SEPTEMBER 2017 / IN - SEM (T2)
F. Y. B.TECH. (COMMON) (SEMESTER - I)
COURSE NAME : Engineering Physics
(2017 PATTERN)

Marking Scheme

Q. No.		Question	Marks Distribution	Marks	Cognitive level	Difficulty level	CO
Q1	a)	Starting from the expressions $E_F = E_{Fi} + kTln\left(\frac{N_D}{n_i}\right)$ and $E_F = E_{Fi} - kTln\left(\frac{N_A}{n_i}\right)$, derive an expression for built-in (or barrier) potential V_{bi} for a p-n junction diode.	$\left(E_{fi}\right)_n$ - 2M, $(E_{Fi})_p$ -2M, $V_{bi} = \left(E_{fi}\right)_n - (E_{Fi})_p$ -2M	[6]	Compre-hension	Medium	3
	b)	Given density of states $g_c(E) = \frac{4}{\sqrt{\pi}}\left[\frac{m_e^*}{2\pi h^2}\right]^{3/2}(E-E_c)^{1/2}$ for E ≥ E_c, derive the expression for number of electrons in the conduction band $n = N_c e^{\frac{(E_F-E_C)}{kT}}$ where, $N_c = 2\left[\frac{m_e^* kT}{2\pi h^2}\right]^{3/2}$	Setting up the integral - 1M Change of variable - 3M Getting final expression using Gamma integral - 2M	[6]	Compre-hension	High	3
	c)	Calculate the probability of finding an electron 0.3 eV above the Fermi energy E_F at T = 450K. Given Boltzmann's constant k = 8.6 × 10^{-5} eV/K.	f(E) = 1/(1+exp((E-EF)/kT))) = 0.00043	[4]	Application	Medium	3
		OR					
	a)	Draw the Fermi-Dirac distribution function for temperatures T = 0 K, T_1 and T_2 where $T_2 > T_1 > 0$ K. Discuss the physical significance of the temperature dependence of Fermi-Dirac distribution function.	Drawing - 3M Physical significance - 3M	[6]	Compre-hension	Medium	3
	b)	Starting from the expressions $n = N_c e^{\frac{(E_F-E_C)}{kT}}$ and $p = N_v e^{\frac{(E_v-E_F)}{kT}}$, obtain an expression for Fermi energy in an intrinsic semiconductor and show that it lies at the centre of the forbidden band if $m_e^* = m_h^*$. Given $N_c = 2\left[\frac{m_e^* kT}{2\pi h^2}\right]^{3/2}$ and $N_v = 2\left[\frac{m_h^* kT}{2\pi h^2}\right]^{3/2}$.	Equating two equations - 1M Writing $\frac{N_v}{N_c}$- 2M Inverting the equation - 1M Substituting N_v and N_c equations and getting in terms of m_e^* *and* m_h^*- 1M Obtaining final equating by using $m_e^* = m_h^*$ - 1M	[6]	Compre-hension	Medium	3

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		Using ideal diode equation, calculate the current for applied voltage V_A = +0.5V at 300K. Given k/e = 8.6 × 10^{-5} eV/K and $I_0 = 10^{-10}$A.	$i = I_0(\exp(eV/kT) + 1)$ = 0.0261A	[4]	Application	Medium	3
Q3	a)	Starting from ideal diode equation, write the expressions for I-V characteristics for solar cell in dark and illuminated by light. Derive I_{sc} and V_{oc} from the equation for a solar cell. Draw the I-V characteristics curve for a solar cell and label it.	Solar cell eq in dark - 1M Solar cell eq in light - 1M I_{sc}- 1M V_{oc}- 1M Labeled I-V curve - 2M	[6]	Compre-hension	Medium	4
	b)	Draw schematically, (a) I-V characteristics for two solar cells connected in series and (b) I-V characteristics for three solar cells connected in parallel. Draw I-V characteristics for single solar cell in these graphs for reference.	(a) - 2M (b) - 2M	[4]	Compre-hension	Medium	4
	c)	The short circuit current for a solar cell is 8 A, and reverse saturation current is 2.5 ×10^{-8} A. Calculate V_{oc} at 350K. Given, k/q = 8.6 × 10^{-5} eV/K.	kT = 0.0301 $V_{oc} = kT/q(\ln(I_{sc}/I_0))$ = 0.589V	[4]	Application	Medium	4
			OR				
Q4	a)	Discuss the merits and demerits of solar photovoltaic system.	3 Merits - 3 M 3 Demerits - 3M	[6]	Knowledge	Low	4
	b)	Discuss four parameters of a battery suitable for storing electrical energy generated by a solar photovoltaic system.	4 parameters - 4M	[4]	Compre-hension	Medium	4
	c)	12 solar cells are connected in series in a solar panel. Two such solar panels are connected in parallel in a solar array. Each solar cell has V_{oc} = 0.59V and I_{sc} = 3A. Calculate the V_{oc} and I_{sc} of the array.	V_{oc} = 0.59V×12=7.08V - 2M I_{sc} = 3A×2 = 6A - 2M	[4]	Application	Medium	4