Register No.: …… Name: ……..

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (S), MAY 2022

MECHANICAL ENGINEERING

(2020 SCHEME)

Course Code: **20MET203**

Course Name: **Mechanics of Fluids**

Max. Marks: **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. State Newton's Law of Viscosity, give its applications and obtain an expression for dynamic viscosity of the fluid.
2. Mention the characteristic fluid properties to which the following phenomenon are attributable and justify your answer: (i) Rise of sap in a tree (ii) Spherical shape of a drop of a liquid (iii) Cavitation.
3. Define the following terms, with neat sketches
   i) Stream line, ii) Streak line and iii) Path line.
4. Explain briefly about i) Stream function and ii) Velocity potential function.
5. Explain Reynolds number and state its significance
6. With a neat sketch, explain briefly the working principle of Pitot static tube.
7. Obtain the condition for Maximum power transmission through pipes
8. Explain briefly on any three minor losses in flow through pipe lines.
9. Define the following terms related to Boundary layer.
   i) Displacement Thickness
   ii) Momentum Thickness
   iii) Energy Thickness
10. Explain briefly the different types of hydraulic similarities that must exist between a prototype and its model.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Blood Pressure is usually stated as the ratio of the maximum pressure (systolic pressure) to the minimum pressure (diastolic pressure). A typical value of this ratio for a human being would be 120/80, where the pressures are in mm of Hg. What would these pressures be in Pascal and in kgf/cm^2? (4)

b) An unknown immiscible liquid seep into the bottom of an open oil tank. Measurements indicate that the depth of the unknown liquid is 1.8m and the depth of the oil (specific gravity 0.83) lying on top is 5.2 m. A pressure gauge connected to the bottom of the tank reads 69 kPa. What is the Specific gravity of the unknown liquid? (10)

OR

12. a) A shaft having 180 mm diameter rotates in a bearing 150 mm long. The two surfaces are separated by an oil film 1.5 mm thick. The dynamic viscosity of the oil is 2.5 Poise. Determine the Torque to be applied to run the shaft at 500 rpm. Also estimate the Power required (in kW) to maintain that speed. (7)

b) Explain the Capillary effect with neat sketches and determine the capillary rise/ depression, when a glass tube of 0.5mm radius is inserted vertically in (a) water and (b) mercury, at 20^0C. Assume the surface tension and contact angle for water – air – glass interface as 0.0735 N/m and 0^0 respectively and the corresponding values for mercury– air – glass interface as 0.48 N/m and 130^0 respectively, at 20^0C. (7)

MODULE II

13. a) The velocity vector in a fluid flow is given by $V = 4x^3i - 10x^2yj + 2tk$. Find the velocity and acceleration of a fluid particle at (2,1,3) at time t = 1 sec. (8)

b) Distinguish between
i) Rotational flow and Irrotational flow
ii) Steady flow and Unsteady Flow (6)

OR

14. a) The velocity vector representing a flow field is given by $V = 7x^3i - 21x^2yj$ Determine whether the flow is
(i) physically possible or not
(ii) steady or unsteady
(iii) uniform or non-uniform
(iv) 1D, 2D or 3D
(v) Rotational or Irrotational. (10)

b) Prove that the Streamlines and Equipotential lines in a flow field are orthogonal. (4)

MODULE III

15. a) Derive Euler's equation and hence deduce the expression for Bernoulli's Equation. State the assumptions made for such derivation. (10)

b) Define Hydraulic Coefficients of an orifice. (4)

OR

16. a) Explain the principle of Venturimeter with a neat sketch and establish an expression for the actual rate of flow through it. (8)

b) A submarine moves horizontally in sea and has its axis below the water (6)

surface. A pitot tube is placed in front of the submarine along its axis is connected to the two limbs of a U- tube containing mercury. The difference in mercury level is found to be 190 mm. Find the speed of submarine in km/hr, knowing that specific gravity of sea water is 1.02.

MODULE IV

17. a) An oil of specific gravity 0.9 and viscosity 10 poise is flowing through a pipe of diameter 110 mm. The velocity at the centre is 2 m/s, find :
(i) the Pressure gradient in the direction of flow
(ii) Shear stress at the pipe wall; (10)
(iii) Reynold's number; and
(iv) Velocity at a distance 30 mm from the wall.

b) Explain water hammer effect. (4)

OR

18. a) Derive Hagen Poiseuille equation for fully developed laminar flow in a circular pipe from the first principles. (10)

b) What is equivalent length of pipe? (4)

MODULE V

19. a) Explain characteristics of laminar and turbulent boundary layer (5)

b) Due to turbulent flow, the pressure drop ΔP in a pipe (diameter D and length L) depends on mass density ρ, viscosity μ of the flowing fluid, mean velocity of flow (V) and average height of roughness projections on the pipe surface (K). Obtain a dimensionless expression for ΔP by Buckingham's π theorem. Hence Show that $h_f = (4fLV^2/2gd)$. (9)

OR

20. a) Derive Von Karman Momentum Integral Equation for Boundary layer applications (10)

b) Write short note on Model Studies and Model Laws (4)

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