

R18

Code No: 154AZ

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year II Semester Examinations, April/May - 2023

FLUID MECHANICS AND HYDRAULIC MACHINES

(Mechanical Engineering)

Time: 3 Hours

Max. Marks: 75

Note: i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A**(25 Marks)**

- 1.a) Define mass density and specific weight. [2]
- b) What is specific gravity? How is it related to density? [3]
- c) What do you understand by hydrostatic law? [2]
- d) Differentiate between rotational and irrotational flow. [3]
- e) Write down the expression for capillary fall. [2]
- f) Define Bernoulli's equation with assumptions. [3]
- g) What is the need for priming in pump? [2]
- h) Explain vapor pressure and cavitation. [3]
- i) What is the function of impeller? [2]
- j) What does indicator diagram indicates? [3]

PART – B**(50 Marks)**

- 2.a) Calculate specific weight, density and specific gravity of two liters of a liquid which weigh 15 N.
- b) The capillary rise in the glass tube is not to exceed 0.2mm of water. Determine its minimum size given that surface tension of water in contact with air is 0.0725 N/m. [5+5]

OR

- 3.a) Explain centre of pressure and total pressure, also derive an expression for it when the plate is imaged vertically.
- b) Define pressure. Obtain an expression for the pressure intensity at a point in a fluid. [5+5]
- 4.a) Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43N/cm² and with mean velocity of 2m/sec. Find the total head or total energy/unit weight of water at a cross section which is 5m above datum line.
- b) Write Euler's equation of motion long a streamline and integrate it to obtain Bernoulli's equation. State all assumptions made. [5+5]

OR

- 5.a) An oil of viscosity 0.1N/m² and relative density 0.9 is flowing through a circular pipe of diameter 50mm and of length 300mm. The rate of flow of fluid through the pipe is 3.5litre/sec. Find the pressure drop in a length of 300m.
- b) What are the losses experienced by a fluid when it is passing through a pipe? [5+5]

- 6.a) Discuss the following:
i) The concept of the boundary layer with reference to fluid motion over a flat plate
ii) Phenomenon of separation for flow over curved surfaces.
- b) Find the loss of head when a pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. The rate of flow of water through the pipe is 250 litres/sec. [5+5]

OR

- 7.a) What do you mean by pipes in series and pipes in parallel arrangements and what is its applications?
- b) Crude oil of kinematic viscosity 0.4 stoke is flowing through a pipe of diameter 300 mm at the rate of 300 litres/sec. Find the head lost due to friction for a length of 50 m of the pipe. [5+5]

- 8.a) Draw main characteristic curves of hydraulic turbine.
- b) A Pelton wheel is to be designed for the following specifications. Shaft power = 11772 kw, Head = 380 m, speed = 750 rpm, overall efficiency = 86%, jet diameter not to exceed 1/6 of wheel diameter. Determine i) Wheel diameter ii) Number of jets required
iii) Diameter of jet Coefficient of viscosity = 0.985, speed ratio = 0.45. [5+5]

OR

- 9.a) With the help of neat diagram explain the construction and working of a radial flow reaction turbine.
- b) A jet of water of diameter 10cm strikes a flat plate normally with a velocity of 15m/sec. The plate is moving with a velocity of 6m/sec in the direction of jet and away from it. Find i) force exerted by the jet on the plate ii) work done by jet on plate/sec. iii) power of the jet. [5+5]

- 10.a) The internal and external diameters of the impeller of a centrifugal pump are 200mm and 400 mm respectively. The pump is running at 1200 rpm the vane angles of the impeller at inlet and outlet are 200 and 300 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller /unit weight of water.
- b) Write about (i) various efficiencies of centrifugal pump (ii) characteristic curves of centrifugal pump. [5+5]

