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# P.E.S. College of Engineering, Mandya - 571 401

*(An Autonomous Institution affiliated to VTU, Belagavi)*

**Third Semester, B.E. - Mechanical Engineering**

**Semester End Examination; March / April - 2022**

**Fluid Mechanics**

*Time: 3 hrs* *Max. Marks: 100*

***Course Outcomes***

*The Students will be able to:*

*CO1: Explain fluid properties like density, weight density, specific volume, specific gravity, viscosity and surface tension. Solve problems on viscosity and surface tension.*

*CO2: Derive Pascal's law and fundamental law of hydrostatics and Explain buoyancy and centre of buoyancy.*

*CO3: Describe the types of fluid flow and solve problems on continuity equation, Euler's equation of motion and Bernoulli's equation.*

*CO4: Explain boundary layer concept and define hydraulic gradient line and total energy line.*

*CO5: Derive Hagen-Poiseuille equation and apply dimensional analysis technique to obtain dimensionless relations.*

***Note:*** ***I) PART - A*** *is compulsory.* ***Two*** *marks for each question.*

***II) PART - B****: Answer any* ***Two*** *sub questions (from a, b, c) for Maximum of* ***18 marks*** *from each unit.*

| Q. No. | | Questions | Marks | BLs | COs | POs |
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| | | **I : PART - A** | **10** | | | |
| I | a. | State the Newton's law of viscosity with mathematical expression. | 2 | L1 | CO1 | PO1 |
| | b. | Define the terms: i) Buoyancy and ii) Centre of Buoyancy. | 2 | L1 | CO2 | PO1 |
| | c. | What is the difference between steady flow and uniform flow? | 2 | L1 | CO3 | PO1 |
| | d. | Define: i) Drag force and ii) Lift force. | 2 | L1 | CO4 | PO1 |
| | e. | State the Buckingham's Π-theorem. | 2 | L1 | CO5 | PO1 |
| | | **II : PART - B** | **90** | | | |
| | | **UNIT - I** | **18** | | | |
| 1 | a. | Define the following Fluid properties with units:<br>i) Weight density ii) Viscosity iii) Density<br>iv) Specific volume v) Kinematic viscosity vi) Surface Tension | 9 | L1 | CO1 | PO1 |
| | b. | State and prove Pascal's Law. | 9 | L2 | CO1 | PO1 |
| | c. | A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm. Both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12 Nm is required to rotate the inner cylinder at 100 rpm, determine the viscosity of the fluid. | 9 | L3 | CO1 | PO2 |
| | | **UNIT - II** | **18** | | | |
| 2 | a. | An inverted U-tube manometer is connected to two horizontal pipes *A* and *B* through which water is flowing. The vertical distance between the axes of these pipes is 30 cm. When an oil of specific gravity 0.8 is used as a gauge fluid, the vertical heights of water columns in the two limbs of the inverted manometer (when measured from the respective centre lines of the pipes) are found to be same and equal to 35 cm. Determine the difference of pressure between the pipes. | 9 | L3 | CO2 | PO2 |

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| b. | Derive an expression for total pressure force and center of pressure for vertical plane surface submerged in a liquid. | 9 | L2 | CO2 | PO1 |
| c. | A wooden cylinder of specific gravity 0.6 and circular in cross-section is required to float in oil of specific gravity 0.90. Find the *L/D* ratio for the cylinder to float with its longitudinal axis vertical in oil, where *L* is the height of cylinder and *D* is its diameter. | 9 | L3 | CO2 | PO2 |

**UNIT - III** **18**

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| 3 a. | Derive an expression for continuity equation for a three-dimensional steady incompressible flow. | 9 | L2 | CO3 | PO1 |
| b. | Derive Euler's equation of motion for a steady flow and deduce Bernoulli's equation with assumptions. | 9 | L2 | CO3 | PO1 |
| c. | The inlet and throat diameters of a horizontal venturimeter are 30 cm and 10 cm respectively. The liquid flowing through the meter is water. The pressure intensity at inlet is 13.734 $N/cm^2$ while the vaccum pressure head at the throat is 37 cm of mercury. Find the rate of flow. Assume that 4% of the differential head is lost between the inlet and throat. Find also the value of $C_d$ for the venturimeter. | 9 | L3 | CO3 | PO2 |

**UNIT - IV** **18**

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| 4 a. | Define the following:<br>i) Stream-lined body ii) Boundary Layer thickness<br>iii) Displacement thickness iv) Momentum thickness v) Energy thickness | 9 | L1 | CO4 | PO1 |
| b. | Experiments were conducted in a wind tunnel with a wind speed 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 coefficients of lift and drag are 0.75 and 0.15 respectively. Determine;<br>i) The lift force ii) Drag force iii) The resultant force<br>iv) Direction of resultant force v) Power exerted by air on the plate | 9 | L3 | CO4 | PO3 |
| c. | Derive Darcy-Weisbach formula to calculate the frictional head loss in pipe in terms of friction factor. | 9 | L2 | CO4 | PO1 |

**UNIT - V** **18**

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| 5 a. | Derive Hagen-Poiseuille equation starting for head loss due to friction in a pipe. | 9 | L2 | CO5 | PO1 |
| b. | Derive an expression for thrust '*T*' developed by a propeller which depends upon the angular velocity '$\omega$', speed of advance '*V*', diameter '*D*', dynamic viscosity '$\mu$', mass density '$\rho$', speed of the sound in the medium '*C*' using Buckingham's Π-theorem. | 9 | L2 | CO5 | PO2 |
| c. | Define the following dimensionless numbers giving their significances:<br>i) Reynold's number ii) Euler's number iii) Mach number | 9 | L1 | CO5 | PO1 |

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