Total number of printed pages:2 **PG/2nd Semester/PGET2108**

2023

Solar PV Energy

Full Marks : 100

Time : Three hours

*Answer **any five** questions.*

1.	a)	What are the advantages and disadvantages of solar photovoltaic cell?	5
	b)	A PV module is composed of 36 solar cells with each solar cell having an area of 0.015 m^2. If the packing factor of the module is 0.8, calculate the total area occupied by the module.	5
	c)	A silicon crystal is doped with an impurity from the 5th group of concentration 10^{15}. The effective density of states in the conduction band is 2.82×10^{19} $cm^{-3}$and Boltzmann constant is 8.62×10^{-5} eV/K. If the band gap for silicon is 1.1 eV, calculate the shift of Fermi energy level (in eV) with the conduction band at the temperature of 27° C.	10
2.	a)	Write the classification of solar photovoltaic cell.	5
	b)	Write the expression of variation of the band gap with temperature	5
	c)	Write the production process of mono-crystalline silicon solar cell.	10
3	a)	Write the properties of semiconductor.	5
	b)	What is doping?	5
	c)	A PV source supplying power to a load whose load line intersects I-V characteristics at 12 V and 7A. The maximum current and voltage are measured to be 7 A and 28 V. The cost of the MPPT is Rs. 4000 and the cost of electricity is assumed as Rs. 6.5 per unit. Take the efficiency of the MPPT to be 98%. (a) If the MPPT is interposed between the source and the load, calculate additional power(watt) gain. (b) Calculate the time(hours) required by the system to operate in order to recover the cost of MPPT.	10
4.	a)	Draw one boost converter. Write its working principle.	10
	b)	A boost converter needs to be designed with the following specification: input voltage=30 V; output voltage 75 V; Peak output power 300 W; maximum ripple in output voltage=0.1% of output voltage. The boost converter should remain in CCM for the load range of 150 W to 300 W.	10

		The maximum ripple allowed in inductor current is limited to 15% of load current. A switching frequency of 50 kHz can be used. Write the voltage rating and current rating of IGBT and diode. Calculate the value of $L_{critical}$ and L_{ripple}.	
5	a)	What is power electronic converter?	5
	b)	What are the applications of power electronic converter?	5
	c)	A buck converter is designed using the following data: input Voltage 35 V; output voltage 21 V; switching frequency 50 kHz; ambient temperature 55° C; average inductor current 6 A. Calculate the conduction loss and switching loss. Assume switch current=inductor current; turn on time=102 ns; turn off time 132 ns; ON state resistance=85 miliohm.	10
6	a)	Write the working principle of Bipolar PWM.	10
	b)	A buck converter is designed using two MOSFETs (IRF540NPbF). One MOSFET is used like a switch by giving gate pulses. Second MOSFET is used like a diode i.e. its body diode is only used and no gate pulse is given. The input voltage of the buck converter is 50 V. The value of parasitic inductance is estimated is estimated as L_p=8 nH. (i) From the datasheet write the dv/dt limit for the body diode. (ii) Using the typical values of Q_{rr} and t_{rr} given in the datasheet, calculate the reverse recovery current.(iii) Use the following limits to design RC snubber: Peak voltage limit, E_l=2 x input voltage; $(dv/dt)_{av}$=half of (dv/dt) limit given in datasheet for body diode. Design the snubber by limiting the peak voltage. Let the corresponding values of $X_0 = 2$ and $\zeta_0 = 0.4$ are obtained using the respective curves to design snubbers by this method. Find the value of C_s and R_s.	10