b) A jet 200 mm diameter moving at a velocity of 20 metres per second impinges normally on a series of flat vanes mounted over a wheel. If the velocity of the vanes is 8 metres per second, find i) the force exerted by the jet on the wheel, ii) the work done by the jet on the wheel per second, [7M]

OR

8 a) Differentiate between reaction turbine and impulse turbine? Explain the importance of draft tube. [7M]

b) A turbine is working under a head of 40 m and at a speed of 1100 rpm. The power developed is 1200 K.W. Determine the speed and power when the head is reduced to 20 m. [7M]

UNIT-V

9 a) Explain the concepts of surge tank and water hammer. [5M]

b) A centrifugal pump discharge 560 liters of water per second has to develop a head of 10 meters, the speed of rotation of the impeller being 700rpm. The manometric efficiency is 85% and the loss of head in the pump due to friction is $0.025\ V_1^2$ meters of water, where V_1 is the velocity with which the water leaves the impeller. Assume that the velocity of flow through the impeller is constant at 2.50 meters per second and that there is no velocity of whirl at inlet. Determine i) The diameter of the impeller ii) the outlet area iii) The vane angle at the outlet edge of the impeller. [9M]

OR

10 a) A hydraulic turbine working under a head of 165 metres runs at 300 rpm, the discharge of the turbine being 0.60 m^3 /sec. The overall efficiency of the turbine is 85%. Find the type of turbine. [7M]

b) Define unit head, unit discharge and unit power of a turbine and derive the expressions for the same. [7M]

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UNIT-I

1 a) A pipe of 5.25 cm internal diameter and 15cm long slides down a vertical shaft of 5.0cm diameter at a constant speed of 0.1m/s. A vertical force 14.7N is required to pull the pipe back up the shaft at the same constant speed. Calculate the viscosity of oil which fills the small gap between the pipe and shaft. [7M]

b) Illustrate the construction and working of piezometer. [7M]

OR

2 a) A Plug having a cylindrical shape and diameter 150 mm and length 200 mm slides concentrically in a stationary cylinder of 150.1 mm internal diameter. If the clearance between the plug and the cylinder is filled with oil of viscosity 2.50 poise. Find the force required to slide the plug along the cylinder at a speed of 2.5 metres/sec. [8M]

b) State and explain pascal and hydrostatic laws in detail. [6M]

UNIT-II

3 a) The x and y components in a three dimensional flow are given by [7M]
$u = x^2 + z^2$ $\vartheta = y^2 + z^2$
Find the simplest z – component of velocity that satisfies the continuity equation?

b) Two reservoirs are connected by three pipes laid in parallel, their respective diameters being d, 2d, and 3d. These are all of the same length l. If f is the same for all the pipes find the discharge through the larger pipes if the discharge through the smallest is 0.05 m^3 /sec. [7M]

OR

4 a) [7M]
The 2-D flow can be described by $\mu = y/b^2$ and $\upsilon = \frac{x}{a^2}$. Show that this is the flow of an incompressible fluid and that the ellipse $x^2/a^2 + y^2/b^2 = 1$ is a streamline.

b) The centre line of a pipe conveying water is horizontal. The sectional areas at sections 1-1 and 2-2 are 5 m^2 and 2 m^2 respectively. The pressure intensity and velocity at section 1-1 are 39.25 kPa and 1.2 m/sec respectively. Calculate the velocity and pressure at section 2-2. Ignore losses. [7M]
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UNIT-III

5 a) Find the displacement thickness and wall shear stress for the velocity distribution in a boundary layer $(u / U) = (y / \delta)$ where U is the Velocity and δ is the boundary layer thickness. [7M]

b) Explain method of repeating variables and Buckingham Pi theorem. [7M]

OR

6 a) Analyze the phenomenon of boundary layer separation. [7M]

b) In a stream of oil of specific gravity 0.85 and kinematic viscosity 0.82 stokes, a plate of 45 cm length and 25 cm width moving at 5 m/sec is placed parallel to the direction of motion. Determine Boundary layer thickness at the trailing edge of the plate ii) Shear stress at trailing edge of the plate [7M]

