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## NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - THEORY EXAMINATION (2021 - 2022)

Subject: Fluid Mechanics &amp; Fluid Machines

Time: 3 Hours

Max. Marks: 100

## General Instructions:

1. The question paper comprises three sections, A, B, and C. You are expected to answer them as directed.
2. Section A - Question No- 1 is 1 mark each & Question No- 2 carries 2 mark each.
3. Section B - Question No-3 is based on external choice carrying 6 marks each.
4. Section C - Questions No. 4-8 are within unit choice questions carrying 10 marks each.
5. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

## SECTION A

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## 1. Attempt all parts:-

- 1-a. For an incompressible fluid, does density vary with temperature and pressure? (CO1) 1
- (a) It varies for all temperature and pressure range
  - (b) It remains constant
  - (c) It varies only for lower values of temperature and pressure
  - (d) It varies only for higher values of temperature and pressure
- 1-b. The specific volume of a liquid is the reciprocal of (CO1) 1
- (a) weight density
  - (b) mass density
  - (c) specific weight
  - (d) specific volume
- 1-c. The characteristic of Ideal fluid are (CO2) 1
- (a) compressible
  - (b) viscid
  - (c) Inviscid, Incompressible
  - (d) Shear stress has a constant, non zero value
- 1-d. If a liquid enters a pipe of diameter  $d$  with a velocity  $v$ , what will it's velocity at the exit if the diameter reduces to  $0.5d$ ? (CO2) 1
- (a)  $v$
  - (b)  $0.5v$
  - (c)  $2v$
  - (d)  $4v$
- 1-e. Which property of the fluid accounts for the major losses in pipes? (CO3) 1
- (a) density
  - (b) specific gravity
  - (c) viscosity
  - (d) compressibility
- 1-f. How does a turbulent boundary layer produce swirls? (CO3) 1
- (a) Due to random motion
  - (b) Collision of molecules
  - (c) Due to eddies
  - (d) Due to non-uniform cross section

- 1-g. \_\_\_\_\_ is an inward radial flow reaction turbine (CO4) 1
- (a) Pelton turbine  
 (b) Kaplan turbine  
 (c) Francis turbine  
 (d) Propeller turbine
- 1-h. A hydraulic coupling belongs to the category of (CO4) 1
- (a) Energy absorbing machines  
 (b) Energy generating machines  
 (c) Power absorbing machines  
 (d) Energy transfer machines
- 1-i. Reciprocating pump is a (CO5) 1
- (a) Negative displacement pump  
 (b) Positive displacement pump  
 (c) Diaphragm pump  
 (d) Emulsion pump
- 1-j. Centrifugal pumps transfer energy from (CO5) 1
- (a) Rotor to fluid  
 (b) Fluid to rotor  
 (c) Draft to rotor  
 (d) None of the mentioned

2. Attempt all parts:-

- 2.a. Define Bernoulli's equation with assumptions. (CO1) 2
- 2.b. Explain hydraulic gradient line and total energy line. (CO2) 2
- 2.c. What is meant by water hammer? (CO3) 2
- 2.d. Describe specific speed of turbine, mention its expression also. (CO4) 2
- 2.e. What is slip of reciprocating pump? (CO5) 2

SECTION B

30

3. Answer any five of the following:-

- 3-a. The dynamic viscosity of an oil used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm, calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the film is 1.5 mm. (CO1) 6
- 3-b. What is Surface Tension? Give the mathematical expression of surface tension for a soap bubble and water droplet? (CO1) 6
- 3-c. Prove that stream lines and lines of constant potential are orthogonal to each other. (CO2) 6
- 3-d. If for a 2-D potential flow, the velocity potential is given by  $\Phi = x(2y - 1)$ . Determine the velocity at the point P(4, 5). Determine also the value of stream function at the point P. (CO2) 6
- 3.e. Briefly explain resistance to flow ? Discuss major losses and minor losses in detail. (CO3) 6
- 3.f. A turbine is to operate under a head of 25m at 200 rpm. The discharge is 9 m<sup>3</sup>/s. If the efficiency is 90% determine. a) specific speed of the machine b) power generated. (CO4) 6
- 3.g. A single acting reciprocating pump has the plunger diameter of 20 cm and stroke of 30 cm. The pump discharges 0.53 m<sup>3</sup> of water per minute at 60 rpm. Find (i) Theoretical discharge (ii) Coefficient of discharge (iii) Percentage slip of the pump. (CO5) 6

SECTION C

50

4. Answer any one of the following:-

- 4-a. Explain hydrostatic law and pascals law. Also Derive the expression for hydrostatic law. (CO1) 10

- 4-b. A venturi-meter of  $D/d = 0.6$  fitted in a pipe of 20 cm diameter, the throat being 30 cm above the inlet. Determine (a). Pressure difference recorded by pressure gauges at inlet and throat. (b). Difference in head in terms of Hg when it is measured by using U-tube manometer. The liquid flowing through the pipe is oil of Specific gravity = 0.8, Take Coefficient of discharge = 0.965. (CO1) 10
5. Answer any one of the following:-
- 5-a. The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as  $u = y^3/3 + 2x - x^2y$ ,  $v = xy^2 - 2y - x^3/3$ . Show that these functions represent a possible case of an irrotational flow. Obtain an expression for stream function and velocity potential. (CO2) 10
- 5-b. Using Buckingham's pi theorem, show that the discharge, Q consumed by an oil ring is given by,  $Q = Nd^3 \Phi [\mu/(\rho Nd^2), (\sigma/(\rho N^2 d^3)), w/(\rho N^2 d)]$  Where, d is internal diameter of ring, N is rotational speed,  $\rho$  is density,  $\mu$  is viscosity,  $\sigma$  is surface tension and w is the specific weight of oil. (CO2) 10
6. Answer any one of the following:-
- 6-a. Derive the expression for head loss in pipe flow due to friction. (CO3) 10
- 6-b. A pipe of diameter 300 mm and length 3500 m is used for the transmission of power by water. The total head at the inlet of the pipe is 500 m. Find the maximum power available at the outlet, if the value of friction factor = 0.006. (CO3) 10
7. Answer any one of the following:-
- 7-a. A jet of water moving at 12 m/s impinges on a concave shaped vane to deflect the jet through  $120^\circ$  when stationary. The vane is moving at 5 m/s. Assuming the vane is smooth, find (i) The angle of jet so that there is no shock at inlet. (ii) The absolute velocity of the jet at exit both in magnitude and direction. (iii) The work done per second per N of water. (CO4) 10
- 7-b. Describe working and constructional features of Pelton turbine. Also explain different efficiencies of the turbine.(CO4) 10
8. Answer any one of the following:-
- 8-a. Define Manometric head and Manometric efficiency, mechanical efficiency and overall efficiency of a centrifugal pump. A single acting reciprocating pump, running at 50 rpm delivers 0.00736 m<sup>3</sup>/s of water. The diameter of the piston is 200 mm and stroke length 300 mm. The suction and delivery heads are 3.5 m and 11.5 m respectively. Determine, (i) Theoretical discharge (ii) Coefficient of discharge (iii) Percentage slip of the pump (iv) Power required to run the pump. (CO5) 10
- 8-b. A centrifugal pump having outer diameter equal to two times of inner diameter and running at 1000 rpm. Works against a head of 40 m, the velocity of flow through the impeller is constant and equal to 2.5 m/s; the vanes are set back at an angle of  $40^\circ$  at outlet. If the outer dia. of the impeller is 500 mm and width at the outlet is 50 mm. Determine, (i) Vane angle at inlet (ii) Work done by impeller on water per second (iii) Mechanical efficiency. (CO5) 10