Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 61241

M.E./M.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Elective

Aeronautical Engineering

PX 4012 – RENEWABLE ENERGY TECHNOLOGY

(Common to : M.E. Aerospace Technology / M.E. Applied Electronics / M.E. Automobile Engineering / M.E. Big Data Analytics / M.E. Biomedical Engineering / M.E. Biometrics and Cyber Security / M.E. CAD / CAM/ M.E. Communication Systems / M.E. Communication and Networking / M.E. Computer Aided Design / M.E. Computer Integrated Manufacturing / M.E. Computer Science and Engineering / M.E. Computer Science and Engineering (With Specialization in Artificial Intelligence and Machine Learning/ M.E. Computer Science and Engineering (With Specialization in Networks) / M.E. Construction Engineering and Management / M.E. Digital Signal Processing / M.E. Electronics and Communication Engineering / M.E. Electronics and Communication Engineering (Industry Integrated) / M.E. Energy Engineering / M.E. Engineering Design / M.E. Environmental Engineering / M.E. Industrial Engineering / M.E. Industrial Safety Engineering / M.E. Infrastructure Engineering and Management/ M.E. Internal Combustion Engineering / M.E. Manufacturing Engineering / M.E. Mechatronics/ M.E. Medical Electronics/ M.E. Mobile and Pervasive Computing / M.E. Multimedia Technology/ M.E. Power Electronics and Drives / M.E. Product Design and Development / M.E. Software Engineering / M.E. Soil Mechanics and Foundation Engineering / M.E. Structural Engineering/ M.E. Thermal Engineering / M.E. VLSI Design / M.E. VLSI and Embedded Systems/ M.Tech. Biopharmaceutical Technology/ M.Tech. Biotechnology/ M.Tech. Chemical Engineering / M.Tech. Information Technology/ M.Tech. Nano Science and Technology/ M.Tech. Plastics Technology/ M.Tech. Remote Sensing and GIS / M.Tech. Textile Technology / M.Tech. Textile Technology (With specialization in Textile Chemistry) / Master of Computer Applications (2 years))

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is overall installed capacity of renewable energy sources based power generation (in GW) in India as on 31st March 2023 with an account of individual categories?

2. What are the impacts of CO_2 emission?

3. Define solar attitude angle.

4. Mention the Standard Test Conditions (STC) used by manufacturers to rate their PV products.

5. What is meant by Fill factor? Give it's expression.

6. What is meant by lift force? Give it's expression.

7. Draw the slip-torque characteristics of PMSG.

8. Define Tip speed ratio.

9. What is the reason for tides?

10. What is geothermal field?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Demonstrate the importance of renewable sources of energy with suitable data on CO_2 emission, global warming and depletion of fossil fuel reserves. (8)

(ii) Discuss about the major challenges of Renewable energy generation. (5)

Or

(b) (i) Provide a detailed report on renewable energy scenario in India against growing energy demand and the conventional energy generation. (7)

(ii) Enumerate the major achievements and milestones reached in renewable energy technology with the support of its recent applications. (6)

12. (a) Explain the working principle of a solar cell from the basic principle. Also develop the single diode equivalent circuit for solar PV panel.

Or

(b) Discuss in detail, the algorithm involved with perturb and observe MPPT applied to a standalone PV system. Demonstrate why the conventional MPPT strategies fail due to the shading impacts.

13. (a) Describe the principle of sizing the PV panel and battery pack for stand-alone PV applications with algorithmic steps.

Or

(b) With suitable diagrams describe the working of grid tied and grid interactive inverters.

14. (a) Prove that in case of horizontal axis wind turbine maximum power can be obtained when exit velocity = (1/3) wind velocity and $P_{max} = (8/27)\,\rho AV^3$.

Or

(b) (i) Find the required diameter of a wind turbine to generate 4 kw at a wind speed of 7 m/s and a rotor speed of 120 rpm. Assume coefficient = 0.4, efficiency of mechanical transmission = 0.9 and efficiency of generator = 0.95. (4)

(ii) Study the aerodynamics of an aerofoil using blade element theory and develop equations for the various forces acting on the blade, (9)

15. (a) (i) Explain in detail the principle of operation of open and closed cycles of OTEC. (7)

(ii) Describe the construction and principle of operation of a turbine used for tidal power. (6)

Or

(b) (i) Describe the principle of working of a fuel cell with reference to H_2 - O_2 cell. (6)

(ii) Discuss in detail, the simple air-driven turbine used in wave energy systems. (7)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Consider b ck boost converter of input DC voltage E = 14 V. The duty cycle a = 0.6 and the switching frequency is 25 kHz. The inductance L = 180 μH and the filter capacitance C = 220 μF. The average load current I = 1.5 A. Compute the average output voltage on peak current of the devices. (7)

(ii) Define 'Solar Constant'. Considering the Sun and Earth to be equivalent to two spheres in space, from the data given below, calculate approximately the solar constant outside the Earth's atmosphere($W\text{-}m^2$) and energy received by the Earth : Diameter of the Sun = 1.39×10^9 m. Diameter of the Earth 1.27×10^7m, Sun-Earth distance = 1.496×10^{11} m, Sun's equivalent black body temperature = 5777 K. (8)

Or

(b) (i) A tidal power plant of the simple basin type has a basin area of $30 \times 106 m^2$. The tide has a range of 12m. The turbine however stops operating when the head on it falls below 3m. Calculate the energy generated in one filling or emptying process in kWh if the turbine-generator efficiency is 0.73.

(ii) A two-blade wind turbine is to produce 75 kw of mechanical power. The blades are of 9 m length and the axis to inner edge distance is 0.5 m. Assuming three blade elements of equal length, find the optimal chord length for each blade element by equalizing (i) the thrust and (ii) the moment. Profile: RG14, TSR=8.5, $V_\alpha = 10\, m/s$; take the pitch angle α in each element to correspond to the maximum aerodynamic efficiency.