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# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## December 2023 Supplementary Examinations

**Programme: B.E.** **Semester: IV**
**Branch: Mechanical Engineering** **Duration: 3 hrs.**
**Course Code: 22ME4PCFME** **Max Marks: 100**
**Course: Fluid Mechanics**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | UNIT - I | *CO* | *PO* | Marks |
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| 1 | a) | Describe the following fluid properties with their relations.<br>i) Specific weight, ii) Specific gravity, iii) Mass density, iv) Dynamic viscosity and v) Surface tension. | *CO1* | *PO1* | **10** |
| | b) | A simple U – tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 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 is 40 cm. and the height of the fluid in the left tube from the center of pipe is 15 cm below. | *CO2* | *PO2* | **05** |
| | c) | Prove that, "*The external static pressure applied on a confined liquid is distributed or transmitted evenly throughout the liquid in all directions"* with appropriate assumptions and diagram. | *CO3* | *PO1* | **05** |
| | | **UNIT - II** | | | |
| 2 | a) | Describe the following with line diagrams and equations:<br>i)Stream Line, ii) Path Line, iii) Stream tube, iv) Streak line, and v)Time line | *CO1* | *PO1* | **10** |
| | b) | Water is flowing through a pipe having diameters 20 cm and 10 cm at sections A and B respectively. The rate of flow through pipe is 35 liters/sec. The section A is 6 m above the datum and section B is 4 m above the datum. If the pressure at section A is 39.24 N/cm$^2$. Evaluate the intensity of pressure at section B. | *CO2* | *PO2* | **05** |
| | c) | With the appropriate method, derive to show the increase in pressure due to conversion of kinetic energy into pressure energy. | *CO3* | *PO1* | **05** |

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| | | | **UNIT - III** | | | |
| | 3 | a) | With appropriate assumptions and figure, derive 2D Naiver Stroke equation. | *CO3* | *PO1* | **12** |
| | | b) | Evaluate the pressure gradient, shear stress at the two horizontal parallel plates and the discharge per meter width for the laminar flow of oil with a maximum velocity of 2 m/s between two horizontal parallel fixed plates which are 100 mm apart. Assume dynamic viscosity as 2.45 $Ns/m^2$. | *CO4* | *PO3* | **08** |
| | | | **OR** | | | |
| | 4 | a) | Derive the Hagen-Poiseuille equation for a flow in a pipe | *CO3* | *PO1* | **10** |
| | | b) | A shaft having a diameter of 50 mm rotates centrally in a journal bearing having a diameter of 50.15 mm and length of 100 mm. The angular space between the shaft and the bearing is filled with oil having viscosity of 0.9 poise. Determine the power absorbed in the bearing when the speed of rotation is 60 rpm. | *CO4* | *PO3* | **10** |
| | | | **UNIT - IV** | | | |
| | 5 | a) | With a neat figure show the formation of boundary layer with different regimes when fluid is flowing over a flat plate. | *CO1* | *PO1* | **08** |
| | | b) | For the velocity profile for laminar boundary layer $\frac{u}{U} = 2\left(y/\delta\right) - 2\left(y/\delta\right)^3 + \left(y/\delta\right)^4$ obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and coefficient of drag in terms of Reynold number. | *CO3* | *PO1* | **12** |
| | | | **OR** | | | |
| | 6 | a) | With a neat diagram of effect of pressure gradient on boundary layer separation, Explain the concept of separation of boundary layer considering the effect of pressure gradient. | *CO1* | *PO1* | **08** |
| | | b) | A boundary layer develops along the walls of a rectangular wind tunnel. The air is at 20°C and atmospheric pressure. The boundary layer starts upstream of the contraction and grows into the test section. By the time it reaches the test section, the boundary layer is fully turbulent. The boundary layer profile and its thickness are measured at both the beginning ($x = x_1$) and the end ($x = x_2$) of the bottom wall of the wind tunnel test section. The following measurements are made: $\delta_1$=4.2cm, $\delta_2$=7.7cm V=10m/s. At both locations the boundary layer profile fits better to a one-eight power law approximation $\frac{u}{U} \cong \left(\frac{y}{\delta}\right)^{1/8}$ for $y \leq \delta$ $\frac{u}{U} \cong 1$ for $y > \delta$ Estimate the total skin friction drag force $F_o$ acting on the bottom wall of the wind tunnel test ; take $\vartheta$=1.516 $\times 10^{-5}$ $m^2/s$ and $\rho$ = 1.204 $kg/m^3$. | *CO2* | *PO2* | **12** |

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| | | | **UNIT - V** | | | |
| | 7 | a) | The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. | *CO4* | *PO3* | **10** |
| | | b) | The frictional torque T, of a disc diameter D rotating at a speed N in a fluid of viscosity $\mu$ and density $\rho$ is a turbulent flow is given by $T = D^5N^5\rho\phi\left[\frac{\mu}{D^2N\rho}\right]$. Take D, N, $\delta$, and $\rho$ as repeating variables. | *CO4* | *PO3* | **10** |

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