

**RENEWABLE ENERGY SYSTEMS  
(MECH 3262)**

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Regenerative Rankine cycle thermal efficiency is  
 (a) same as simple Rankine cycle thermal efficiency  
 (b) always less than simple Rankine cycle thermal efficiency  
 (c) always greater than that of simple Rankine cycle thermal efficiency  
 (d) none of the above.
- (ii) The turbine used in a tidal range plant is  
 (a) Pelton turbine (b) Francis turbine  
 (c) Kaplan turbine (d) Propeller turbine.
- (iii) For 1 *degree* change in longitude, the change in solar time  
 (a) 4 minutes (b) 4 seconds  
 (c) 1 minute (d) 1 hour.
- (iv) Use of booster mirrors with a flat plate collector  
 (a) increases the reflection to the atmosphere  
 (b) increases the diffused radiation component on the absorber  
 (c) decreases the reflection to the atmosphere  
 (d) increases the beam radiation component on the absorber.
- (v) Compactness of a flywheel storage  
 (a) leads to storage of only a small amount of energy  
 (b) makes its handling difficult  
 (c) enables a portable energy storage medium  
 (d) none of the above.
- (vi) The most important advantage of a solar furnace is  
 (a) cheap low-grade heating  
 (b) availability of both heat and light

- (c) heating without contamination and in absence of electromagnetic field  
 (d) heating available throughout the day.
- (vii) Cut-in speed for a wind turbine is  
 (a) the minimum wind speed at which the turbine is designed to come into operation  
 (b) the maximum wind speed at which the turbine is designed to come into operation  
 (c) the wind speed at which the turbine stops functioning  
 (d) the rotor speed
- (viii) The energy flux in waves is  
 (a) less than that in wind energy  
 (b) more than that in wind energy but less than solar energy  
 (c) more than that in wind energy  
 (d) comparable to that in wind energy.
- (ix) Compared to a conventional steam power plant, the efficiency of a geothermal plant is  
 (a) higher (b) comparable  
 (c) lower (d) same.
- (x) Heating value of producer gas is in the range of  
 (a) 4 – 8 MJ/m<sup>3</sup> (b) 14 – 18 MJ/m<sup>3</sup>  
 (c) 24 – 28 MJ/m<sup>3</sup> (d) 34 – 38 MJ/m<sup>3</sup>.

**Group - B**

2. (a) There are two alternative sources of heat energy. Source 1 can supply energy at the rate of 12,000 *kJ/min* at 340°C. Source 2 can supply energy at the rate of 140,000 *kJ/min* at 75°C. The temperature of the surroundings is 35°C. If an ideal reversible engine is used to harness power from each of these sources, then which source will provide larger power? What conclusions do you draw?  
 (b) What do you understand by energy conservation? State and explain the three important aspects of energy conservation.  
**(4 + 1) + (1 + 6) = 12**
3. (a) Define energy yield ratio. What is meant by commercial and non-commercial energy resource?  
 (b) An industry requires 20 MW electrical power and 40 MW process heat for production. There are two alternative options: (i) use a cogeneration unit having an overall efficiency of 65%, or (ii) use two

separate units for electrical and thermal outputs. The efficiencies of electrical and thermal power units are 25% and 80% respectively. Which option would be preferable on the basis of the overall efficiencies in each case?

$$(1 + 2 + 2) + 7 = 12$$

### Group - C

4. (a) Define the following terms:  
 (i) Hour angle  
 (ii) Solar azimuth angle  
 (iii) Angle of incidence.
- (b) Define concentration ratio of a solar collector. Name three collectors requiring one-axis sun tracking.

$$(2 + 2 + 2) + (3 + 3) = 12$$

5. (a) Compare the relative merits and demerits of LiBr-water and aqua-ammonia vapour absorption cooling systems.
- (b) What is the purpose of double-layer of glazing in a greenhouse?
- (c) What is the advantage of using a glass cover in a box-type solar cooker?

$$6 + 3 + 3 = 12$$

### Group - D

6. (a) Describe the basic components of wind energy conversion systems.
- (b) A PV system feeds a DC motor to produce 2 hp power at the shaft. The motor efficiency is 85%. Each module has 36 multi-crystalline silicon solar cells arranged in  $9 \times 4$  matrix. The cell size is  $125\text{mm} \times 125\text{mm}$  and the cell efficiency is 15%. Calculate the number of modules required in the solar PV array. Assume global radiation incident normally to the panel as  $1.5\text{ kW/m}^2$ .

$$6 + 6 = 12$$

7. (a) Explain the principles of design and selection of hydraulic turbines.
- (b) Discuss on mini-hydel power advantages and disadvantages.

$$8 + 4 = 12$$

### Group - E

8. (a) Briefly discuss the origin and nature of tidal energy.

- (b) Calculate the volume of a cow-dung based biogas plant required for cooking needs of a family of 7 adults, and lighting needs with 5 numbers of 100 CP lamps for 3 hours daily. The biogas required for cooking is about  $0.228\text{ m}^3/\text{person}/\text{day}$ . The gas required for lighting one 100 CP lamp is  $0.126\text{ m}^3/\text{hour}$ . Assuming that a single cow yields 10 kg of dung per day, and the dung that can be collected is 80% of the yield, calculate the required number of cows to feed the plant. The percentage weight of dry solid mass in the dung is 21% and the gas yield is  $0.36\text{ m}^3$  per kg of dry matter. Assume that the digester slurry is made by mixing with equal quantity of water, and a 60-day retention time is necessary. Taking the volume percentage of slurry in the digester as 90%, and the slurry density as  $1090\text{ kg/m}^3$ , calculate the volume of the digester.

$$6 + (3 + 3) = 12$$

9. (a) Explain different types of geothermal resources.
- (b) What are the main advantages and disadvantages of ocean wave energy?

$$8 + 4 = 12$$