M.Tech (Heat Power Engineering) Sem II

MT-1016 - Fluid Dynamics

P. Pages : 2 **GUG/W/16/3964**

Time : Three Hours Max. Marks : 70

Notes :
1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
5. Answer **any five** questions.

1. a) Derive Cauchy Riemann equation in Cartesian form for a 2 – Dimensional complex velocity potential. **7**

b) The velocity components in a fluid flow are given by: **7**

$u = 2xy$; $v = a^2 + x^2 - y^2$

i) Show that the flow is possible

ii) Derive the relative stream function.

2. a) Derive the general three dimensional equation of continuity and deduce from it the continuity equation for one dimensional frictionless flow. **8**

b) The velocity potential function for a 2 – Dimensional flow is $\phi = x(2y-1)$. At a point P(4,5) **6**

Determine:

i) The velocity and

ii) The value of stream function.

3. a) Starting with the continuity equation and Navier – Stokes equation, solve the following parallel flow problems: **7**

i) Couette flow

ii) Flow through a concentric circular annulus

iii) Flow through a circular pipe

b) What is Free Vortex? Give some examples of its occurrence. Show how the velocity and pressure vary with radius in a free vortex flow. **7**

4. a) Define the term total head as applied to a fluid mass in motion. What does it comprises of? **6**

b) An oil of viscosity 0.15 Ns/m^2 and specific gravity 0.9 is flowing through a circular pipe of diameter 30mm & length of 3m at $1/10^{th}$ of critical velocity for which Reynolds numbers is 2450 Find: **8**

i) The velocity of flow through a pipe

ii) The head in meters of oil,

Across the pipe length required to maintain the flow.

5. a) The velocity distribution in a boundary layer is given by $\frac{u}{U} = \frac{y}{\delta}$; Find out displacement momentum and energy thickness for Laminar boundary layer. **6**

b) A horizontal pipe of 5 cm diameter conveys an oil of specific gravity 0.9 and dynamic viscosity 0.8 kg/ms. Measurement indicates a pressure drop of 20 kN/m^2 per meter of pipe length traversed; Calculate **8**
i) Flow rate of oil & centre line velocity.
ii) Wall shear stress & frictional drag over 100m of pipe length.
iii) Power of a pump required assuming an overall efficiency of 60%.
iv) The velocity & shear stress at 1cm from pipe surface.

6. a) Work out a relation prescribing the power absorbed due to viscous resistance in a bush bearing. **6**

b) Air is flowing over a flat plate 5m long and 2.5m wide with a velocity of 4 m/s at 15ºC. If $\rho = 1.208 \text{ kg}/\text{m}^3$ and $\nu = 1.47 \times 10^{-5} \text{m}^2/\text{s}$. Calculate: **8**
i) Length of plate over which the boundary layer is Laminar & thickness of the boundary layer(Laminar).
ii) Shear stress at the location where boundary layer ceases to be Laminar and
iii) Total drag force on both sides on that portion of plate where boundary is Laminar.

7. a) Explain the effect of flow separation and methods of control of boundary layer thickness. **7**

b) Derive Von – Karman momentum integral equation for flow post a flat plate. **7**

8. a) A passenger ship of 10m draft and 250m length is required 5 MW of power when cruising at the design speed of 35 km/hr. Calculate the combined wave and form resistances of a ship. For sea water, mass density = 1025 kg/m^3 and kinematic viscosity = 10^{-6} m^2/s **7**

b) A streamlined train is 200m long with a typical cross-section having a perimeter of 9m above the wheels if the kinematic viscosity of air at the prevailing temp is 1.5 x 10^{-5} m^2/sec and density 1.24 kg/m^3. Determine the approximate surface drag (friction drag) of the train when running at 90 km/hr. Make allowance for the fact that boundary layer changes from Laminar to turbulent on the train surface. **7**

****

munotes.in