USN | | | | | | | | | |

18ME43

Fourth Semester B.E. Degree Examination, Feb./Mar.2022
Fluid Mechanics

Time: 3 hrs.　　　　　　　　　　　　　　　　　　　　Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1　a. Define the following properties of fluids and mention their units:
　　　(i)　Weight density　　(ii)　Specific gravity
　　　(iii)　Surface tension　(iv)　Capillarity　　　　　　　　**(08 Marks)**
　　b. Show that for a liquid droplet, the pressure intensity varies inversely with the diameter of the droplet.　　　　　　　　　　　　　　　　　　　　　　　　　　　**(04 Marks)**
　　c. An oil film of thickness 1.5 mm is used for lubrication between a square plate of size 0.9 m × 0.9 m and an inclined plane having an angle of inclination of 20° with the horizontal. The weight of the square plate is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Find the dynamic viscosity of the oil in poise.　　　　　　**(08 Marks)**

OR

2　a. State and prove hydrostatic law.　　　　　　　　　　　　　　　　　　　**(06 Marks)**
　　b. Obtain the expressions for total pressure and centre of pressure for an inclined plane surface submerged in a static fluid.　　　　　　　　　　　　　　　　　　　　　　**(08 Marks)**
　　c. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of sp.gr. 0.8 and having vacuum pressure is flowing. The other end of the manometer is open to atmosphere. Find the vacuum pressure in pipe, if the difference of mercury level in the two limbs of U-tube is 40 cm and the height of fluid in the left limb is 15 cm below the centre of the pipe.　　　　　　　　　　　　　　　　　　　　　　　　　　　　**(06 Marks)**

Module-2

3　a. Define : (i) Buoyancy,　(ii) Centre of Buoyancy,　(iii) Metacentre　(iv) Metacentric height　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**(08 Marks)**
　　b. Explain the equilibrium conditions of floating and submerged bodies.　　　**(06 Marks)**
　　c. A wooden block of size 2m × 1m × 0.8m and Sp.Gr. 0.7 floats in water. Determine the metacentric height of the block.　　　　　　　　　　　　　　　　　　　**(06 Marks)**

OR

4　a. Derive 3 dimensional continuity equation in Cartesian co-ordinates.　　　**(08 Marks)**
　　b. The steam function for a 2 dimensional flow is given by $\psi = 2xy$. Find the velocity at point P(4, 2). Also find the velocity potential function.　　　　　　　　　　**(12 Marks)**

Module-3

5　a. Obtain the Euler's equation of motion along a stream line and hence deduce Bernoulli's equation for a steady incompressible flow. Mention the assumptions made.　**(12 Marks)**
　　b. A horizontal venturimeter with inlet dia 20 cm and throat dia 10 cm is used to measure the flow of water. The pressure of inlet is 17.658 N/cm^2 and vacuum pressure at the throat is 30 cms of mercury. Find the discharge of water through the venturimeter. Take $C_d = 0.9$.　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**(08 Marks)**

OR

6 a. Show that for viscous flow through a circular pipe, the maximum velocity is twice the average velocity. (08 Marks)
   b. Derive Darcy-Weisbach equation for a fluid flow through a pipe. (08 Marks)
   c. An oil of sp.gr.0.7 is flowing through a pipe of diameter 300 mm at the rate of 500 lps. Find the head lost due to friction and power required to maintain the flow for a length of 1000 m. Take r = 0.29 stokes. (04 Marks)

Module-4

7 a. Explain the terms: (i) Boundary layer thickness   (ii) Displacement thickness
   (iii) Momentum thickness   (iv) Energy thickness   (08 Marks)
   b. A flat plate 2m × 2m moves at 40 km/hr in stationary air of density 1.25 kg/m^3. If the co-efficient of drag and lift are 0.2 and 0.8 respectively, find (i) the lift force (ii) the drag force (iii) the resultant force and (iv) the power required to keep the plate in motion. (08 Marks)
   c. Define : (i) Laminar boundary layer (ii) Laminar sub-layer for flow over a flat plate. (04 Marks)

OR

8 a. What do you mean by dimensional homogeneity? Explain with example. (04 Marks)
   b. Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity μ of mass density ρ and velocity of motion V of the sphere. Obtain the expression force shear force F, using Bucklingham's π-theorem method. (08 Marks)
   c. What is similitude? Explain different types of similarities performed between model and prototypes. (08 Marks)

Module-5

9 a. Define : (i) Mach number   (ii) Mach angle   (iii) Mach cone   (06 Marks)
   b. Derive an expression for velocity of sound in a fluid. (08 Marks)
   c. Find the velocity of a bullet fired in air, if the mach angle is 30°. Temperature of air is 15°C. Assume K = 1.4 and R = 287 J/kg.K. (06 Marks)

OR

10 a. Define : (i) Subsonic flow   (ii) Sonic flow and   (iii) Supersonic flow   (06 Marks)
    b. Obtain the expression for stagnation pressure. (06 Marks)
    c. Mention the applications and limitations of CFD. (08 Marks)

* * * * *