Odd Semester, 2020

(Held in March, 2021)

PHYSICS

(Elective/Honours)

[Phy–01(T)]

(Mathematical Physics—I, Mechanics, Waves and Acoustics)

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **ten** questions

1. *(a)* State Gauss' divergence theorem and Stokes' theorem and explain their significance. 2½+2½=5

(b) Calculate the work done in moving a body along a vector $\vec{r} = 3\hat{i} - 6\hat{j} + 3\hat{k}$ through 1 m if the force applied is given by $\vec{F} = 2\hat{i} - \hat{j} + \hat{k}$. (Units of force and displacement are in SI.) 2½

2. *(a)* Solve : 3½

$$\frac{dy}{dx} + y\sec x = \tan x$$

(b) Find the solution of the following equation : 4

$$\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 5y = 0$$

3. Derive the expressions for tangential and normal components of acceleration of a particle moving along a curve. What is the magnitude and direction of acceleration when the particle moves in a circular path with a uniform velocity? 6+1½=7½

4. *(a)* What are geosynchronous satellites? Obtain the expression for velocity of a satellite in circular orbit at a height H above the surface of the earth. 1+3=4

(b) Show that the central forces are conservative in nature. 3½

5. *(a)* Distinguish between elastic and inelastic collisions. Obtain the expression for loss of kinetic energy in an inelastic collision in the laboratory system in one dimension. 2+4=6

(b) Two particles of masses 3 g and 5 g have position vectors $(2\hat{i} + \hat{j} - \hat{k})$ and $(\hat{i} + 2\hat{j} + 3\hat{k})$ respectively (in cm). Calculate the position vector of the centre of mass. 1½

6. State the theorems of parallel axës and perpendicular axes related to moment of inertia. Obtain an expression for the moment of inertia of a thin spherical shell rotating about any of its diameter. 3+4½=7½

7. *(a)* State Hooke's law. Deduce the relation

$$\frac{3}{\eta}+\frac{1}{K}=\frac{9}{Y}$$

where the symbols have usual significance. ½+5½=6

(b) The Young's modulus and Poisson's ratio of a material are $7{\cdot}25\times10^{10}\ \mathrm{N/m^2}$ and 0·39 respectively. Calculate its Bulk modulus. 1½

8. State and prove Bernoulli's theorem. 1½+6=7½

9. What is surface tension? Derive the expression for the height to which a liquid may rise in a capillary tube. 1½+6=7½

10. Two mutually perpendicular simple harmonic vibrations of same frequency but different amplitude with constant phase difference ϕ are acting simultaneously on a particle. Show that the resultant motion is in general elliptic. What would be the nature of the resultant figure if the phase difference is $\pi/2$ and the two amplitudes are equal? 5½+2=7½

11. Write down the equation of damped simple harmonic motion and solve it for critical damping. 1½+6=7½

12. What is progressive wave? Show that the kinetic energy and potential energy densities in the plane progressive wave are equal. 1½+3+3=7½

13. *(a)* Deduce an expression for the speed of a transverse wave in a stretched string. 3½

(b) Explain how constructive interference and destructive interference of sound wave occur. 4

14. What are ultrasonic waves? Give a detailed description of any method for generating ultrasonic wave. 1½+6=7½

15. What are the requirements of a good auditorium? Obtain the equation for growth of sound intensity and decay of sound intensity in an auditorium. 3½+4=7½

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