CBCS SCHEME

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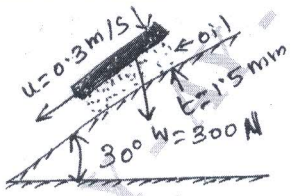
BAE/BAS303

# Third Semester B.E./B.Tech. Degree Examination, Dec.2023/Jan.2024
## Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

***Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.***
***2. M : Marks , L: Bloom's level , C: Course outcomes.***

| | | Module – 1 | M | L | C |
|---|---|---|---|---|---|
| Q.1 | a. | State Newton's law of viscosity and explain the types of fluid based on Newton's law with suitable sketch. | 6 | L2 | CO1 |
| | b. | Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size 0.8m×0.8m and an inclined plane with angle of inclination 30° as shown in Fig. Q1 (b). The weight of square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. Thickness of oil film is 1.5 mm.   Fig. Q1 (b) | 6 | L3 | CO1 |
| | c. | Explain surface tension with a sketch and obtain the expression surface tension on a following conditions: (i) Liquid droplet (ii) Liquid jet | 8 | L2 | CO1 |
| | | **OR** | | | |
| Q.2 | a. | State and prove Pascal's law with a neat sketch. | 8 | L2 | CO1 |
| | b. | A hydraulic press has a ram of 20 cm diameter and a plunger of 3 cm diameter and it is used to lift a weight of 30 kN. Find the force required at the plunger. | 6 | L3 | CO1 |
| | c. | Explain the following terms with a help of sketch: (i) Absolute pressure. (ii) Gauge pressure. (iii) Vacuum pressure. | 6 | L2 | CO1 |
| | | **Module – 2** | | | |
| Q.3 | a. | List and explain the types of fluid flow. | 10 | L2 | CO2 |
| | b. | A 30 cm diameter pipe, conveying water branches into two pipes of diameters 20 cm and 15 cm. If the average velocity in 30 cm pipe is 2.5 m/sec. Find the discharge in 30 cm pipe. Also find the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s. | 10 | L3 | CO2 |
| | | **OR** | | | |
| Q.4 | a. | Obtain the expression for Navier-stokes equation using momentum equation. | 12 | L2 | CO2 |
| | b. | For an incompressible flow, the velocity potential components is given by, $u = \left(\frac{y^3}{3}\right) + (2x) - (x^2y)$ ; $v = (xy^2) - (2y) - \left(\frac{x^3}{3}\right)$ Obtain the expression for stream function and velocity potential. | 8 | L3 | CO2 |

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| | | **Module – 3** | | | |
| **Q.5** | **a.** | Obtain Euler's equation of motion and obtain the Bernoulli's equation from that. | **12** | **L2** | **CO3** |
| | **b.** | A pipe of diameter 400 mm carries a water at a velocity of 25 m/s. The pressure at the points A and B are given as 29.43 N/cm$^2$ and 22.563 N/cm$^2$ respectively. The Datum head at A and B are 28 m and 30 m respectively. Find the loss of head between A and B. | **8** | **L3** | **CO3** |
| | | **OR** | | | |
| **Q.6** | **a.** | An aircraft is flying with a propeller engine. The thrust developed by a propeller 'T' depends on the angular velocity 'W', speed of aircraft 'V' diameter of propeller 'd', dynamic viscosity 'μ', density of air 'ρ', and speed of sound 'a'. Obtain the thrust developed by a propeller using Buckingham's π-theorem. (Take (D, V, ρ) as repeating variable). | **12** | **L3** | **CO3** |
| | **b.** | Explain about types of similarities in the model analysis and write the expressions. | **8** | **L2** | **CO3** |
| | | **Module – 4** | | | |
| **Q.7** | **a.** | Define and obtain the expression for the following :<br>(i) Momentum thickness (θ).<br>(ii) Energy thickness (δ**) | **10** | **L3** | **CO4** |
| | **b.** | In a subsonic wind tunnel which is having a test section velocity of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m$^3$. The co-efficient of lift and drag are 0.75 and 0.15 respectively. Determine : (i) Lift force (ii) Drag force. | **10** | **L3** | **CO4** |
| | | **OR** | | | |
| **Q.8** | **a.** | Obtain the expression for Drag force on a flat plate due to boundary layer and write Von-Karman momentum Integral equation. | **12** | **L3** | **CO4** |
| | **b.** | Explain the following :<br>(i) Laminar and Turbulent Boundary layer.<br>(ii) Kutta-Joukowsky theorem. | **8** | **L2** | **CO4** |
| | | **Module – 5** | | | |
| **Q.9** | **a.** | Obtain an expression for velocity of sound wave in a fluid. Also deduce the relation for adiabatic process. | **10** | **L3** | **CO5** |
| | **b.** | An aircraft is flying at a particular altitude of 15 km. At 15 km altitude, temperature is -50°C. The speed of the aircraft corresponding to Mach number 2.0. Assume K = 1.4, R = 287 J/kg-K. Find the speed of the aircraft. | **10** | **L3** | **CO5** |
| | | **OR** | | | |
| **Q.10** | **a.** | Calculate the stagnation pressure, temperature and density at the nose of the aircraft. The aircraft is flying at 800 km/hour through the stationary air which has a pressure of 8.0 N/cm$^2$ (abs) and temperature of -10°C. Take R = 287 J/kg-K and K = 1.4 | **10** | **L3** | **CO5** |
| | **b.** | Draw and explain the propagation of pressure waves in a compressible fluid and explain about Mach cone, Mach angle. Also mention the zone of action and zone of silence. | **10** | **L2** | **CO5** |

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