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Reg. No. : .....

Name : .....

First Semester M.Tech. Degree Examination, February 2015
(2013 Scheme)
MECHANICAL ENGINEERING
Stream : Thermal Engineering
MTC 1003 : INCOMPRESSIBLE AND COMPRESSIBLE FLOWS

Time : 3 Hours Max. Marks :60

Instructions : *i) Answer **any two** questions from **each** module.*
*ii) **Use** of approved charts and tables are permitted.*

Module – I

1. a) Using Reynolds transport theorem, derive the integral form of linear momentum equation. 4

   b) Derive the vorticity transport equation in two dimensions. Explain the significance and use of this equation. 6

2. a) Investigate the complex potential function $f(z) = U_\alpha \left(z + \frac{a^2}{z} \right)$ and interpret the flow pattern, where a is a constant. 5

   b) Using potential flow theory derive the expression for flow past a vertical flat plate. 5

3. a) Show that for potential flow past a two-dimensional cylinder, the variation of pressure coefficient is given by $C_p = 1 - 4 \sin^2 \theta$. 5

   b) It is desirable to study the ideal flow pattern around a Rankine oval 1.5 m long and 1 m wide is a uniform flow of 10 m/s along its length. Determine the strength of the source and sink and the distance between them in the uniform flow to idealize the flow pattern. 5

Module – II

4. a) Derive the momentum integral equation for a boundary layer flow with zero pressure gradient. 5

   b) Obtain the expression for the velocity profile for axial flow through annular space between two co-axial cylinders. 5

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5. Consider a viscous fluid flowing between two stationary walls kept at a distance 'h' apart. For a given pressure gradient between the inlet and outlet compute :
   a) expression for velocity distribution. 4
   b) average velocity. 2
   c) wall shear stress and 2
   d) stream function 2

6. a) Explain with a neat sketch, the measurement of velocity using Particle Image Velocimetry (PIV). 5
   b) Explain the concept of eddy viscosity in turbulent flow. 2
   c) Explain the features of turbulent flows. 3

Module – III

7. a) Using linearized theory, calculate the lift and drag coefficient for a flat plate at 5° angle of attack in a Mach 3 flow. 5
   b) Air enters a constant area duct at 0.3 MPa and 15° C and is heated while flowing. The initial Mach number is 0.2. The final total temperature is 897° C. What are the final total pressure and Mach number. 5

8. a) What are the features of flow field around a re-entry vehicle at hypersonic speed ? 5
   b) Derive the conservation of momentum for a generalised one dimensional compressible flow with mass addition. 5

9. Write short notes on :
   i) Entropy layer in hypersonic flow 3
   ii) Method of characteristics and influence coefficients. 4
   iii) Rarefaction effects at hypersonic speeds. 3