(Set-L)

## M.Tech - 1st
## Fluid and Gas Dyna

*Full Marks* : 70

*Time* : 3 hours

Answer any **six** questions including Q. No. 1

*The figures in the right-hand margin indicate marks*

1. Answer the following questions :  $2 \times 10$

   (a) Write the $x$-component of Euler's equation and explain the meaning of different terms.

   (b) Explain what you understand by flow work. What is the expression for it ?

   (c) Explain the terms angular deformation and rotation. What is the relation between them ?

   (d) Explain the difference between Stoke's law of viscosity and Newton's law of viscosity. Write down the equations in each case.

   (e) What is the Bernoulli's equation for flow of a compressible fluid ?

   (f) What is a doublet ? Draw its potential lines and stream lines.

   (g) Describe Kutta-Joukowski theorem with reference to flow around a cylinder.

   (h) Explain with the help of the relevant equation, how a nozzle in subsonic flow behaves like a diffuser in supersonic flow.

   (i) What is the use of the parameter $\Gamma/4\pi R U_0$ in determining the number of stagnation points in flow around a cylinder ?

   (j) Explain with T-S diagram, the importance of Fanno and Rayleigh lines to determine the condition of a normal shock.

2. (a) Derive the equations for stagnation properties like $T_0/T$, $P_0/P$ and $\rho_0/\rho$ for an isentropic flow. 6

   (b) An object is immersed in an air flow with a

static pressure of 200 kPa(abs) and static temperature of 20°C and a velocity of 200 m/s. What are the temperature and pressure at the stagnation point ? Take $R = 287J/kgK°$. 4

3. (a) Show the pressure distribution along a converging and diverging nozzle for different values of back pressure. 5

(b) A nozzle of throat area 2·5 cm is fixed on the side of a tank. The air pressure and temperature within the tank are 844 kPa and 15°C. Determine the back pressure for maximum discharge. Also calculate the maximum discharge. 5

4. (a) Explain the procedure for drawing the Fanno and Rayleigh lines along with the governing equations. http://www.odishastudy.com 5

(b) A normal shock wave exists in a 500 m/s stream of nitrogen with static temperature and pressure of –40°C and 70 kPa respectively. Calculate the mach number, pressure and temperature downstream of the wave. 5

Derive the equations of velocity components in radial and circumferential directions. 5

(b) A long circular cylinder lies in an air stream having a velocity of 60 m/s. In addition, there is a flow around the cylinder with circulation of –400 m²/s (Clockwise). Neglecting viscous and compressibility effects, determine : 5

(i) Location of stagnation points

(ii) Lift force per unit length of cylinder.

Take density of air as 1·22 kg/m³ and cylinder diameter 1·2 m.