PES UNIVERSITY

PES University, Bengaluru

(Established under Karnataka Act 16 of 2013)

UE17PH101

END SEMESTER ASSESSMENT (ESA) MAKEUP EXAM B TECH. I SEMESTER FEB 2018

ENGINEERING PHYSICS

Time: 3 hours **Answer all questions** **Max marks: 100**

1 a)	Consider a plane electric wave and using Maxwell's equations show that the associated magnetic wave is perpendicular to the electric wave and the direction of propagation of the electric wave.	5
b)	In a Compton scattering of electrons with X rays discuss the condition under which the energy gained by the electron is maximum. If the wave length of the incident X ray is 0.1nm calculate the maximum energy gained by the electron.	5
c)	Discuss the Young's double slit experiment to show that photons or electrons can behave as waves.	5
d)	An electron has a life time of 0.5×10^{-9}s in an upper excited state. If the wavelength of the photon emitted is 498.3nm obtain the uncertainty in the wavelength of the photon.	5
2 a)	What are observables and expectation values of a quantum system? Discuss the expectation value of momentum.	4
b)	Discuss the wave functions of a particle with energy **E** incident on a potential step of height **Vo <E** for **x > 0** and potential V=0 for **x <0.** Show that the probability of reflection at the potential step is non zero.	6
c)	Discuss the potential of a harmonic oscillator and energy Eigen values of the system. How does this differ from the energy Eigen values of an infinite potential well?	5
d)	Show that the probability of finding the particle in a infinite potential well of width **L** in the n^{th} state in an interval **L/n** is **1/n**	5
3 a)	Discuss the concept of density of states of electrons in a metal. How do find the distribution of occupied states at a temperature >0K. Support your answer with suitable graphs.	5
b)	Determine the free electron concentration, the Fermi velocity for electrons in a metal with Fermi energy of 5.10 eV.	5
3c)	How does the quantum free electron explain the temperature dependence of conductivity of metals?	5
d)	Outline the concepts that lead to the formation of bands in materials.	5
4 a)	Discuss why a two level system cannot be operating as a Laser. What are the characteristics of a three level and four level Laser system?	5
b)	Elaborate on the requirements of a Laser system.	5
c)	The ratio of population between the high energy states to the lower energy state is $5x\ 10^{-19}$ at **400K**. Find the emission wavelength between two states and the ratio **A/B**.	4
d)	Discuss the draw backs of a homo junction laser and elaborate on the working of a hetero-junction laser system.	6
5 a)	What is Larmor precession? Obtain an expression for the Larmor frequency. Calculate the Larmor frequency for electrons and protons at B=2T.	5
b)	Discuss Giant Magneto resistance and explain how this is used as the read head of hard disk drives.	5
c)	What the components of the electric fields that prevail in a dielectric and how do they affect the polarization of the material?	5
d)	Explain the behavior of piezo electrics and pyro electrics with suitable examples.	5

END SEMESTER ASSESSMENT (ESA) B TECH. I SEMESTER DEC 2017 ENGINEERING PHYSICS

Time: 3 hours | Answer all questions | Max marks: 100

Useful constants: | $m_e = 9.1x10^{-31}Kg$ | $h = 6.63x10^{-34}Js$ | $k_B = 1.38 \times 10^{-23} JK^{-1}$ | $c = 3x10^8 ms^{-1}$ | $N_A = 6.02x10^{23}$ per mol |

1 a)	From the Maxwell's equation $\nabla \times \mathbf{B}$ obtain the wave equation of a transverse magnetic wave in free space. How does this compare with the corresponding transverse electric wave?	5
b)	Briefly discuss how Compton effect proves the particle nature of radiation. What do you infer from the expression for the Compton shift?	5
c)	Estimate the energy of an **electron** if it to confined in a region of width 10^{-14} **m** and calculate the de Broglie wavelength of the electron with this energy. Comment on the results obtained	5
d)	Starting with the wave function $\psi = e^{i(kx-\omega t)}$ obtain the operators for kinetic energy and total energy?	5
2 a)	Write the Schrodinger's time dependent wave equation and obtain the time independent form of the wave equation.	5
b)	Discuss the wave functions of a particle with energy **E** incident on a potential barrier of height **Vo >E** between **x = 0 to x = L** and **V=0** for all **other values of x**. Elaborate on the sensitivity of the tunneling probability to the width of the barrier.	6
c)	How do you conclude that the **energy levels** of a particle in a **finite potential well** of width **L** are always lesser than the corresponding energy levels of a particle in an **infinite potential well** of the same width **L**?	5
d)	Graphically show that the probability of finding a particle in an infinite potential well in the 2^{nd} and 4^{th} state in an interval $= \frac{L}{4}$ is $\frac{1}{4}$ *or* **0.25**	4
3 a)	Discuss how quantum mechanics describes the valence electrons in a metal. What are the factors that determine the occupancy of the electron states? Which energy state of electron would have an occupation probability of **50%** at any temperature **> 0 K**?	5
b)	A mono valent metal has **5 x 10^{28}** valence electrons per m^3. Estimate the number of electron energy states per unit volume in the metal between **2eV** and **2.005eV** from the concept of the density of states.	4
3c)	Calculate the ratio of the thermal conductivity of a metal to the electrical conductivity of the metal at **500K.**	3
d)	Outline the Kronig Penny model to describe the motion of electrons in a metal and discuss how the band structure evolves from this model.	8
4 a)	Starting from the rate equations for the absorption and emission processes in a two level system show that the coefficients of stimulated emission and the coefficient of induced absorption are equal.	6
b)	Elaborate the round trip gain of a Laser and obtain an expression for the threshold gain	5
c)	The emission wavelength between two states is **532nm at 300K**. Estimate the ratio of population between two states N_1 and N_2 and obtain an estimate of the ratio **A/B**.	3
d)	Discuss with appropriate energy level diagram how the He Ne system works as a continuous wave laser. Suggest an appropriate distance between the mirrors for a characteristic neon red emission for practical He Ne laser.	6
5 a)	Write the expression for the magnetic moments of an atom from quantum mechanical ideas and show that the spin magnetic moment is twice the orbital magnetic moment for electrons.	5
b)	Discuss the Brillouin function for magnetic materials for large values of *j* and when *j=1/2*. How does this lead to the expression for the paramagnetic susceptibility?	5
c)	Obtain an expression for the dielectric polarization of a linear dielectric when placed in an external field.	5
d)	Discuss the BaTiO3 unit cell in the ferroelectric phase. What is the behavior of the system above the Curie temperature?	5

*** * ***