OR

- 11.a) What is a reciprocating pump? Describe the principle and working of a reciprocating pump with a neat sketch.
- b) A centrifugal pump is to discharge $0.118\text{m}^3/\text{sec}$ at a speed of 1450 rpm against a head of 25m. The impeller diameter is 250mm, its width at outlet is 50mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller.[5+5]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**B. Tech II Year II Semester Examinations, August/September - 2021****FLUID MECHANICS AND HYDRAULIC MACHINES****(Mechanical Engineering)****Time: 3 Hours****Max. Marks: 75****Answer any five questions****All questions carry equal marks**

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- 1.a) Find the height through which water rises by capillary action in a glass tube of 2 mm bore if the surface tension at the prevailing temperature is 0.075 g/cm.
- b) When 12 liters of a liquid of sp.gr. 1.3 is mixed with nine liters of a liquid of Sp. gr. 0.8. and the bulk of the liquid shrinks 1% on mixing, calculate the Sp.gr, the volume and the weight of the mixture. [8+7]
- 2.a) Define the terms gauge pressure, vacuum pressure and absolute pressure? Indicate their relative positions on a chart.
- b) Prove that the pressure is the same in all directions at a point in a static fluid. [8+7]
- 3.a) Define and distinguish between:
i) Steady flow and Unsteady flow ii) Rotational and Irrotational flow.
- b) What is meant by one dimensional, two dimensional and three dimensional flows? Give the examples. [8+7]
- 4.a) When 2500 liters of water flows per minute through a 0.3m dia pipe, which later reduces to a 0.15 diameter pipe. Calculate the velocity of flow in the two pipes.
- b) Explain how Bernoulli's equation which is valid for Irrotational fluids, can be used to solve real fluid flow problems. [8+7]
- 5.a) Explain the following terms with respect to boundary layers flows.
i) Local drag coefficient ii) Velocity defect iii) Critical roughness.
- b) Differentiate between major and minor losses in flow through pipes. [8+7]
- 6.a) A thin and long flat plate is placed with zero incidence position and parallel to a free stream of water flows over it at 6m/sec. The kinematic viscosity of water is 1×10^{-6} . At what distance from the leading edge will the laminar boundary layer over plate reaches its critical zone?
- b) Write about Venturi meter along with a neat sketch. [6+9]
- 7.a) Describe the advantages of a Kaplan turbine over Francis turbine.
- b) Describe the working of a Pelton wheel. [8+7]
- 8.a) What is an air vessel? Describe its function in reciprocating pumps.
- b) Define Static head, Manometric head and Total head.
- c) Explain briefly:
i) Manometric efficiency ii) Overall efficiency. [6+3+6]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech II Year II Semester (Special) Examinations, January/February - 2021
FLUID MECHANICS AND HYDRAULIC MACHINES
(Mechanical Engineering)

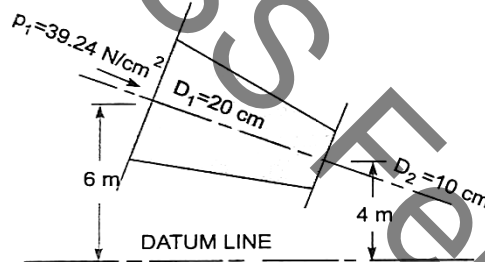
Time: 2 Hours

Max. Marks: 75

Answer any five questions
All questions carry equal marks

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1. Define pressure. Obtain an expression for pressure intensity at a point in a fluid. [15]
2. Differentiate between:
 - a) Absolute and gauge pressure
 - b) Simple manometer and differential manometer
 - c) Piezometer and pressure gauge. [5+5+5]
3. Write Euler's equation of motion along a stream line and integrate it to obtain Bernoulli's equation. State all the assumptions. [15]
4. The water is flowing through a pipe having diameter of 20 cm and 10 cm at section 1 and 2 respectively. The rate of flow through pipe is 35 litres/s. The section 1 is 6m above datum and section 2 is 4 m above datum. If the pressure at section 1 is 39.24 N/cm^2 , find the intensity of pressure at section 2. [15]



