U.G. 6th Semester Examination - 2021

MATHEMATICS

Course Code : BMTMDSHT5

Course Title : Mechanics-II

Full Marks : 40 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Notations and symbols have their usual meanings.

1. Answer any **ten** questions: 1×10=10

a) Define moment of a force about an axis.

b) When two couples are said to be equivalent.

c) State a force which will not appear in the equation of virtual work.

d) State the necessary and sufficient conditions of equilibrium of a particle under the action of a system of forces.

e) Define degree of freedom of a body.

f) Which of the following are body forces? Give reason.

i) Magnetic force

ii) Gravitational force

iii) Friction force

g) Write down the stress matrix at a point in a moving perfect fluid.

h) Define compressible fluid and incompressible fluid.

i) Write down the pressure equation of a fluid at a point under external forces. What will be the form of this equation in equi-pressure surface?

j) What do you understand by an 'effective surface' of a liquid?

k) State a common characteristics of liquid and gas.

l) Can a viscous fluid be homogeneous? Give your answer with reasons.

m) State the converse of the principle of virtual work.

n) Define equi-density surface of a fluid.

o) Write down the mathematical expression of Boyle's law.

2. Answer any **five** questions: 2×5=10

a) Explain why the forces of action and reaction at smooth joint may be omitted while writing down the equation of virtual work.

b) Write down the conditions of equilibrium of a freely floating body.

c) If the force per unit mass of a fluid at (x, y, z) parallel to the axes are $y(a-z)$, $x(a-z)$ and xy respectively, then show that the fluid is in equilibrium.

d) What do you mean by specific heat at constant volume?

e) State the energy test of stability of a system of bodies under the conservative system of force field.

f) Establish the relation pV^{γ}=constant between pressure p and volume V of a gas in an adiabatic change.

g) Find the centre of pressure (C.P.) of a square of side a immersed in a homogeneous fluid so that one side of the square is in the effective surface.

h) State Pascal's law.

3. Answer any **two** questions: 5×2=10

a) Forces P, Q, R act along the straight lines y=b, z= –c; z=c, x= –a and x=a, y= –b respectively. Find the condition that the system will reduce to a single resultant force. Find the equation of the central axis.

b) State and prove the necessary and sufficient condition for equilibrium of a fluid under the action of external forces.

c) ABCD is a square lamina totally immersed in a liquid with its side AB in the surface. The square is divided into two rectangles by means of a horizontal line through a point P in AD such that the thrusts on these two portions are equal. Show that $AP : AD = 1 : \sqrt{2}$.

4. Answer any **one** question from the following: 10×1=10

a) i) Find the general equations of equilibrium of a uniform heavy inextensible string under the action of given coplanar forces.

ii) A rhombus ABCD be formed of four uniform rods freely jointed together and suspended from the point A. It is kept in position by a light rod joining the mid

points of BC and CD. If T be the thrust in the rod and W be the weight of the rhombus, then prove that $T = W \tan\frac{A}{2}$.

5+5

b) i) A cone whose vertical angle 2α has its lowest generator horizontal and is filled with liquid. Prove that the resultant thrust on the curved surface of the cone is $\sqrt{1+15\sin^2\alpha}$ times the weight of the liquid.

ii) If the absolute temperature T at a height z is a given function f(z) of the height, show that the ratio of the pressures at two heights z_1 and z_2 is given by $\log\left(\frac{P_2}{P_1}\right) = -\frac{g}{R}\int_{z_1}^{z_2}\frac{dz}{f(z)}$, where P_1, P_2 are the pressures at height z_1 and z_2 respectively and R is the universal gas constant. 4+6

c) i) A plane area is immersed in a heavy liquid (homogeneous) at rest. Show that depth of its centre of pressure below the horizontal line through the centroid of the

plane is $\frac{K^2}{h}$, the symbols are to be explained by you.

ii) A gas satisfying Boyle's law and is acted upon by forces $\left(-\frac{y}{x^2+y^2}, \frac{x}{x^2+y^2}\right)$ per unit mass. Show that density of the gas varies as $e^{\frac{\theta}{k}}$, where $\tan\theta = \frac{y}{x}$. 5+5

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