Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B.Tech. (End Sem- 2018)

Branch	**: ECE+EEE**	**Semester**	**: I**
Title of the Course	**: Electromagnetics and Quantum Physics**	**Course Code**	**: PHL100**

Time: 3 Hours **Maximum Marks: 50**

Note : This question paper divided into three sections A, B and C and each section must be solved with rules given as follows:

Section A: Contains Ten (10) questions of 01 mark each and all questions are compulsory.

Section B: Contains Five (05) questions of 5 marks each and any four (04) are to be attempted.

Section C: Contains Three (03) questions of ten (10) marks each and any two (02) are to be attempted.

Assume suitable data, if found missing.

Used symbols have their usual meaning.

Section A

Q1: Write the differential form of the Faraday's law of EM waves.

Q2: What do you understand by ultraviolet catastrophe?

Q3: How the coherence length of a light source is related with its spectral width? Write the expression.

Q4: What would be the expectation value of momentum of a particle of mass m moving freely between $x = 0$ *and* $x = L$ inside an infinite square well potential?

Q5: The resonating cavity in a laser design for.....

Q6: What is the basic mechanism responsible for the emission of light in semiconductor diode laser?

Q7: Write down the expression of the de-Broglie wavelength in terms of applied electric potential.

Q8: The two sources of light are said to be....., if they emit continuously the wave either in the same phase or with a constant phase difference.

Q9: The average energy of Plank's oscillator of frequency 'v' is .....

Q10: What is phase velocity of de-Broglie wave associated with photon?

Section B

Q1: In a nonmagnetic medium, the electric field associated with EM wave is expressed as $\boldsymbol{E} = 4\sin(2\pi\times10^7 t - 0.8\,x)\,\boldsymbol{a}_z$ Vm. Find

(a) Dielectric constant and intrinsic impedance of the medium,

(b) Time average power carried by wave,

(c) The total power crossing 100 cm^2 of plane $2x + y = 5$. **[5]**

Q2: What do you understand by orthogonal coordinate system? Let $\boldsymbol{A} = \rho\cos\varphi\,\boldsymbol{a}_\rho + \rho z^2\sin\varphi\,\boldsymbol{a}_z$. Transform A into spherical coordinate system and calculate its magnitude at point (3, -4, 0). **[5]**

Q3: [a]: Plane polarized light is incident on a piece of quartz cut parallel to the axis. Find the least thickness for which the ordinary and extraordinary rays combine to form plane polarized light. **[3]**

[b]: What do understand by process of stimulated emissions? Why is the laser action not feasible in two levels pumping scheme? [2]

Q4. [a]: Explain the working of Michelson interferometer. How will you produce circular fringes with it? [2]
[b]: A soap film suspended in air has thickness 5 X 10^{-5} cm viewed at an angle 35° to the normal. Find the wavelength of light in visible spectrum, which will be absent for a reflected light. The refractive index of the soap film is 1.33. [3]

Q5. What do you understand by Fraunhofer class of diffraction? For a plane transmission grating with 5000 lines/cm:
(i)- What is the highest order of spectrum observable with light of $6000A^0$ and
(ii)- If the width of the opacity is twice that of transparency, find the absent orders of spectra. [5]

Section C

Q1: -[a]: A circular disk of radius r is uniformly charged with $\rho_s\ C/m^2$. The disk lies on the z = 0 plane with its axis along the z-axis.

(i) Find the value of the electric field (**E**) at point, (0, 0, h),

(ii) If $r << h$, show that **E** is similar to the field due to a point charge. [5]

[b]: Why do you not observe the Compton shift for visible photons? Photon of initial energy 90 keV undergoes Compton scattering at an angle 60^0. Find: (i) the energy of scattered photon and (ii) the recoil energy of the electron. [3]

[c]: For an ordinary light source, the coherence time is $10^{-10}\ s$. Obtain the degree of monochromaticity for the wavelength of 6000 A^0. [2]

Q2: [a]: Consider a one – dimensional particle which is confined within the region $0 \leq x \leq a$ and whose wavefunction is $\Psi\ (x, t) = \sin(^{\pi x}/_{a}) \exp\ (-i\omega t)$.

(i) Find the potential $V(x)$.

(ii) Calculate the probability of finding the particle in the interval $a/4 \leq x \leq 3a/4$. [5]

[b]: Discuss the salient characteristics of the laser beam. Derive the expression for achieving the threshold condition for lasing action. [5]

Q3: [a]: Why is uncertainty principle important for microscopic world but having significance in practical life? [2]

[b]: Why should Ψ and d Ψ/dx be continuous everywhere? And why we are not aware of quantisation in our daily life. [2]

[c]: The work function of aluminum is 4.2 eV. Calculate the kinetic energy of the fastest and slowest photoelectrons, the stopping potential and the cut off wavelength when light of wavelength 2000 A° falls on a clean aluminum surface. [3]

[d]: The refractive indices of core and cladding of a fibre are 1.465 and 1.460, respectively, and the light of wavelength 1.25 μm is used. What should be the diameter of core for single mode propagation? If the core diameter is given as 50 μm, how many modes can propagate through fibre? [3]

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