5. How will you measure the loss of head due to friction in pipes by using:
 - a) Darcy formula and
 - b) Chezy's formula? [7+8]
6. Obtain an expression for boundary shear stress in terms of momentum thickness. [15]
7. What do you mean by gross head, net head and efficiency of the turbine? Explain the different types of the efficiencies of a turbine. [15]
8. What is meant by Priming of a pump? What are the different priming arrangements employed for small and big pumping units? [15]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**B. Tech II Year II Semester Examinations, July/August - 2021****FLUID MECHANICS AND HYDRAULIC MACHINES****(Mechanical Engineering)****Time: 3 Hours****Max. Marks: 75****Answer any five questions****All questions carry equal marks**

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- 1.a) What is differential manometer? Explain how it works?
b) Find the pressure in N/m^2 represented by a column of 10 cm of water. 4 cm of oil of relative density 0.89 and 2 cm of mercury of specific gravity 13.6. Specific weight of water is 9810 N/m^3 . [7+8]
- 2.a) Derive the continuity equation in Cartesian coordinates for one-dimensional flow.
b) Derive the expression for Bernoulli's theorem for steady incompressible fluid from first principle. What are the limitations of the Bernoulli's equation? [7+8]
- 3.a) Explain what do you understand by Hydraulic Grade Line and Total Energy Line. Discuss its practical significance in analysis of fluid flow problems.
b) Two pipes each 300m long are available for connecting to a reservoir from which a flow of $0.085 \text{ m}^3/\text{s}$ is required. If the diameters of the two pipes are 300mm and 150mm respectively. Determine the ratio of head lost when the pipes are connected in series to the head lost when they are connected in parallel. Neglect minor losses. [7+8]
4. A 20m/s velocity jet of water 5cm in diameter strikes perpendicularly a flat smooth plate. Determine the force exerted by the jet on the plate, if
a) The plate is at rest.
b) Moves in the direction of jet with a velocity of 8m/s . Draw the relevant sketches in the two cases. Also determine the work done in each case and efficiency of jet in the second case. [7+8]
- 5.a) What do you understand by hydroelectric power station? What are its types?
b) A jet of water of diameter 7.5 cm strikes a curved plate at its centre with a velocity of 20 m/s . The curved plate is moving with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of 165° . Assuming the plate smooth find:
i) Force exerted on the plate in the direction of jet.
ii) Power of the jet
iii) Efficiency of the jet. [7+8]
- 6.a) Define unit speed, unit power and specific speed as used in connection with the operation of a hydraulic machine.
b) A hydraulic turbine is to develop 845.6 kW power when running at 100 rpm under a head of 10 m . Work out the maximum flow rate and specific speed for the turbine if the overall efficiency at the best operating point is 92% . In order to predict its performance, a $1:10$ scale model is tested under a head of 6 m . what would be the speed, power, output and water consumption of the model if it runs under the similar conditions to the prototype? [7+8]

- 7.a) Obtain an expression for the work done by impeller of a centrifugal pump on water per second per unit weight of water.
- b) The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. [7+8]
- 8.a) Obtain expression for head loss in a sudden expansion in the pipe. List all the assumptions made in the derivation.
- b) Find the loss of head when pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. the rate of flow of water through the pipe is 250 litres/s. [7+8]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**B. Tech II Year II Semester Examinations, March - 2022****FLUID MECHANICS AND HYDRAULIC MACHINES****(Mechanical Engineering)****Time: 3 Hours****Max. Marks: 75****Answer any five questions
All questions carry equal marks**

