March 2018 / IN - SEM (T2)
F. Y. B.TECH. (COMMON) (SEMESTER - II)
COURSE NAME: Engineering Physics
COURSE CODE: ES 10175A
(2017 PATTERN)
Paper Code – U127-105A (T2)

Marking scheme

Q. no.	Question	Marks	Distribution	DL	BT	CO
Q1(a)	Define Fermi level for a semiconductor. What is Fermi-Dirac probability distribution function? Explain the terms used in it. Show that the probability of finding an electron with energy $E_F+\Delta E$ is equal to the probability of absence of an electron with energy $E_F-\Delta E$.	[6]	Definition – 1M FD – 1M Terms – 1M Derivation – 3M	M	K, C	3
Q1(b)	Draw the energy level diagram for an unbiased p-n junction diode at equilibrium. Explain the formation of built in potential on the basis of charge re-distribution in both regions. Derive the expression for built in potential (V_{bi}) for a p-n junction diode.	[6]	Diagram – 1M Explanation – 1M Derivation – 4M	M	K, C	3
Q1(c)	Find E_F-E_{Fi} for an n-type semiconductor if the doping concentration is $N_D = 2.1\times10^{15}$ /cm^{-3}. Given $n_i = 2.4\times10^{13}$ /cm^{-3} at 300K. Boltzmann constant k = 8.6×10^{-5} eV/K. How far is E_F from E_c if the band gap is 0.7 eV for Ge?	[4]	$E_F-E_{Fi} = kT\ln(N_D/n_i)$ 0.115eV Ec-EF = 0.115+0.35 =0.235eV	M	A	3
Q2(a)	Given density of states $g_c(E) = \frac{4}{\sqrt{\pi}}\left[\frac{m_e^*}{2\pi\hbar^2}\right]^{3/2}(E-E_c)^{1/2}$ for $E \geq E_c$, derive an expression for electron density 'n' in the conduction band.	[6]	6M	M	K, C	3
Q2(b)	Starting from the expression for current through a diode, obtain expressions for current in forward and reverse bias. Explain with help of band diagram, I-V characteristics for a diode.	[6]	Forward and reverse current– 1M each Forward and reverse explanation – 2M each	L	A, K	3
Q2(c)	Find the probability of finding an electron 0.15eV above and 0.15eV	[4]	$f = 1/(1+e^{(E-E_F)/kT})$ =0.00298 1-f = 0.997	M	A	3

	below the Fermi energy at 300K, Given, $k = 8.6\times10^{-5}$ eV/K.					
Q3(a)	Starting from the ideal diode equation, obtain expressions for short circuit current I_{sc} and open circuit voltage V_{oc}. Give the expression for fill factor. Explain the terms in it and its significance using the I-V characteristics.	[6]	Isc – 1M Voc – 2M FF – 1 Significance – 2M	M	K, C	4
Q3(b)	Explain the functions of bypass diode and blocking diode while connecting solar panels in an array.	[4]	2M each	M	K, C	4
Q3(c)	A Si solar cell typically has reverse saturation current density $J_0 = 1\times10^{-12}$ A/cm^2. Such a Si solar cell with an area of 275 cm^2 is illuminated by sunlight of intensity P_{solar} = 1000W/m^2. Short circuit current $I_{sc} = I_L$ = 4.2 A. If the fill factor FF of the cell is 0.65, then calculate efficiency of the solar cell at 27°C.	[4]	$V_{oc} = \frac{kT}{q}\ln\left(\frac{I_L}{I_0}\right)$ $= 0.0258 \times ln\left(\frac{4.2}{2.75 \times 10^{-10}}\right)$ $= 0.605\ V$ $\eta = \frac{I_{sc}V_{oc}FF}{P_{in}}$ $= \frac{3.3 \times 0.605 \times 0.65}{27.5}$ $= 0.0472$	H	A	4
Q4(a)	Define and explain the following battery parameters: (i) battery capacity (ii) depth of discharge (iii) C-rating.	[6]	2M each	M	C, A	4
Q4(b)	Explain use of anti-reflection coating and surface texturing to enhance efficiency of a solar cell.	[4]	2M each	M	C, A	4
Q4(c)	Four solar cells are connected in series in a row. Seven such rows are connected in parallel to form an array. Calculate open circuit voltage $(V_{oc})_{array}$ and short circuit current $(I_{sc})_{array}$ for the array. Given, V_{oc} = 0.6 V and I_{sc} = 1 A for a single solar cell.	[4]	$(V_{oc})_{array}=4\times0.6$ = 2.4V $(I_{sc})_{array}=7\times1$ = 7A	L	A	4