Total Pages—5

(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 : 2×10

(*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 $\Gamma/4\pi RU_0$ 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 ρ_0/ρ 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 $R = 287 J/kgK°$. 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. 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 m^2/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/m^3 and cylinder diameter 1·2 m.