Bachelor of Engineering Examination 2019
(First Year Second Semester)
PHYSICS (BS/PH/T104)

Time: 3 hours Full Marks: 100

Answer **any five** questions

1. (a) Deduce a relation among Young's modulus, Poisson's ratio and the modulus of rigidity of an isotropic elastic solid.
   (b) Deduce the expression for the torsional rigidity of a solid cylinder of length l and radius r.
   (c) Show that the strain energy of a twisted wire is $\frac{1}{2}C_m\theta_m$ where C_m is the couple for the maximum twist θ_m. 8+8+4

2. a) Write down the equation of motion for a particle executing damped simple harmonic motion. Explain the physical origin of each term. Solve it for the case of small damping. 3+3+6

b) Why is damping usually taken to be proportional to instantaneous velocity? 2

c) A mass of 10 kg is acted upon by restoring force of 0.01 N/m and a resisting force of 0.002 N.s/m. Find out whether the motion is oscillatory or non-oscillatory. Also find the value of resisting force for the motion to be critically damped. 6

3. (a) Deduce an expression for the velocity of a plane progressive wave in a fluid medium. Mention the assumptions you make.
(b) Write the absolute unit of intensity of sound. What is decibel?
(c) Write down the characteristics of a good auditorium. What do you mean by the optimum reverberation time of a live room? 10+5+5

4. a) What do you mean by coherent sources? Give two practical examples.

b) Show that in case of superposition of waves from two incoherent sources the resultant intensity is the sum of individual intensities.

c) State and explain the conditions for the production of sustained interference fringes.

d) Consider two coherent sources of same frequency and of intensities I and 2I. Find the ratio of maximum intensity to minimum intensity in their interference pattern. 5+5+5+5

5. a) What do you mean by diffraction of light? Distinguish between diffraction and interference of light.

b) Derive an expression for the intensity of Fraunhofer diffraction pattern due to a single slit.

c) State Brewster's law. Light travelling in water of refractive index 1.33 is incident on a glass plate of refractive index 1.53. At what angle of incidence the reflected light is completely polarized?

6+8+6

6. (a) Explain de Broglie's concept of matter waves.

Using the concept of matter waves, obtain the Bohr's condition for quantization of angular momentum.

(b) State uncertainty principle. Write its mathematical form for the following pairs of variables:

(i) Position and momentum (ii) Energy and time

(c) Explain how uncertainty principle is the outcome of the wave description of a particle.

(d) Compute the minimum uncertainty in the location of a mass of 2.0 g moving with a speed of 1.5 m/s and the minimum uncertainty in the location of an electron moving with a speed of 0.5×10^{8} m/s. Given that the uncertainty in momentum p for both is $\Delta p = 10^{-3} p$.

6 + 4 + 4 + 6

7. (a) Suppose a one dimensional potential is defined as follows

$V(x) = 0$ for $0 < x < L$
$V(x) = \infty$ otherwise

Write down the Schrodinger equation for the above and solve it for energy eigen values and also obtain the normalized wave function.

(b) Plot the wave functions in the first three states of the above potential and find the position of maximum probability where the particle can be found.

(c) The first member of Balmer series of hydrogen has a wavelength of 653.6 nm. Calculate the wavelength of its second member.

10 + 4 + 6

8. (a) Explain the origin of characteristic x-rays and continuous x-rays.

(b) Obtain the Bragg equation for x-ray diffraction from a crystal. Explain why a crystal cannot diffract visible light.

(c) Write Moseley's law and explain its significance.

(d) In an X-ray tube the accelerating potential is 20 kV. Determine the minimum wavelength of X-rays that could be emitted from this tube.

6 + 7 + 3 + 4