UNIT-IV

7 a) Explain in brief i) Hydrodynamic force ii) Impact of jet iii) Velocity triangles at inlet and outlet. iv) Work done and efficiency. [8M]

b) An inward flow reaction turbine running at 450 rpm has an external diameter of 500 mm and a width of 150 mm. If guide vanes are at 150 to the wheel tangent and the absolute velocity of water at inlet is 20 metres per second. Find i) the discharge of the turbine and ii) the vane angle of the runner at inlet. [6M]

OR

8 a) A jet 120 mm in diameter moving at 20 metres per sec strikes a plate which remains at rest. Find the force exerted on the plate normal to it when i) the plate is held normal to the jet and ii) when the plate makes an angle of 60^0 to the jet. [6M]

b) A reaction turbine works at 460 rpm under a head of 110 metres. Its diameter at inlet is 1150 mm and the flow area is 0.03 metre^2. The angles made by the absolute velocity and relative velocity at inlet are respectively 18^0 and 50^0 with the tangential velocity. Determine i) The volume flow rate ii) The power developed iii) The efficiency. Assume whirl at outlet to be zero [8M]

UNIT-V

9 a) Illustrate the working of reciprocating pump with neat diagram. [7M]

b) A turbine develops 7725 kW under a head of 28 metres at 140 rpm. Calculate the specific speed of the turbine and state the type of turbine? [7M]

OR

10 a) A turbine is working under a head of 40 m and at a speed of 1100 rpm. The power developed is 1200 K.W. Determine the speed and power when the head is reduced to 20 m. [7M]

b) Analyze the different efficiencies of a centrifugal pump? Explain the methods adopted to increase the efficiency of the pump. [7M]

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UNIT-I

1 a) A glass tube of internal diameter 4 mm is immersed in a liquid of specific gravity 12.2 and surface tension 0.55 N/m. The angle of contact with the glass is 120^0. Calculate capillary rise or depression in the tube. [7M]

b) Evaluate meta center and stability of floating body. [7M]

OR

2 a) A shaft 80 mm in diameter is being pushed through a bearing sleeve 80.20mm in diameter and 300 mm long, The clearance is filled with oil having a kinematic viscosity of 0.005 m^2 /s and specific gravity 0.90. If the shaft moves axially at 0.50m/s. find the resistance offered by the oil on the shaft [8M]

b) Analyze the concepts of buoyancy and floatation. [6M]

UNIT-II

3 a) Discuss Darcy Weisbach equation and minor losses in pipes. [7M]

b) For a two dimensional potential flow, the velocity potential is given by $\phi = 4x(3y-4)$, determine the velocity at the point (2, 3) and also the value of stream function at the point (2, 3). [7M]

OR

4 a) Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into considerations? [7M]

b) A bend in pipe line conveying water gradually reduces from 60cm to 30cm diameter and deflects the flow through the angle of 60^0. At the larger end the gauge pressure is 1.75 Kg/cm^2. Determine the magnitude and direction of force exerted on the bend, when there is no flow and when the flow is 876 lit/sec. [7M]

UNIT-III

5 a) Discuss the causes leaving to separation of boundary layer. [7M]

b) The velocity distribution in the boundary layer was found to fit the equation $(u/U) = (y/d)^{1/7}$. Find the displacement thickness? [7M]

OR

6 a) Explain the effect of pressure gradient on boundary layer separation. [7M]

b) Analyze the concepts of velocity profiles in detail. [7M]
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UNIT-IV

7 a) A jet of water strikes a flat plate normally at 30 m/s at a point 150 mm below the top- of the plate. If diameter of the jet is 25 mm, what force should be applied at 100 mm below the axis of the jet, in order to keep the plate vertical. [7M]

b) Illustrate the working of Pelton wheel with neat diagram. [7M]

OR

8 a) Explain flow over radial vanes in detail. [6M]

b) A Francis turbine working under a head of 14 m, has guide blade angle of 20^0 and radial vanes at inlet. The ratio of inlet and outlet diameters is 1.5. The velocity of flow of water at exit is 4 m/s. Assuming the velocity of flow to be constant, determine the peripheral velocity of water at inlet and the vane angle at outlet. [8M]

