S.E. (SEM. IV)(CBSGS) (MECHANICAL ENGG.) 21st May, 2015
FLUID MECHANICS

Mechanical/Automobile **QP Code : 3470**

(03 Hrs) **[Total Marks 80]**

N.B.:
(1) **Question No.1 is compulsory**
(2) Attempt any **three** questions out of remaining **five** questions
(3) Figures to right indicate full marks
(4) Assume suitable data if **necessary and justify the same.**

Q.1(A) Explain Newton's law of viscosity and concept of continuum of fluid 05

(B) A two dimensional flow is described in the Langrangian system as 05

$$x = x_0 e^{-kt} + y_0(1 - e^{-2kt})$$

and

$$y = y_0 e^{kt}$$

Find :
(i) the equation of a fluid particle in the flow field and
(ii) the velocity components in Eulerian system

(C) Write short note on boundary layer separation and methods to control it. 05

D) An aeroplane is to move at Mach number of 1.5 at altitude of 1000 m. The atmospheric pressure and densities at this elevation are 89.89 KPa (abs) and 1.112 Kg/m^3 respectively. Calculate the speed of the plane in Km/h at this altitude. Assume ratio of specific heats k=1.4. 05

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Q. 2(A) A hemisphere projection of diameter 0.6 m exists on one of the vertical sides of a tank. If the tank contains water to an elevation of 1.5 m above the centre of the hemisphere, calculate the vertical and horizontal forces acting on the projection. 10

(B) The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through 120^0 (angle measured in clockwise direction between direction of fluid flow at inlet and outlet) in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting friction, calculate the magnitude and direction of the force exerted on the bend by water flowing through it at 250 litres/s and when inlet pressure is 0.15 N/mm^2. 10

Q.3 (A) A venturimeter is installed in a pipeline carrying water and is 30 cm in diameter. The throat diameter is 12.5 cm. The pressure in pipeline is 140 KN/m^2, and the vacuum in the throat is 37.5 cm of mercury. Four percentages of the differential head is lost between the gauges. Working from first principles find the flow rate in the pipeline assuming the venturimeter to be horizontal. 10

(B) If velocity distribution, u in laminar boundary layer over a flat plate is assumed to be given by second order polynomial $u=a+by+cy^2$, where y is the perpendicular distance measured from the surface of the flat plate, and a, b and c are constants. Determine the expression of velocity distribution in dimensionless form as $\frac{u}{U}=f\left(\frac{y}{\delta}\right)$, 10

where, U is main stream velocity at boundary layer thickness δ. Further also find boundary layer thickness in terms of Reynolds number.

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Q. 4(A) Fluid is in laminar motion between two parallel plates separated by distance 'b' under the action of motion of one of the plates and also under the presence of a pressure gradient in such a way that the net forward discharge across any section is zero. Consider 'U' be the velocity of the moving plate. 10

(i) Find out the point where minimum velocity occurs and its magnitude

(ii) Draw rough sketch of velocity distribution across any section.

(B) The velocity potential function for two dimensional flow is 10

$\phi = x(2y-1)$ determine: (i) velocity, and (ii) stream function.

Q.5(A) Explain eddy viscosity theory for turbulent fluid flow. 05

(B) What is critical pressure ratio for compressible flow in nozzle? Explain its significance. 05

(C) The pressure, velocity and temperature just upstream of a normal shock wave in air are 100 KPa (abs), 660 m/s and -20^{0}C respectively. Calculate the pressure, velocity and temperature just downstream of the shock wave. [Take ratio of specific heats k=1.4 and gas constant R=287 J/(Kg.K)]. 10

Q.6 (A) A pipeline carrying water has a diameter of 0.5 m and is 2 Km long. To increase the delivery another pipeline of the same diameter is introduced parallel to the first pipe in the second half of its length. Find the increase in discharge if the total head loss in both the cases is 15 m. Assume 4f=0.02 for all the pipes. 10

(B) Draw rough nature of Moody chart showing different regimes of fluid flow and explain its significance 05

(C) Write short note on stalling of aerofoil. 05