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- 1.a) What is capillarity? Derive an expression for height of a capillary rise.
- b) What is the difference between cohesion and adhesion?
- c) Determine the minimum size of glass tube that can be used to measure water level, if the capillary rise in the tube is not to exceed 0.25 mm. Take surface tension of water in contact with air as 0.0735 N/m. [5+5+5]
- 2.a) Derive an expression for capillary fall.
- b) Calculate the capillary rise in a glass tube 2.5 mm diameter when immersed vertically in: i) water ii) mercury. Take surface tension = 0.00725 N/m for water surface tension = 0.52 N/m for mercury in contact with air. The specific gravity of mercury is given as 13.6 and angle of contact = 130° . [7+8]
- 3.a) State the momentum equation. How will you apply momentum equation for determining the force exerted by a flowing liquid on a pipe bend?
- b) A 45° reducing bend is connected in a pipe line, the diameter at the inlet and outlet of the bend being 600 mm and 300 mm respectively. Find the force exerted by the water on the bend if the intensity of pressure at inlet to bend is 8.829 N/cm^2 and rate of flow of water is 600 litres/ s. [7+8]
4. Explain the uniform flow with source and sink. Obtain expressions for stream and velocity potential functions. [15]
5. Explain the principle working of a: a) Orifice meter b) pitot tube and c) rotameter. [5+5+5]
- 6.a) Show the governing mechanism of a Pelton wheel turbine with a neat sketch and explain how it works.
- b) A Pelton wheel has a mean bucket speed of 10 meters per second with a jet of water flowing at the rate of 700 litres/s under a head of 30 meters. The buckets deflect the jet through an angle of 160° . Calculate the power given by water to the runner and hydraulic efficiency of the turbine. Assume co-efficient of velocity as 0.98. [7+8]

- 7.a) Briefly explain about governing of turbine.
- b) A turbine operates under a head of 25 m and 200 r.p.m. The discharge is 9 cumecs. If the efficiency is 90%, determine the performance of the turbine under a head of 20 meters. [7+8]
- 8.a) Define cavitation, Effects of cavitation.
- b) A double-acting reciprocating piston pump is pumping water (diameter of the piston 250 mm, diameter of piston rod which is on one side of piston 50 mm, piston stroke 380 mm). The suction and discharge heads are 4.5 m and 18.6 m respectively. Find the work done by the piston during outward stroke. Would the work done change for the inward stroke? [5+10]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year II Semester Examinations, November/December - 2020
FLUID MECHANICS AND HYDRAULIC MACHINES
(Mechanical Engineering)

Time: 2 hours

Max. Marks: 75

Answer any five questions
All questions carry equal marks

- 1.a) What is the difference between the dynamic viscosity and kinematic viscosity? State their units of measurements.
- b) A soap bubble 51 mm in diameter has an internal pressure in excess of outside pressure of $0.00021 \text{ kg(f)/cm}^2$. Calculate the surface tension in the soap film. [8+7]
- 2.a) Prove that the pressure is the same in all directions at a point in a static fluid.
- b) An inverted differential manometer containing an oil of specific gravity 0.9 is connected to find the difference of pressures at two points of a pipe containing water. If the manometer reading is 40 cm, find the difference of pressures. [8+7]
3. Define the equation of continuity. Obtain an expression for continuity equation for three dimensional flow. [15]
- 4.a) State the Bernoulli's theorem. Mention the assumptions made. List out the Engineering applications.
- b) Show that in case of forced vortex flow, the rise of liquid level at the ends is equal to fall of liquid level at axis of the rotation. [8+7]
5. Determine the rate of flow of water through a pipe of diameter 20 cm and length of 50 m when one end of pipe is connected to a tank and other end of pipe is open to the atmosphere. The pipe is horizontal and height of water in the tank is 4 m above the centre of the pipe. Consider all minor losses and take $f = 0.009$. [15]
6. Find the displacement thickness, energy thickness and momentum thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at distance y from the plate and $u=U$ at $y=\delta$, where δ = boundary layer thickness. Also calculate the value of δ^*/Θ . [15]
7. What is draft tube? Describe with sketch two different types of draft tubes. Why it is used in reaction turbine. [15]
- 8.a) Explain the working principles of reciprocating pump with a neat sketch.
- b) A single acting reciprocating pump, running at 50 r.p.m. deliver $0.01 \text{ m}^3/\text{s}$ of the water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine i) the Theoretical discharge of the pump ii) Coefficient of the discharge and iii) slip and percentage of the slip. [8+7]