2018

MATHEMATICS

MAT 403

FLUID DYNAMICS II

Full Marks : 80

Time : 3 hours

The figures in the margin indicate full marks for the questions

(All questions are compulsory)

1. Answer any two : **10×2=20**

   (a) Define long waves. Prove that the velocity of propagation of a wave $n = a\sin(mx - nt)$ at the surface of water of uniform depth is $C^2 = \frac{g}{m} \tanh mh$.

   (b) What do you mean by group velocity ? Prove that the group velocity for deep water waves is half the wave velocity

   (c) Show that when irrotational waves of length λ are propagated in water of infinite depth, the pressure at any particle of water is the same as it was in the equilibrium position of the particle when the water was at rest.

2. Answer the followings :

   (a) Given a velocity filed with components $u = cx + 2w_0 y + u_0$, $v = cy + v_0$, $w = -2cz + w_0$, where c, u_0, v_0 and w_0 are constants. With the above velocity components at a point $P(x, y, z)$ determine the velocity components at a neighbouring point $Q(x + dx, y + dy, z + dz)$ and determine the different types of motion which are involved.

Or,

Establish the relation between the stresses and the rate of strain in a viscous compressible fluid.

(b) Define deformation. Consider the rectangular flow of an isotropic incompressible fluid, show that strain rate tensor has non-zero components. Velocity field at a point is given by $1+2y-3z$, $4-2x+5z$, $6+3x-5y$. Show that it represents a rigid body motion. **7**

(c) Give the geometrical interpretation of translation of a fluid element. If in a two dimensional flow the velocity components are $u=x+y+2t$, $v=2y+t$ then find the translation and rotation of fluid particles. **6**

3. Answer any two : **2×10=20**

(a) Define laminar flow. Discuss the plane couette flow.

(b) Discuss the laminar flow through a circular pipe.

(c) Discuss the plane Poiseuille flow.

4. Answer any two : **2×10=20**

(a) Mention the natures of magnetohydrodynamics. Discuss about the Maxwell's electromagnetic field equations.

(b) Define magnetic Reynolds number. Discuss briefly the applications of magnetohydrodynamics.

(c) What do you mean by permittivity of free space ? Discuss the decay of magnetic fields and currents into a solid conductor.

****