Total No. of Questions – [3]

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G.R. No.	

PAPER CODE	U112-204A(BE)

DEC 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 where ever required**

Q.1 **Solve the following**

i) For a spring-mass system, if the mass suspended from the spring is increased by 4 times, then the damping ratio [2]

a) remains the same b) doubles c) increase four times d) becomes half

ii) For a spring-mass system, if the mass suspended from the spring is increased by 4 times, then the natural time period [2]

a)remains the same b) doubles c) increase four times d) becomes half

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 initial phase? [2]

a) -45° b) 45° c) 90° d) 0°

iv) A mass of 1kg is suspended from a spring and the spring is found to extend by 1cm. If this mass-spring system is set into oscillations, what would be its natural angular frequency? [2]

a) 9.9rad/s b) 1 rad/s c) 0.313 rad/s d) 31.3 rad/s

v) Using the expressions, $\frac{\omega_D^2}{\omega_n^2} + \zeta^2 = 1$ and $\delta = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$ [2]

select the correct expression

a) $\delta = 2\pi\left(\frac{\omega_n}{\omega_D}\right)$ b) $\delta = 2\pi\left(\frac{\omega_D}{\omega_n}\right)$ c) $\delta = 2\pi\left(\frac{\omega_n}{\omega_D} - \frac{\omega_D}{\omega_n}\right)$ d) $\delta = 2\pi\sqrt{\frac{\omega_n^2}{\omega_D^2} - 1}$

vi) A damped forced oscillation system has a natural angular frequency of ω_n and the external exciting force has an angular frequency of ω. In the steady state, the system oscillates with an angular frequency of [2]

a) ω_n b) ω c) $\omega_n + \omega$ d) $\omega_n - \omega$

vii) For a forced damped oscillator, if the damping factor is doubled then the deformation response factor at $\omega = \omega_n$ becomes _____ the original value [2]

a) half of b) twice of c) one-fourth of d) does not change from

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 and angular frequency equal to the natural angular frequency of the mass-spring system. If the damping coefficient c = 3 Ns/m, then what is the amplitude of oscillation in steady state? [2]

a) 0.26 m b) 0.47 m c) 0.53 m d) 0.005m

ix) In the derivation of electron density in a n-type semiconductor, it was stated that the impurity doping is assumed to be low if $E_c - E_F \leq 3kT$. Calculate the donor impurity density N_D for $E_c - E_F = 3kT$ in silicon which has a band gap of 1.12eV and intrinsic charge carrier density $n_i = 1 \times 10^{10}\ cm^{-1}$ at a temperature of 300K. [2]

a) $1.329 \times 10^{18}\ cm^{-3}$ b) $3\times 10^{16} cm^{-3}$ c) $7\times 10^{15} cm^{-3}$ d) $5\times 10^{14} cm^{-3}$

x) Lattice spacing of Ge is $a = 5.6575$Å. Calculate the value of k for which the second band gap will appear. [2]

a) $1.77\times 10^{9} m^{-1}$ b) $11.1 \times 10^{-9} m^{-1}$ c) $5.55\times 10^{9} m^{-1}$ d) $11.1 \times 10^{9} m^{-1}$

xi) Germanium has an intrinsic charge carrier density of 2×10^{13} /cm^3. A p-n junction diode is formed by doping 1.4×10^{17} /cm^3 donor impurity on the n-side and 9.3×10^{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) 0.33 V b) 0.44 V c) 0.55V d) 0.66 V

xii) Which of the following statements is the most appropriate? [2]

a) the effective resistance of a p-n junction diode decreases in the forward bias

b) the effective resistance of a p-n junction diode increases in the reverse bias

c) The current flowing through an unbiased p-n junction diode is zero

d) all of the options

xiii) The probability of absence of an electron 0.12 eV below the Fermi energy at 350K is [2]

a) 0.012 b) 0.018 c) 0.98 d) 0.95

xiv) If the current flowing through a p-n junction diode is 10mA for a forward voltage of 0.5V at a temperature of 300K, then the value of reverse saturation current is: [2]

a) 38 nA b) 3.8 nA c) 38pA d) 3.8 pA

xv) The effective density of states Nc for the conduction band of Ge at 300K is $1 \times 10^{19} cm^{-3}$. What is its value at 400K? [2]

a) $5.319 \times 10^{20} cm^{-3}$ b) $7.973 \times 10^{17} cm^{-3}$ c) $1.5396 \times 10^{19} cm^{-3}$ d) $1 \times 10^{19} cm^{-3}$

Q2 **Solve any three out of four**

a) With the help of a neat diagram, derive the expression for RMS inter-modal dispersion in a multi-mode step refractive index optical fiber. [5]

b) With the help of a schematic graph of attenuation versus wavelength for an optical fiber, explain the role of different absorption and scattering mechanisms in attenuation. [5]

c) An optical fibre has a core refractive index n_1=1.5 and cladding refractive index n_2=1.4995. What are the values of critical bending radius Rc and Numerical aperture NA for a wavelength of 1550nm? [5]

d) The refractive index of the core of an optical fibre is $n_1 = 1.4440$ and the dispersion $\left|\lambda^2 \frac{d^2 n_1}{d\lambda^2}\right| = 0.0054$ at λ=15500Å. The fibre laser used as the source of light has a spectral width $\Delta\lambda = 0.1$Å. What is the maximum bit rate at which a digital signal could be sent over a distance of 10 km? Assume that the RMS inter-modal dispersion is 1ns. [5]

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

a) Draw a neat diagram of an optical cavity of a laser and derive an expression for the mode frequency and mode separation. From a schematic diagram for loop gain versus frequency of light indicate which frequencies will be sustained and which will be not. [5]

b) With the help of a neat physical diagram of an optical fibre laser and the energy level diagram of Er^{3+} ion, describe the construction and working of the optical fibre laser. [5]

c) An Argon laser emits light with a wavelength of 4580Å. Calculate the ratio of population in the higher energy level to that of the lower level at 100°C. [5]

d) If a beam of Ruby laser having a power of 10^5 W comes out of a circular hole of diameter 10 mm, then what is its intensity at a distance of 17 m, from the output of a laser, if the wavelength of the light is 6943Å? [5]