BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO/2024)

CLASS: BTECH **SEMESTER :** III/ADD
BRANCH: ECE **SESSION :** MO/2024

SUBJECT: EC201 ELECTRONIC DEVICES

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. **The question paper contains 5 questions each of 5 marks and total 25 marks.**
2. **Attempt all questions.**
3. **The missing data, if any, may be assumed suitably.**
4. **Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	Differentiate between Direct and indirect semiconductors using appropriate E-K diagrams.	[2]	1	4
Q.1(b)	Explain Hall Effect. For an n-type Ge specimen, width = 4mm, length = 1mm, current (along the length of specimen) = 1mA, perpendicular magnetic field = 0.1 Wb/m^2, Hall voltage = 0.005V. Calculate majority carrier density.	[3]	1	3
Q.2(a)	Explain the Fermi-Dirac distribution function, denoted as f(E), with the help of an f(E) vs E plot for both T = 0K and T > 0K. How is Fermi distribution used for finding the carrier concentration?	[2]	1	2
Q.2(b)	Evaluate the intrinsic electron concentration at thermal equilibrium if the density of the state function of the conduction band is $n(E) = a(E - E_c)^{\frac{3}{2}}$, where E_c represents the minimum energy of the conduction band. Assume the Boltzmann approximation is valid, and the energy at the top of the conduction band tends to infinity. (Hint: Gamma Function is defined as: $\Gamma(\alpha) = \int_0^\infty x^{\alpha-1}e^{-x}dx$ and it has the following properties: $\Gamma(\alpha+1) = \alpha\Gamma(\alpha)$ and $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$)	[3]	1	3 & 5
Q.3(a)	If the concentration gradient of electrons injected into a p-type semiconductor is $10^{21}\ cm^4$, then calculate the electron diffusion current density. (Assume Electronic charge $q = 1.6 \times 10^{-19}C$ and thermal voltage $(V_T = kT/q) = 25\ mV$)	[2]	2	3
Q.3(b)	Explain Drift and diffusion currents with appropriate equations. Derive the Einstein relation for electrons.	[3]	2	4
Q.4(a)	Derive the expression of Recombination lifetime for direct band-to-band Recombination.	[2]	2	4
Q.4(b)	Consider a bar of a p-type semiconductor with a doping concentration of $10^{16}\ cm^{-3}$. The bar is exposed to light, generating electron-hole pairs at a rate of $10^{20}\ cm^{-3}s^{-1}$ throughout the material. If the recombination lifetime is $100\ \mu s$ then calculate the product of the steady-state electron and hole concentrations. (Assume the intrinsic carrier concentration is $10^{10}cm^{-3}$ and the semiconductor operates in the Extrinsic region)	[3]	1 & 2	3
Q.5(a)	Illustrate mobility of charge carriers. Draw a suitable graph to demonstrate the combined effect of scattering and temperature on mobility.	[2]	1	2 & 3
Q.5(b)	Define Diffusion length. Derive the continuity equation for holes in general form and steady state conditions.	[3]	2	1 & 4

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