M.E. Power Engineering First Year First Semester Examination – 2024
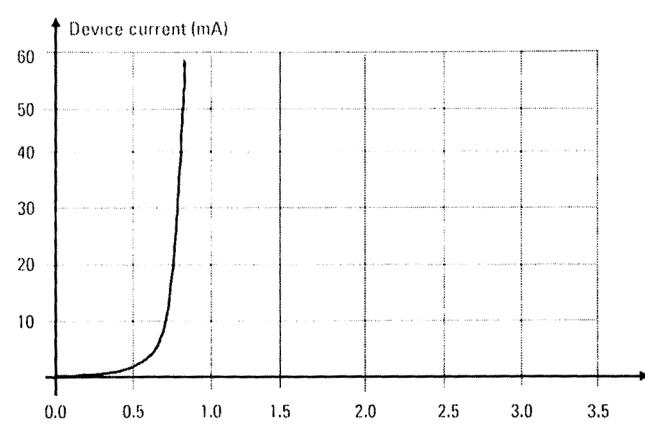
Subject: Power Generation Methodologies

Full Marks: 100   **Time: 3 Hrs**

Question No.	Answer any *Five* Questions	Marks
	CO1 (Marks - 30) **Answer any *Three***	
1	a. What are the advantages and disadvantages of nuclear power generation? b. Is nuclear energy renewable energy or not? Explain why.	3+3 1+3
2	a. Identify and characterize different components of solar irradiance at ground level for solar PV application. b. Briefly discuss the influences of Earth's atmosphere on the solar spectrum.	5 5
3	a. Define and differentiate terms: Solar Radiation, Solar Irradiance, Irradiation b. What is Air Mass? Explain significance of AM1.5 in PV solar application?	2+2+2 2+2
4	a. What is Betz' limit? Derive the Betz' efficiency. b. What is Wind power curve? Explain briefly the significance of wind power curve.	2+3 2+3
	CO2 (Marks – 40) **Answer any *Four***	
5	a. Define and explain theoretical maximum efficiency of PV cells. b. Briefly explain the working principle of PV cells.	5 5
6	a. Develop the I-V characteristic of solar cell giving proper expression for open circuit voltage and short circuit current. b. Discuss with proper diagram the influence of series resistance and temperature on I-V and P-V characteristics of PV cell.	5 5
7	a. Differentiate and characterize on-shore and off-shore wind energy. b. What are the major components of Wind energy conversion system? Briefly explain their functionalities.	3 2+5
8	a. What are the different wind turbine control methods? b. Classify wind turbine based on components and mode of operations. Briefly explain their mode of operation with schematic.	2 2+6
9	a. Discuss various factors which govern the selection of site for hydro plant. b. What is Weir channel in hydro plant? Briefly explain with proper expression the different losses in hydro power generation.	3 2+5
10	a. What is OTEC? State different schemes of OTEC. b. Briefly the working principle of tidal energy conversion system and explain various mode of operation.	1+2 2+5
	CO3 (Marks - 30) **Answer any *Three***	
11	A solar cell has a reverse saturation current of $I_o = 4 \times 10^{-10}$A and a short-circuit current of 2A at full insolation and room temperature. Given that its ideality factor is unity, determine its open-circuit voltage at full insolation and the percentage change in the open-circuit voltage if the insolation is reduced by 30%.	10

[Turn over

12	The silicon diode 1N50X whose terminal characteristic is given in Figure is connected in series with a resistor of 30 ohms. The combination is connected across a DC voltage source of 5V in such a direction to forward bias the diode. Determine the diode current and voltage.	10

Device current (mA)

Fig: Terminal characteristic of the 1N50X diode

13	A HAWT generates 220kW when the air density is 0.95kg per cubic meter and the wind speed is 15m/s. The length of each blade is 20m. a. Determine the tip speed and the speed of the turbine in revolutions per minute if the tip speed ratio is 5; b. Determine the required gear ratio if the generator needs to run at 1500 rpm; c. Determine the efficiency of the overall system.	10

14	It is intended to build a micro hydropower plant at a canal having a 15m gross head and 10m³/second flow rate. The required length of the cemented penstock is 10m. To hold the water in the penstock a butterfly valve is used. The combined efficiency of the turbine and the generator is 85%. Find
	    i. The cross-sectional area of the penstock
	    ii. Theoretically available power in the water
	    iii. Actual power at the output
	    iv. If the turbine speed is 150 rpm, find the capacity factor of the turbine.
		10