PY211IA

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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

I / II Semester B. E. Regular / Supplementary Examinations August -2024

CONDENSED MATTER PHYSICS FOR ENGINEERS

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2 & 11 are compulsory. Answer any one full question from 3 and 4, 5 and 6, 7 and 8, 9 and 10, and 11 lab components (compulsory).
3. Handbook of Physics is allowed.

PART A

			M	BT	CO
1	1.1	Write the energy Eigen value of the lowest state in one dimensional potential box of length 'a'.	01	1	1
	1.2	Write the condition for which the Fermi factor becomes 0.5 at $T > 0K$.	01	1	1
	1.3	Name one application of a diode.	01	1	1
	1.4	Name the temperature dependent dielectric polarization mechanism.	01	1	1
	1.5	A fibre of $500m$ long has an input power of 8.6μW and an output power of $7.5\ \mu$W . What is the attenuation coefficient of a fibre?	02	2	2
	1.6	If an electron moves in one dimensional box of length $2\ nm$, what is the normalization constant?	02	2	2
	1.7	A steel wire of length $2m$ has inner radius $1cm$ and outer radius $1.2\ cm$. Calculate the elongation produced when it is stretched by force of $3N$. Given the Young's modulus of steel is $18 \times 10^{10}\ Nm^{-2}$.	02	2	2

PART B

2	a	Find the solution for a particle in an infinite potential well of width 'L' using the time independent Schrodinger's wave equation. Hence obtain normalized wave function and plot the probability density as a function of 'x' for the particle in first excited state.	10	2	2
	b	State de-Broglie hypothesis. Find the de-Broglie wavelength of electron acceleration from rest under a potential of $100V$.	04	1,3	1,3
3	a	Derive an expression for electron concentration in conduction band of an intrinsic semiconductor. By analogy write the expression for hole concentration in valence band. Sketch the position of, Fermi level in an n-type semiconductor.	10	2	2
	b	Find the temperature at which there is 1% probability that a state with energy $0.5eV$ above Fermi energy is occupied.	04	3	3
		OR			

4	a	State and explain Hall effect in a metal. Obtain the expression for carrier concentration and Hall coefficient in terms of Hall voltage for it. Calculate the Fermi energy at $0K$ for a metal having 5.86×10^{28} free electrons per unit volume.	10	2	2
	b	A sample of silicon is doped with 10^7 phosphorous atoms/cm^3. Find the Hall voltage, if the sample is $100mm$ thick, $I_x = 1mA$ and $B_z = 10^{-5} Wb/m^2$. Assume all dopant atoms are ionized.	04	3	3
5	a	Explain the terms stimulated emission and population inversion. Obtain an expression for energy density of photons in terms of Einstein's coefficients. Mention the advantage of three energy level system over two energy level system for laser production.	10	2	2
	b	The ratio of population of two energy levels is 9.44×10^{29}. Find the wavelength of light emitted at $300K$.	04	3	3
		OR			
6	a	Obtain an expression for numerical aperture of an optical fibre kept in water and relate it to the fractional index change. Explain how in graded index multimode optical fibre the intermodal dispersion is minimum.	10	2	2
	b	The numerical aperture of an optical fibre is 0.2 when surrounded by air. Determine the refractive index of its core given refractive index of cladding as 1.59. Also find the acceptance angle when it is in a water medium of refractive index 1.33.	04	3	3
7	a	Describe the signal amplification process in a transistor circuit in CE mode. Elucidate the differences between Avalanche and Zener breakdown mechanism	10	2	2
	b	A transistor is used in CE mode in an amplifier circuit. When a signal of $20\,mV$ is added to the base-emitter voltage, the base current changes by 20μA and the collector current changes by $2mA$. The load resistance is $5k\Omega$. Calculate: i) the factor β, ii) the input resistance R_{BE} and iii) the voltage gain.	04	3	3
		OR			
8	a	Describe how a Zener diode works as voltage regulator and p-n junction diode is used in a Bridge rectifier with circuit diagram and the input and output waveforms. Current flowing in a p-n junction is $0.2\,\mu$A at room temperature when a large reverse bias voltage is applied. Calculate the current when a forward bias of $0.1\,V$ is applied.	10	2	2
	b	Explain direct and indirect band gap semiconductor.	04	1	1
9	a	What is meant by local field in a dielectric and deduce the Clausius-Mosotti relation for elemental solid dielectrics. Calculate the polarizability of CO_2. If its electrical susceptibility is $0.985 \times 10^{-3} C^2/N/m^2$. Given that the density of CO_2 is $1.977 kg/m^3$ and atomic weight of CO_2 is 44.	08	3,2	3,2
	b	Briefly explain Dielectric breakdown and any two dielectric breakdown mechanisms in solid dielectrics.	06	1	1

OR

10 a What is a transducer? Explain the construction and working of ultrasonic Piezoelectric transducer. Calculate the dielectric constant of NaCl, Crystal is subjected to an electric field of $1000V/m$ and resulting polarization is 4.3×10^{-8} C/m^2 — 10 — 1,3 — 1,3

b Explain the functioning of a thermocouple as a temperature transducer. — 04 — 1 — 1

11 a Following is the data for an experimental determination of energy gap of a thermistor. Calculate the band gap of a thermistor by determining the slope graphically.

T in °C	25	84	82	80	78	76	74	72	70	68	64
R in Ω	39.7	6.3	6.6	6.9	7.1	7.5	8.0	8.3	8.7	9.1	9.3

10 — 3 — 3

b Determine the capacitance of a parallel plate capacitor and hence calculate the dielectric constant of the dielectric medium using following data. $C = 3300\,\mu F, R = 47$ kΩ, and dimensions of the dielectric medium (Length = $47\,cm$, Breadth = $1.5\,cm$, Thickness = $80\,\mu m$). Apply a correction factor = 10^{-6}.

$Time(s)$	0	30	60	90	120	150	180	210
$Charging\ Voltage\ (V)$	0	0.41	0.7	0.94	1.14	1.3	1.43	1.54
$Discharging\ voltage\ (V)$	1.75	1.34	1.10	0.9	0.74	0.61	0.5	0.42

$Time(s)$	240	270	300	330	360	390	420
$Charging\ Voltage\ (V)$	1.62	1.68	1.72	1.74	1.75	1.75	1.75
$Discharging\ voltage\ (V)$	0.33	0.27	0.21	0.15	0.09	0.09	0.09

10 — 3 — 3