

- N.B.:**
1. **Q.1 is compulsory**
  2. Answer **any Three** out of remaining **Five** questions
  3. Assume any suitable data wherever required but justify the same
  4. Use graph paper wherever necessary

**Q.1** Answer the following:

- (A) What are different ways of commercial electrical energy generation adopted in India? What is the current state of the power generation in MW in India using different technologies including renewable energy? **05**
- (B) State the Standard Test Conditions (STC) for a solar PV module. If a solar PV module specification is 250Wp at STC, what will be the expected power at 800W/m<sup>2</sup> solar radiation? Draw I-V (current v/s voltage) characteristics of this solar PV panel with  $V_{mp}= 29.1$  Volts and  $I_{mp}=8.6$  Amps at STC and clearly mark all essential parameters on it when operating at 800W/m<sup>2</sup>. **05**
- (C) What way the extraction of maximum power is possible in case of the wind energy systems and fuel cells? Suggest suitable power topology for the same in each case and discuss the working principle for extraction of maximum power. **05**
- (D) Compare mono-crystalline, poly-crystalline and thin film solar PV technology. State the effect of mismatch in modules on Solar PV system performance. **05**
- Q.2** (A) For a single phase (230V/ 50Hz) standalone rooftop solar PV system with battery backup is to be designed for a residential application which has average electricity consumption of 10 units (kWhr) per day. Calculate (i) solar PV array capacity (ii) number of series and parallel SPV modules if poly-crystalline PV panels of  $P_{mp}= 315$ Wp,  $V_{mp}= 36$  V and  $I_{mp}= 8.75$ A at STC are used (iii) Area occupied by solar PV array (iv) 12 volts lead acid battery storage capacity in AHr (ampere hour) and WHr. Assume suitable data if needed. **10**
- (B) What are different types of solar thermal systems used in practice? How electrical power can be generated using solar thermal systems? **10**
- Q.3** (A) Explain the working principle and operation of Wind Energy System (WES) with reference to the components of WES, types of wind turbines and wind turbine characteristics **10**
- (B) Explain the principles of following technologies and their suitability in hybrid energy generation system **10**  
 (i) Flywheels (ii) Pumped hydro storage system
- Q.4** (A) Describe the working principle of Proton Exchange Membrane Fuel Cell (PEMFC) and explain its electrical characteristics. **07**
- (B) Explain in brief the power convertor topology used in Doubly Fed Induction Generators (DFIG) based WES. **07**

- (C) Draw a typical schematic of power topology used to extract power from Solar PV and explain the operation in standalone mode and grid connected mode.
- Q.5 (A) Describe the types, characteristics and compare the performance of: batteries, ultra-capacitors, flywheels in the context of modern power system scenario **08**
- (B) What type of energy storage is suitable for hybrid combination with (i) solar PV source (ii) Fuel cell source? Justify your answer? **04**
- (C) Describe the working principal of power generation system for the following in brief: (i) Wave energy (ii) Micro-hydro **08**
- Q.6 (A) Explain the working of a PEMFC fed power converter/inverter topology that can be used to feed a signal phase AC standalone load. **08**
- (B) Illustrate a typical hybrid power generation system comprising of solar PV, Fuel cell and batteries as the sources with their interface schematic. Determine the power capacity you would propose for each one of the source if the net capacity of system is 15 kW and justify the same. Make necessary assumptions if needed. Explain the operation and role of each source in operation of the system in detail. **12**

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