RENEWABLE ENERGY SYSTEMS
(MECH 4126)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which of the following is a disadvantage of Hydro Power?
(a) It causes deforestation and affects wildlife
(b) It causes harmful emissions
(c) It is an unstable source of energy
(d) It is not suitable for long-distance electricity transmission.

(ii) The percentage of the incoming radiation reflected back to space by the earth is
(a) 10%   (b) 20%   (c) 30%   (d) 40%.

(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) Which of the following is a substrate for biogas production?
(a) Municipal and residential waste   (b) e-waste
(c) Metallic waste   (d) Gaseous effluents.

(v) If no load is connected to a solar PV system, it will
(a) stop absorbing light
(b) dissipate energy in the panel and result in temperature rise
(c) start reflecting the light
(d) eventually break down due to continual increase in voltage.

(vi) Biogas is predominantly
(a) hydrogen   (b) carbon monoxide
(c) carbon dioxide   (d) methane.

(vii) The type of turbine used in a tidal energy production is
(a) radial flow   (b) axial flow with fixed blades
(c) axial flow with adjustable blades   (d) mixed flow.

(viii)   Two-basin tidal schemes
(a) are more economical than single-basin schemes
(b) operate on ebb cycles in both basins
(c) produce less uniform power
(d) produce more uniform power

(ix)   The cut-in speed of traditional wind turbines is
(a) 5m/s   (b) 15m/s   (c) 25m/s   (d) 55m/s

(x)   Power available in wind is expressed by
(a) $\frac{1}{2}\rho AV$ (b) $\frac{1}{2}\rho AV^2$ (c) $\frac{1}{2}\rho AV^3$ (d) $\frac{1}{2}\rho AV^4$

Fill in the blanks with the correct word

(xi)   A 1 MW capacity electricity plant runs on full capacity. The energy (in units) it will generate during one year is _____.

(xii)   The energy recovery efficiency of flywheel storage is of the order of _____.

(xiii)   At solar noon, the hour angle is _____.

(xiv)   Tides are caused by the combined effect of _____ on earth.

(xv)   In ocean thermal energy, a minimum ___°C temperature difference is required for practical energy conversion.

Group – B

2.   (a)   What are the different aspects of 'Energy Conservation'?   *[(CO1)(Understand/LOCQ)]*
      (b)   Briefly discuss various methods of mechanical energy storage systems.
          [(CO2)(Analyse/IOCQ)]
          6 + 6 = 12

3.   (a)   Briefly explain the working principle of Combined Cycle Power Plants.
          [(CO1)(Understand/LOCQ)]
      (b)   What are the main advantages and limitations of Flywheel energy storage system?   *[(CO2)(Analyse/IOCQ)]*
          6 + 6 = 12

Group - C

4.   (a)   What is the future prospect of solar water desalination systems?
          [(CO3)(Analyse/IOCQ)]
      (b)   The following observations were made at a site:
          Theoretical maximum possible sunshine hours = 9.5 h
          Average measured length of a day during April = 9.0 h
          Solar radiation for a clear day = 2100 kJ/m²/day
          Constants: a = 0.27, b = 0.50
          Calculate the average daily global radiation.   *[(CO3)(Evaluate/HOCQ)]*
          6 + 6 = 12

5. (a) What is the basic difference between active and passive solar heating system?
   [(CO3)(Analyse/IOCQ)]
   (b) What is the purpose of double-layer of glazing in a greenhouse?
   [(CO3)(Analyse/IOCQ)]
   (c) State major limitations of solar thermo-mechanical systems.
   [(CO3)(Understand/LOCQ)]
   3 + 3 + 6 = 12

Group - D

6. (a) What is the principle of solar photovoltaic energy conversion? Briefly explain the phenomenon of photoconduction in an *intrinsic* semiconductor.
   [(CO3)(Understand/LOCQ)]
   (b) A *PV* system feeds a *DC* motor to produce 2 h*p* power at the shaft. The motor efficiency is 85%. Each module has 45 multi-crystalline silicon solar cells arranged in 9 $\times$ 5 matrix. The cell size is 125 mm $\times$ 125 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 kW/m^2.
   [(CO3)(Evaluate/HOCQ)]
   (2 + 4) + 6 = 12

7. (a) Briefly explain the significance of different components of a typical Vertical axis wind turbine. *[(CO4)(Analyse/IOCQ)]*
   (b) Explain the characteristics of vapour dominated geothermal resources.
   [(CO4)(Understand/LOCQ)]
   6 + 6 = 12

Group - E

8. (a) State three advantages and three limitations of biomass energy use.
   [(CO5)(Understand/LOCQ)]
   (b) Discuss on the applicability of different tidal power conversion schemes.
   [(CO5)(Analyse/IOCQ)]
   6 + 6 = 12

9. (a) Discuss about the limitations of tidal energy application. *[(CO6)(Analyse/IOCQ)]*
   (b) Write the feasibility of wave energy technologies at present. *[(CO6)(Evaluate/HOCQ)]*
   6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	43.8	18.7

Course Outcomes (CO):

After the completion of the course students will be able to
CO1: Describe the fundamentals and characteristics of various renewable energy sources.
CO2: Explain the technological basis for harnessing and storing renewable energy sources.
CO3: Analyse the characteristics of solar energy systems.

CO4: Analyse the characteristics of non-solar renewable energy systems.
CO5: Justify utilization of various renewable energy resources.
CO6: Formulate for implementation of various renewable energy resources.

LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.