

## B.Tech. 2<sup>nd</sup> Semester Examination, 2021

### PH 201: PHYSICS- II

Duration: 3 Hours

Total Marks:70

#### Group A(Answer any Three questions)

3×10 =30

- 1.(a) Obtain a condition for flowing maximum current in a series LCR circuit biased with an ac power source. 5
- (b) Using the maximum current flowing condition, derive the value of capacitance for a circuit, where,  $R = 10 \text{ ohm}$ ,  $L = 100 \text{ mH}$ ,  $V = 220\text{V}$  &  $50 \text{ Hz}$ . 3
- (c) Mention the value of maximum current through the circuit. 2
2. (a) What is Doppler effect? 2
- (b) A siren is fitted in a car speeding towards a vertical wall with a speed  $36 \text{ km/h}$ . A stationary observer, behind the car, listens to the siren sound directly from the source and that on reflection from the wall. Find the apparent frequency of the direct and reflected waves. Speed of sound =  $340\text{m/s}$ , frequency of siren =  $500 \text{ Hz}$ . 5
- (c) How the velocity of sound depends on the humidity of the air? 3
3. (a) A mass of  $1 \text{ kg}$  is suspended from a spring of stiffness constant  $25\text{Nm}^{-1}$ . If the suspended frequency is  $2/\sqrt{3}$  times the damped frequency, calculate the damping factor. 5
- (b) What do you mean by critically damped oscillation? 3
- (c) Graphically show the variation of amplitude of a critically damped oscillation with time 2
4. (a) State Gauss law for electric fields. 2
- (b) Find the volume density of charge in a region of space where electrostatic potential is given by  $\phi(x, y, z) = a - b(x^2 + y^2) - c \log(x^2 + y^2)$ , where  $a, b, c$  are constants. 4
- (c) The electrical field for a certain region is given as  $\vec{E} = A r^3 \hat{r}$  (Symbols have their usual meaning). Calculate the charge contained within a spherical surface of radius  $a$ , entered at origin. 4
5. (a) Derive an expression for electric field intensity due to an electric dipole. 4
- (b) If a dipole of dipole moment  $p$  is placed in a uniform electric field  $E$ , then calculate the torque acting on it. 3
- (c) What are polar and non-polar dielectric, give one example? 3

**Group B (Answer any Four questions)****4×10=40**

- 6.(a)** What is Blackbody? Why it is not possible to achieve a perfect Blackbody? **2+2**
- (b)** Draw blackbody radiation curves with proper identification for three different temperature  $T_1$ ,  $T_2$  and  $T_3$  where the wavelengths corresponds to the peak of each of the graphs are  $\lambda_{m1}$ ,  $\lambda_{m2}$ ,  $\lambda_{m3}$  respectively and  $\lambda_{m1} < \lambda_{m2} < \lambda_{m3}$ . Also show clearly that which portion of the curve is explained by the Wien's law and which portion of the curve is explained by the Rayleigh-Jeans law. **2+2**
- (c)** What is Ultraviolet Catastrophe? **2**
- 7. (a)** Let us consider a pendulum consisting of a 15gm mass is suspended from a string 15 cm in length. Let the amplitude of its oscillation be such that the string in its extreme positions makes an angle of 0.2 rad with the vertical. Then show that the experiments involving this above pendulum cannot determine whether Planck's postulate is valid or not? **3**
- (b)** Show that how the Rayleigh- Jeans law and Wien's law can be obtained from Planck's Radiation formula. **2+2**
- (c)** Assume that a certain 700-Hz tuning fork can be considered as a harmonic oscillator whose vibrational energy is 0.06 J. Compare the energy quanta of this tuning fork with those of an atomic oscillator that emits and absorbs yellow light whose frequency is  $6.00 \times 10^{14}$  Hz. **3**
- 8. (a)** What is the basic difference between Normal scattering and Compton's scattering? **2**
- (b)** Why the intensity (Photon counts) corresponds to new wavelength is higher than that of the original one in case of Compton's effect? **2**
- (c)** Find out the expression of Compton's Shift with indicative diagram. **4**
- (d)** Explain with schematic diagram what are the mechanism of the energy loss of a photon when it interacts with electron of higher atomic number material? **2**
- 9. (a)** An x-ray photon of wavelength  $0.5\text{\AA}$  is scattered through an angle  $300^\circ$  by a loosely bound electron. Then (i) Find the maximum kinetic energy of the recoiled electron. (ii) What percentage of incident photon energy is lost? **2+2**
- (b)** Find the De-Broglie wavelength of an electron which is accelerated by potential difference of 500 kV. **3**

- (c) Using uncertainty principle show that electron cannot be a part of nucleus having dimension of the order of 1 Fermi. 3
10. a) Show that  $\Delta L \Delta \theta \geq \hbar / 2$  (*Symbols have their usual meaning*) 3
- (b) Write down the Schrödinger equation for a free particle. Show that, in practice we cannot have an absolutely free particle. 1+3
- (c) Find the total energy of a conservative system with zero potential which is denoted by a wavefunction  $\Phi(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{2\pi x}{a}\right)$  3
11. a) A 15-g marble is in a box 8 cm across. Find its permitted energies. Hence show that, in the domain of everyday experience, quantum effects are imperceptible. 2+2
- (b) Draw the schematic diagram for probability density of a particle in a one dimensional potential box for first three consecutive energy states and point out the contradiction to that of classical concept. 3
- (c) Find out the expectation value of momentum for a particle in a one dimensional potential box and briefly explain the findings from that result about the motion of the particle within that box. 3