Registration No: | | | | | | | | | | |

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B.TECH
PAP1A102

1st Semester Regular Examination 2016-17
APPLIED PHYSICS
BRANCH(S): ALL
Time: 3 Hours
Max Marks: 100
Q.CODE: Y763

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Answer the following questions: **(2 x 10)**

a) The total energy of a particle executing simple harmonic motion is directly proportional to ……..[(i) inverse square of amplitude(ii) square of amplitude (iii) amplitude (iv) inverse amplitude].

b) Divergence of position vector is ……..

c) According to Huygen's principle, each point on a primary wave front acts as a source of ……., that travels in all directions.

d) A wave along a string is given by the equation $y = 0.01 \sin(50\pi t - 31.4x)\ m$. The wave travels with a speed of …….. m/s.

e) Spacing between (220) planes is found to be $1.414\ A^0$. Its lattice constant is ……

f) The probability of occupying a state for fermions $2\ kT$ above the Fermi level is ……

g) The wavelength of a HE-Ne LASER generating 3.14 mW power is 632.8 nm. When it is in operation, the number of photons emitted per minute is ……..

h) The S I unit of electric displacement $\vec{D}$ is …….

i) In a Compton scattering process, the wavelength of the incident beam changes from 1.876 A^0 to …… when scattered at an angle 90^0.

j) ……. Is the dimensional formula of the wave function of a particle restricted to move in the region $-2 \leq x \leq 2$.

Q2 Answer the following questions: **(2 x 10)**

a) Graphically show the variation of phase difference between the oscillator and driving force with frequency for two representative damping forces.

b) State de Alembert's principle.

c) Show the plot of Fermi-Dirac distribution function both at T=0 and T>0.

d) Write two applications of LASER.

e) The refractive indices of for core and cladding for a step index fibre are 1.52 and 1.41 respectively. Calculate the numerical aperture of the fibre.

f) Write in SI unit system, the integral and differential forms of Gauss' law in electrostatics in a dielectric medium.

g) Electro static potential is given by the field $\varphi = x^3 - yz^2 + xy^2z$. Calculate the electric field $\vec{E}$ at the point $(1,0,-2)$.

h) State Gauss divergence theorem.

i) Mass of proton is approximately 1840 times of the mass of an electron. Calculate the ratio of the de Broglie wavelengths of electron and proton if both the particles move with same velocity.

j) Write two characteristics of a quantum mechanical wave function.

Part – B (Answer any four questions)

Q3 **a)** What are normal coordinates? Set up the differential equations of motion of two pendulums of equal masses coupled together by a spring and hence find out the normal mode frequencies. Discuss the in phase mode and out of phase mode of oscillations. **(10)**

b) Apply Lagrange's equation of motion to obtain the differential equation for a one dimensional harmonic oscillator. **(5)**

Q4 **a)** Derive an expression for fringe spacing in a two source interference pattern. **(5)**

b) With neat diagrams, explain in detail, the determination of wavelength of light using Fresnel's Biprism. **(7)**

c) The diameter of the central zone of a zone plate is 2.3mm. If a point source of light of wavelength $\lambda = 5893\ A^0$ is placed at a distance of 6.0m from the zone plate, calculate the position of the first image. **(3)**

Q5 **a)** What is band theory of solids. Discuss the classification of materials on the basis of band theory of solids. **(8)**

b) State and explain Bragg's law. **(3)**

c) X-ray of wavelength $1.4\ A^0$ is found to be Bragg reflected from (111) plane of an fcc crystal structure. If the lattice parameter of the crystal is $5A^0$, find the angle at which the X-ray is incident on the (111) plane of the crystal. **(4)**

Q6 **a)** What does LASER stand for? Describe in detail, the components, principle of operation and working of a Ruby LASER. **(10)**

b) Write five differences between step-index and graded-index optical fibers. **(5)**

Q7 **a)** Define curl of a vector field. Write its physical significance. **(7)**
Find the curl of the vector field is given by $\vec{A} = -\frac{2z^2y}{x^3}\hat{\imath} + \frac{z^2}{x^2}\hat{\jmath} + \frac{2yz}{x^2}\hat{k}$.

b) State Ampere's circuital law. Write the integral and differential forms of Ampere's law in free space in SI unit. **(4)**

c) Distinguish between real current and displacement current. **(4)**

Q8 **a)** Wave function for a quantum mechanical particle constrained to move in the region $-\frac{\pi}{2} \leq x \leq \pi/2$ is given by $\psi = A\,sin^2x$. Normalize the wave function and obtain the normalization constant. **(5)**

b) Calculate the probability of finding a particle in the region $2 \leq x \leq 4$, if the wave function for the particle is given by $\psi = 0.25e^{2ix}$. **(4)**

c) State and explain Heisenberg's uncertainty principle. Using the uncertainty principle derive the ground state energy of harmonic oscillator. **(6)**

Q9 **a)** With a neat labeled diagram, describe the construction of Michelson interferometer. **(5)**

b) What are Miller indices? Explain the steps to find out these indices of a crystal plane from the intercepts made by this plane along the three axes. **(4)**

c) What is expectation value of an observable? A particle is observed to have five quantum mechanical states $\psi_1, \psi_2, \psi_3, \psi_4$ and ψ_5 with relative probabilities 0.2, 0.1, 0.3, 0.2 and 0.2 respectively. If the corresponding energy eigen values for these states are 2 eV, 3eV, 3 eV, 1eV, 1 eV then calculate the energy expectation value. **(3)**

d) Write some of the advantages of optical fibers over conventional wires. **(3)**