Roll No.:......................

National Institute of Technology, Delhi

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

Branch	:CSE+ECE+EEE	Semester	:I+II
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: Avector field **A**is said to be solenoidal, if.....................

Q2: Magnetic vectorpotential is expressed as.....................

Q3: In a single slit diffraction pattern for a slit width (d) and wavelength (λ), the separation between the central maximum and the first minimum is ....

Q4: 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 is ....

Q5: The Laser beam is made of ______________________________

Q6: The basic mechanism responsible for the emission of light in semiconductor diode laser is _______

Q7:de-Broglie wavelength in terms of applied electric potential is expressed as ________

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: Single mode property can be realized in a multimode fibre by ___________the value of fractional refractive index change.

Q10: Momentum of the photon whose total energy is E will be ______________________________

Section B

Q1: Write down the Maxwell's equations for the linear, isotropic, homogeneous and charge free dielectric medium and show that wave phase speed in such a medium is equal to $\frac{1}{\sqrt{\frac{\epsilon\mu}{2}\left[\sqrt{1+\left[\frac{\sigma}{\omega\epsilon}\right]^2}+1\right]}}$. **(5)**

Q2:[a]: What is acceptance angle of the optical fibre? Show that in a step index optical fibre acceptance angle is approximated by $\boldsymbol{\delta} = \boldsymbol{sin^{-1}}[\sqrt{\boldsymbol{n_1^2 - n_2^2}}]$, where $\boldsymbol{n_1}$ ***and*** $\boldsymbol{n_2}$ are the refractive indices of core and cladding respectively. **(2)**

[b]: What do you understand the phenomenon of pulse dispersion in optical fibre communication system? A step-index fibre is with a core of refractive index 1.55 and cladding of refractive index 1.51. Compute the intermodal dispersion per kilometer of length of the fibre and the total dispersion in a 15 km length of the fibre. **(3)**

Q: 3-[a]: Express the vector $\boldsymbol{V} = \frac{1.0}{r}\boldsymbol{a_r} + r\,cos\theta\,\boldsymbol{a_\theta} + \boldsymbol{a_\varphi}$ in the cylindrical coordinate and find out the value of $\boldsymbol{V}\left(5, \frac{\pi}{2}, -2\right)$. **(3)**

[b]: What do you understand by the processes of spontaneous and stimulated emissions? Why is the laser action not feasible in two levels pumping scheme? **(2)**

Q4. Obtain Heisenberg's uncertainty principleby using deBroglie's wave concept and further show the non-existence of electron inside the nucleus by this principle. **(5)**

Q5. What are the main differences exist between interference and 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)**

(a) In the case of negative energies, show that this particle has only one bound state; find the binding energy and wavefunction.

(b) Calculate the probability of the finding the particle in the interval $-a \leq x \leq a$.

(5)

[b]: What do you mean by normalized wave function? Find out the expressions of the first three lower energy state wavefunctions and energies for a particle when is confined in an infinite potential well. **(5)**

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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]: Calculate the wavelength of incident x-ray photon which produces recoil electron of energy $4.0KeV$ in Compton effect. The electron recoils in the direction of incident photon and photon is scattered at an angle of 180^0. **(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 $0 \le x \le a$ and whose wavefunction is $\Psi(x,t) = \sin(\pi x/_a) \exp\ (-i\omega t)$.

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

(b) Calculate the probability of finding the particle in the interval$a/4 \le x \le 3a/4$.**(5)**

[b]: Suppose two identical conducting wires, lying along the x-axis are separated by an air gap of thickness $L = 1nm$. An electron is moving inside either conductor has potential energy zero, whereas in the gap its potential energy $U>0$. Thus, the gap is a kind of barrier. The electron approaches the barrier from the left with energy such that $U - E = 1\ eV$, below the top of the barrier. Find the probability of the electron emerging on the side of the barrier? If the barrier is twice as wide how the probability changes? **(5)**

Q3:[a]: Consider a particle of mass m subject to an attractive delta potential $V(x) = -V_0\ \delta(x)$, where $V_0 > 0, (V_0\ has\ the\ dimension\ of\ energy \times distance)$.