CBCS SCHEME

USN | | | | | | | | | |  17AE/AS35

# Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
# Mechanics of Fluids

Time: 3 hrs. Max. Marks: 100

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



## Module-1

1 a. A vertical gap 2.2 cm of infinite extent contains a fluid of viscosity 2 NS/$m^2$ and specific gravity 0.9. A metallic plate 1.2m × 1.2m × 0.2cm is to be lifted up with a constant velocity of 0.15 m/s, through the gap. If the plate is in middle of gap, find the force required to lift the plate upwards. The weight of plate is 40 N. **(10 Marks)**

b. Derive an expression for capillary rise. **(06 Marks)**

c. Explain cavitation and vapour pressure. **(04 Marks)**

**OR**

2 a. Derive an expression for total pressure and center of pressure for an inclined plane surface submerged in liquid. **(10 Marks)**

b. Explain conditions of equilibrium for a floating and submerged bodies. **(10 Marks)**

## Module-2

3 a. Explain different types of fluid flow. **(10 Marks)**

b. Sketch the streamlines represented by $\psi = x^2 + y^2$. Also find out the velocity and its direction at point (1, 2). **(04 Marks)**

c. Define and explain with neat sketches:
i) Source
ii) Sink
iii) Doublet **(06 Marks)**

**OR**

4 a. Derive an expression for continuity equation in 3D, in differential form for steady incompressible fluid flow. **(10 Marks)**

b. For a finite control volume fixed in space derive momentum equation in integral form. **(10 Marks)**

## Module-3

5 a. Derive an expression for discharge through orifice meter. **(10 Marks)**

b. Water is flowing through a pipe having diameter 300mm and 200mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 24.525 N/$cm^2$ and the pressure at upper end is 9.81 N/$cm^2$. Determine the difference in datum head if the rate of flow through pipe is 40 lit/second. **(06 Marks)**

c. Derive Bernoulli's equation from Euler's equation and also explain terms used. State Bernoulli's theorem for steady flow of an incompressible fluid. **(04 Marks)**

**OR**

6 a. Using Buckingham's $\pi$ - theorem, show that thrust P developed by a propeller is given by $P = D^2V^2\rho\ f\left(\frac{DW}{V}, \frac{\mu}{\rho VD}, \frac{C}{V}\right)$ where in W is angular velocity, V is speed of advance, $\mu$ is dynamic viscosity, $\rho$ is mass density and C is elasticity of fluid medium denoted by speed of sound in medium. **(10 Marks)**

b. The pressure drop in an aeroplane model of size $\frac{1}{40}$ of its prototype is 80 N/cm$^2$. The model is tested in water. Find corresponding pressure drop in prototype. Given: $\rho_{air} = 1.24$ kg/m$^3$, $\mu_{water} = 0.01$ poise, $\mu_{air} = 0.00018$ poise. **(06 Marks)**

c. Define and derive an expression for Froude's No and Weber's No. **(04 Marks)**

## Module-4

7 a. A spherical steel ball of diameter 4mm and of density 8500kg/m$^3$ is dropped in large mass of water. The coefficient of drag of the ball in water is 0.45. Find terminal velocity of ball in water. If the ball is dropped in air, find increase in terminal velocity of ball. Take $\rho_{air} = 1.25$ kg/m$^3$ and $C_D$ of ball in air is 0.1. **(10 Marks)**

b. With a neat sketch derive an expression for drag and lift. **(06 Marks)**

c. Explain boundary layer concept with neat sketch. **(04 Marks)**

**OR**

8 a. Derive Von Karman's integral equation for boundary layer flows. **(10 Marks)**

b. Find displacement thickness, momentum thickness, energy thickness and $\delta^*/\theta$ for velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$ where u is velocity at distance y from plate and u = U at y = $\delta$, where $\delta$ = boundary layer thickness. **(10 Marks)**

## Module-5

9 a. Derive an expression for velocity of sound wave in a fluid. **(10 Marks)**

b. A projectile travels in air of pressure 10.1043 N/cm$^2$ at 10°C at a speed of 1500 km/hour. Find: i) Mach Number and ii) Mach Angle. Given K = 1.4 R = 287 J/kg K. **(04 Marks)**

c. Derive Bernoulli's equation for i) Isothermal process ii) Adiabatic process in a steady compressible flow. **(06 Marks)**

**OR**

10 a. Derive expression for i) Stagnation density ($\rho_s$) ii) Stagnation temperature for a compressible fluid. **(10 Marks)**

b. Explain normal shocks and the variation of flow properties across it using continuity, momentum and energy equation. Also draw sketch of h-s diagram for flow across a normal shock wave. **(10 Marks)**

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