Total No. of Questions – [3]

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PAPER CODE	U111-204A

DECEMBER 2021 (INSEM+ ENDSEM) EXAM

F.Y. B. TECH. (SEMESTER - I)

COURSE NAME: ENGINEERING PHYSICS

COURSE CODE: ES10204A

(PATTERN 2020)

Time: [2Hr]

[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 where ever required**

Q.1 **Solve the following**

i)For a damped spring mass system with m=12kg, k=100N/m, $u(0) = -1.8$cm, $\dot{u}(0) = -2cm/s$, $\zeta = 0.07$, the exponential envelop at 5 s in terms of the amplitude is [2]

$(a)0.36\, u_0$. (b) $\frac{1}{0.36u_0}$ (c) $\frac{1}{0.36}u_0$ (d) $\frac{0.36}{u_0}$

ii) A spring mass system with m=1kg, k=64N/m and ζ=0.19 is driven by an external harmonic force $F = (3.2N)sin\omega t$. Calculate the static amplitude and the angular frequency ω at which there will be resonance. [2]

a)0.05m, 8rad/s (b) 0.5m, 8rad/s (c) 0.005m, 8rad/s (d) 0.05m, 0.8rad/s

iii) A mass m = 1000g is suspended from a spring having a spring constant k= 410 N/m and damping ratio ζ=0.39. Find the value of deformation response factor R_d for frequency of forced oscillation of 3.22 Hz. [2]

(a) 1.82 (b) 1.28 (c) 1.52 (d) 1.25

iv) For a spring mass system, with mass of 7.5kg, oscillating with a damping ratio of 0.012 and a damped frequency of 5Hz, what is the critical damping coefficient? [2]

(a) 741 (b) 417 (c) 147 (d) 471

v) For a damped spring mass system with m=1kg, k=16N/m, ζ=0.8, calculate the natural frequency and the ratio of damped to undamped frequency. [2]

(a) 6 rad/s, 0.4 (b) 4 rad/s 0.6 (c) 6 rad/s, 4 (d) 4 rad/s, 6

vi) At what frequency ω of the external force does R_d exhibit a maximum for a spring and mass system with m = 5kg, spring constant k = 125N/m and damping ratio ζ= 0.5? [2]

(a)3.54rad/s (b) 3.44 rad/s (c) 3.43 rad/s (d) 3.34 rad/s

vii) In free damped vibrations, what is the effect of small ζ on $\frac{\omega_D}{\omega_n}$? [2]
(a) tends to 1 (b) tends to 0 (c) becomes infinitely large (d) takes a complex value

viii) In Forced Harmonic Oscillations with Viscous Damping, when the frequency of the harmonic driving force is much less than the natural frequency of the system ($\omega \ll \omega_n$), the deformation response factor is governed by [2]
(a)The mass of the system (b) The applied force (c) The stiffness of the system (d) None of these factors

ix) In a semiconductor at room temperature [2]
(a) the valence band is completely filled & the conduction band is completely empty
(b) the valence band is partially empty & conduction band is partially filled
(c) the valence band is completely filled & conduction band is partially filled
(d) the valence band is completely empty and the conduction band is completely filled

x) In an unbiased p-n junction diode at equilibrium [2]
(a) Intrinsic Fermi energy E_{Fi} is higher on the p-side than that on the n-side
(b) Intrinsic Fermi energy E_{Fi} is lower on the p-side than that on the n-side
(c) Intrinsic Fermi energy E_{Fi} is equal on the p-side and the n-side
(d) none of the options

xi) The barrier potential V_{bi} in an unbiased p-n junction diode is due to [2]
(a) difference in the E_{Fn} and E_{Fp} of the n- and p- regions, respectively.
(b) difference in the E_{Fi} of the n- and p- regions
(c) difference in E_c of the n-region and E_v of the p- regions
(d) difference in E_v of the n-region and E_c of the p- regions

xii) The position of Fermi energy in a p-type semiconductor, with a low doping concentration, depends upon [2]
(a) acceptor impurity concentration
(b) intrinsic carrier density
(c) temperature
(d) all of the options

xiii) In a reverse biased p-n junction diode, [2]
(a) electrons travel from n-side to p-side and holes from p-side to n-side
(b) holes travel from n-side to p-side and electrons from p-side to n-side
(c) only electrons travel from n-side to p-side

(d) only holes from p-side to n-side

xiv) If the temperature of an intrinsic semiconductor is doubled, then the ratio of charge carrier densities at the two temperatures $\frac{n_i(2T)}{n_i(T)}$ is [2]

(a) 2 (b) $\frac{1}{2}$ (c) $e^{\frac{1}{2}}$ (d) $e^{\frac{E_g}{4kT}}$

xv) In a p-type silicon sample, the hole concentration is 2.25×10^{15} cm^{-3}. If the intrinsic carrier concentration is 1.5×10^{10} cm^{-3}, the electron concentration is [2]

(a) Zero (b) 10^{10} cm^{-3} (c) 10^{5} cm^{-3} (d) 1.5×10^{10} cm^{-3}

Q2 **Solve any three out of four**

a) Define acceptance angle of an optical fiber. Derive the expression for the same. Comment on what happens when light is incident at an angle greater than the acceptance angle. What does an optical fiber having larger NA imply qualitatively? [5]

b) A glass clad fiber is made with core glass of refractive index 1.55. The cladding is doped to give a fractional refractive index of 0.001. Find (a) the cladding index (b) the numerical aperture (NA) (c) the external acceptance angle and (d) the internal critical angle. What happens if light strikes the core cladding interface at an angle less than the critical angle? [5]

c) A multi-mode step index optical fibre with core refractive index of 1.4028 has a relative refractive index difference of 0.15% and is thirty kilometers long. Calculate RMS intermodal pulse broadening $(\Delta t)_s$. What is the total maximum bit rate if the RMS material pulse broadening is given as $(\Delta t)_m$=82 nanoseconds. [5]

d) Discuss in brief the various reasons for light to be attenuated in an optical fiber. Which of the processes is most dominant? How would this help in selecting a suitable wavelength for the source of light? [5]

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

a) In a state of thermal equilibrium, how are the population densities of two states E_1 and E_2 (E_2>E_1) related to each other? Find the ratio of population of the two states in a He-Ne laser that produces light of wavelength 6328Å at room temperature. Comment, with justification, whether lasing action can occur in such a system. [5]

b) Give the construction of an optical cavity with a neatly labelled diagram. Explain how it can be used to make the emergent laser beam monochromatic. [5]

c) A He-Ne laser has a full width of the gain curve of $\Delta\nu$ =2.6 GHz at 6328Å. If the length of the optical cavity of the laser is 0.25 m, what is the [5]

1) mode number m

2) peak frequency
3) width of the gain curve in terms of wavelength ($\Delta\lambda$)
4) mode separation frequency v_{ms}
5) how many modes are allowed in the width of the gain curve

d) Explain with neatly labelled diagrams of the diode with band gap and refractive index variations, the construction and working of a single heterojunction laser (SHL). How is light confined to the active medium? [5]