Total No. of Questions – [3]

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May 2022 (INSEM+ ENDSEM) EXAM
F.Y. B. TECH. (SEMESTER - II)
COURSE NAME: ENGINEERING PHYSICS
COURSE CODE: ES10204A
(PATTERN 2020)

Time: [2Hrs] [Max. Marks: 60]

Instructions to candidates:

1) **Figures to the right indicate full marks.**
2) **Use of scientific calculator is allowed**
3) **Use suitable data wherever required**

Q.1 **Solve the following**

i) For a spring-mass system, if the damped time period is 1.5 s and the damping ratio is 0.1, then the natural angular frequency is [2]

a) 4.19 rad/s b) 4.21 rad/s c) 0.77 rad/s d) 0.67 rad/s

ii) For an undamped oscillator with a time period of 1.5 s, the displacement of the mass from the equilibrium position is 1 cm at t = 3s. What is the acceleration at that time? [2]

a) -2 cm/s^2 b) -3 cm/s^2 c) 4.19 cm/s^2 d) -17.5 cm/s^2

iii) The initial displacement, initial velocity and natural angular frequency for an undamped free oscillation is 1cm, -1cm/s and 1 rad/s. What is its amplitude? [2]

a) 1 cm b) -1.4 cm c) 1.4 cm d) 0 cm

iv) The ratio of 4^{th} to 17^{th} amplitude of a damped free oscillations is 274. What is the logarithmic decrement? [2]

a) 0.432 b) 0.188 c) 5.613 d) -0.432

v) The ratio of damped frequency and natural frequency is 0.9 for an oscillator. The damping ratio of the system is [2]

a) 0.1 b) 0.19 c) 0.436 d) 0.81

vi) A damped forced oscillation has an amplitude which _____ with time in steady state [2]

a) decreases b) increases c) is constant d) none of the options

vii) For a forced damped oscillator, the frequency of the external force (also known as excitation frequency) is 20 times the natural frequency of the oscillator. The deformation response factor is [2]
a) 0.05 b) 0.0025 c) 1 d) 400

viii) A mass spring system with mass m=1kg and spring constant k=10 N/m is subjected to a sinusoidal external force with an amplitude of F_0=5N. What is the amplitude of oscillation in steady state if the deformation response factor is 0.01? [2]
a) 0.002 m b) 0.01 m c) 0.5 m d) 0.005m

ix) If the ratio of donor impurity concentration to the intrinsic charge carrier density is 10^5 in a Silicon based n-type semiconductor, then the value of E_F-E_{Fi} at T = 300K is _____. Given Boltzmann constant k = 8.6×10^{-5} eV/K. [2]
a) 0.3 eV b) 0.35 eV c) 0.4 eV d) 0.45eV

x) A Si diode has a reverse saturation current of 0.1nA. What will be the applied voltage at which the current flowing through the diode is 1mA at T=300K? Given k/e = 8.6×10^{-5} V/K. [2]
a) 0.18 V b) 0.416 V c) 0.55 V d) 1.1 V

xi) Silicon has an intrinsic charge carrier density of 1×10^{10} /cm^3. A p-n junction diode is formed by doping 3.4×10^{12} /cm^3 donor impurity on the n-side and 5.9×10^{14} /cm^3 on the p-side. The built-in potential of this diode at 300K is _____. Given k/e = 8.6×10^{-5} V/K. [2]
a) 0.239 V b) 0.319 V c) 0.434V d) 0.594 V

xii) The type of bond between Si atoms in a Silicon crystal is [2]
a) covalent b) metallic c) ionic d) semiconducting

xiii) The probability of finding an electron 0.2 eV above the Fermi energy at 500K is [2]
a) 0.095 b) 0.95 c) -0.95 d) 0.0095

xiv) The depletion region on the p-side of the p-n junction diode has [2]
a) positively charged immobile ions and holes
b) positively charged immobile ions and both holes and electrons
c) negatively charged immobile ions and no electrons and no holes
d) negatively charged immobile ions and holes

xv) In the limit of low doping concentration in a n-type semiconductor, the bottom of the conduction band E_c is said to be at an energy of 3kT above the Fermi energy. What is the probability of finding an electron at E_c according to the Fermi-Dirac distribution function? [2]
a) 0.0064 b) 0.047 c) 0.019 d) 0.00098

Q2 **Solve any three out of four**

a) With the help of a neat diagram, derive the expression for acceptance angle for a multimode step refractive index optical fibre. [5]

b) With the help of a neat diagram explain the working of an optical fibre communication system. [5]

c) An optical fibre communication has to be carried out using a single 10km long glass fibre. If the core refractive index is n_1=1.5, then what should be the cladding refractive index so that the signal can be sent at a maximum bit rate of 1Gbps. Assume that the material RMS dispersion is negligible. [5]

d) The refractive index of the core of an optical fibre is $n_1 = 1.4440$ and the slope of refractive index versus wavelength curve is $\frac{dn_1}{d\lambda} = 1 \times 10^{-6}\text{Å}^{-1}$ at λ=15500Å. What are the times taken by light when it travels at the phase velocity and group velocity, respectively? [5]

Q.3 **Solve any three out of four**

a) Draw a neat diagram of an optical cavity of a laser and define the loop gain. Hence derive an expression for the threshold optical gain necessary for a sustained lasing action. [5]

b) With the help of a neat physical diagram of a single hetero-junction diode and its energy level diagram, describe the construction and working of a diode laser. [5]

c) A collimated beam of light with a diameter d=2.54cm is focused by a lens of focal length f=5cm. If the wavelength of light is 1.5μm, then what is the beam waist diameter? If the power of light is 1W, what is the intensity of light at the focal point? [5]

d) If the diameter of a laser beam is 5.434 mm and 5.63mm at 1m and 1.45m from the output of the laser, then what is the half beam divergence θ? What is the Rayleigh range if the wavelength of the laser light is 8900Å? [5]