UNIT-V

9 a) Explain advantages, limitations and applications of fluidics. [6M]

b) A centrifugal pump is discharging water at the rate of 500 lt/min at 1200 RPM. The internal and external diameters and width of impellers are 12 cm and 24 cm and 16 mm and 8 mm respectively. The vanes are curved back 25^0 to the tangent at outlet. Find the increase in pressure, as water passes through the impeller. [8M]

OR

10 a) Explain the working of hydraulic system with neat sketch. [7M]

b) A centrifugal pump is required to lift water to a total head of 40 m at the rate of 50 H/s. Find the power required for the pump, if the overall efficiency is 62%. [7M]

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UNIT-I

1 a) A piston 99.5mm diameter works in a cylinder 100 mm diameter, 120mm long. The space between the two is filled with lubricating oil of viscosity 0.05 poise. Calculate the speed of the piston through the cylinder under the action of an axial force of 5 N. [7M]

b) Define manometer? Explain the working of differential manometer with neat sketch. [7M]

OR

2 a) Show that the centre of pressure of any lamina immersed under liquid is always below its centroid. [7M]

b) An open tank contains water for a depth of 2 metres and above it oil for a depth of 1 metre. If oil has a specific gravity of 0.8. find the pressure intensity (i) at the interface of the two liquids and (ii) at the bottom of the tank [7M]

UNIT-II

3 a) Derive Bernoulli's equation for the flow of an incompressible frictionless fluid from consideration of momentum. [7M]

b) Explain momentum equation and its application on force on pipe bend. [7M]

OR

4 a) Analyze the equation of continuity for one dimensional flow, circulation and vorticity? [6M]

b) A pipe 300 meters long has a slope of 1 in 100 and tapers from 1.20 m diameter at the high end to 0.6 m diameter at the low end. The rate of flow of water through the pipe is $0.10 m^3$/sec. If the pressure at the high end is 73.575 kPa, find the pressure at the low end. Neglect losses. [8M]

UNIT-III

5 a) Explain the boundary layer separation with a neat sketch. [6M]

b) Prove that the boundary shear stress is directly proportional to the pressure gradient and the boundary spacing for the case of laminar flow between parallel flat plates when both the plates are at rest. [8M]

OR

6 a) Differentiate between stream line body and bluff body. [6M]

b) Derive an expression for the momentum thickness of boundary layer. [8M]
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UNIT-IV

7 a) Derive an expression for maximum efficiency of pelton wheel in terms of jet deflection angle. [5M]

b) A jet of water delivers 0.56 m^3 /sec with a velocity of a 24 metres/sec and impinges tangentially on a vane moving in the direction of the jet with a velocity of 12 metres per second. The value is so shaped that if stationary it would deflect the jet through an angle of 45^0. Through what angle will the jet be actually deflected? What driving force will be exerted on the vane in the direction of motion? [9M]

OR

8 a) How is Kaplan Turbine different from Francis Turbine? What is speed ratio and flow ratio of Kaplan Turbine? Why are hydraulic losses less in Kaplan Turbine than in Francis Turbine? [7M]

b) A Kaplan turbine working under a head of 18 metres develops 18390 kW at an overall efficiency of 85%. The boss diameter is 0.3 times the runner diameter. If the velocity of flow is 9.05 metres per second, calculate the discharge and the diameters of the runner and the boss. [7M]

UNIT-V

9 a) A turbine is to operate under a head of 30 metres at 250 rpm. The discharge is 10.5 m^3 /sec. If the efficiency is 85%, determine i) Power generated ii) The specific speed of the turbine iii) Type of turbine iv) Performance under a head of 25 metres. [8M]

b) Define Cavitation. Explain how it is detected. What are the effects of Cavitation? Explain how Cavitation can be avoided. [6M]

OR

10 a) Explain fluidics with amplifiers, sensors and oscillators. [7M]

b) A centrifugal pump works against a head of 20 m. If the outer and inner diameters of the impeller are 30cm and 18cm respectively determine the minimum starting speed. [7M]