

(3 Hours)

[Total Marks: 80]

- 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

- 1 (a) What is the importance of energy storage in stability enhancement under large penetration of renewable energy sources in existing power system? 5  
(b) Explain and compare the features of horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT). 7  
(c) State and compare the working principle of a Wave energy and Tidal energy power generation system with the help of suitable diagrams 8

- 2 (a) Explain the working of a Wind Energy System (WES) with its various components. What are the different power converter topologies used for WES? Explain any one of them in detail. 12  
(b) Describe the working principle of Proton Exchange Membrane Fuel Cell (PEMFC) and explain its electrical characteristics. Explain the working of a PEMFC fed power converter topology that can be used to feed a single phase standalone load. 8

- 3 (a) Explain the mechanical and electrical means of extracting maximum power from solar PV systems. Explain the principle of the 'Perturb and Observe' MPPT algorithm with the help of suitable diagrams. Under certain ambient conditions, a solar PV module has its maximum power point at  $V_{mp} = 36.8$  volts and  $I_{mp} = 8.25$  A, suggest a dc-dc converter suitable to be used as MPPT converter if the PV module is delivering power to a  $47\Omega$  resistance? Calculate the duty cycle for the MPPT converter. 10  
(b) What are different types of solar thermal systems used in practice? How electrical power can be generated using solar thermal systems? 10

- 4 (a) Describe various types or forms of energy storage which are commonly used in renewable energy system and compare their performance. What type of energy storage is suitable for hybrid combination with (i) solar PV source (ii) Fuel cell source? Justify your answer. 12  
(b) If a solar PV standalone AC system to be designed of a 100 kWp power to feed an 3 phase ac load at 415V, with the solar PV panels of  $P_{mp} = 250$  Wp,  $V_{mp} = 31.2$  V and  $I_{mp} = 8$  A at standard test condition (STC), then calculate the numbers of series and parallel combination of the solar PV panels those are required to be used. 8

- 5 (a) Draw I-V (current v/s voltage) and P-V (power v/s voltage) characteristics of a solar PV cell and clearly mark all essential parameters on it. What is the impact of change in solar radiation and temperature on solar PV characteristics? 10  
(b) Compare mono-crystalline, poly-crystalline and thin film solar PV technology. Also state the effect of the following on Solar PV system performance (i) Mismatch in modules (ii) Hot spots in the modules. 10

- 6 Write short notes on: 20  
(i) Biomass based energy power generation.  
(ii) Pumped hydro storage system  
(iii) Ocean thermal electric conversion  
(iv) Electric and hybrid electric vehicles