ME-703B

RENEWABLE ENERGY SYSTEMS

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer all questions. $10 \times 1 = 10$

(i) Main criterion for selecting the site for a wind firm is
(A) high wind velocity
(B) very low wind velocity
(C) high velocity area with forests, etc.
(D) adequate and uniform average wind velocity

(ii) Types of geothermal fluids used as input to power plants
(A) hot brine (B) cold water
(C) sea water (D) vapour

(iii) The energy content of biomass fuel depends upon
(A) carbon content (B) moisture content
(C) ash content (D) all of these

(iv) PV cell is basically
(A) p-n junction (B) photo transistor
(C) amorphous p-n junction (D) none of these

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(v) Wave energy is basically harnessed as
(A) thermal energy (B) chemical energy
(C) electrical energy (D) mechanical energy

(vi) MHD utilizes
(A) direct conversion of heat to electricity (B) conversion of heat to steam
(C) conversion of heat to force (D) none of these

(vii) Photovoltaic energy is the conversion of sunlight into:
(A) chemical energy (B) biogas
(C) electricity (D) geothermal energy

(viii) Horizontal axis and vertical axis are the types of:
(A) nuclear reactor (B) wind mills
(C) biogas reactor (D) solar cell

(ix) Which among the following is not an adverse environmental impact of tidal power generation?
(A) interference with spawing and migration of fish
(B) pollution and health hazard in the estuary due to blockage of flow of polluted water into the sea.
(C) navigational hazard
(D) none of these

(x) A solar thermal water pump:
(A) uses solar thermal energy to evaporate water
(B) uses solar thermal energy to circulate hot water
(C) uses electric powered pump to circulate water heated by solar energy
(D) uses solar thermal energy for production of power to drive the pump

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GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Write down the basic operating principle of a solar cell with proper diagram. 5

3. Draw a neat diagram and label the different parts of a wind turbine. 5

4. Define Fill factor. Write down the major limitations of solar energy. 1+4

5. What do you understand by greenhouse effect? How is it caused? 3+2

6. What do you understand by energy audit? What is meant by ECOs and ECMs? Enumerate some general ECOs. 2+1+2

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Briefly describe manufacturing process of commercial Multi-crystalline Silicon cell. Highlight the steps taken in manufacturing the minimize wastage of material. 5+3

   (b) The following data were measured for a HWAT: 7
   Speed of wind =20m/s at 1atm and 27°C,
   Diameter of rotor = 80m, Speed of rotor =40rpm,
   Calculate the torque produced at the shaft for maximum output of the turbine.

8. (a) Briefly explain the main features of a flat plate collector. 6
   What are the components of radiation energy falling on an inclined flat plate collector.
   Also briefly discuss the major losses occurring in a flat plate collector.

   (b) Show that the factor 'R' for total thermal radiation energy falling on a flat plate collector making an angel β with the horizontal is given by: 4
   $R=[(1-Hd/H).Rb + (Hd/H).(1+\cos\beta)/2.+(\rho).(1-\cos\beta)/2$
   Where, H=Total of direct beam radiation and diffused radiation
   Hd=Diffused radiation, ρ= reflectivity of radiation from surrounding.

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   (c) Data for a flat plate collector placed at Baroda (22 ° N) on 1st January at 12 noon oriented at an angle of +15° with horizontal is given below: 5
   Effective total beam radiation on the collector : 395 w/m2; No. of glass covers: Two; Trasmittance of glass : 0.81; Absorptance of glass : 0.90; Collector loss coefficient : 7.88 w/m2C; Collector fluid temperature : 60 C; Ambient temperature : 15 C.
   Calculate : (i) Solar altitude angle, (ii) Useful heat gain by the collector, (iii) Collector efficiency.

9. (a) What is cavitation? Estimate the power available from a proposed micro hydro scheme at a site having a small stream with 100 litres per second flow at a head of 30m. Assume density of fresh water as 996kg/m^3 and overall efficiency of the whole system as 55%. 2+4

   (b) Explain the production of biogas from biomass. What are the main advantages of anaerobic digestion of biomass? 6+3

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

   (b) A house has a power requirement of 400 W for 4 hours every night. A PV array made up of modules with single crystalline silicon cells, a battery storage system and inverter is to be designed for this load. It is also to be taken care that one night's requirement will have to be taken care even if there is no sunshine in the day. Calculate number of PV modules and batteries required. Given (i) Solar radiation is available for average 6 hours daily and average global radiation flux incident on array is 650 W/M sq. (ii) Battery rating 12V, 120AH, depth of discharge = 0.7, charging and discharging efficiency = 0.9, (iii) Inverter efficiency at full load = 0.85, (iv) Module size =1.191 M×0.533 M. 7

11.(a) An industry has a daily requirement of 200 tonnes of coal to meet its electrical energy and thermal energy requirements of 1.2×10^6 MJ and 1.6×10^6 MJ respectively. It uses a cogeneration plant for this purpose. What is the overall efficiency of this plant? If it makes use of two separate plants for electrical and thermal power production instead of a cogeneration plant, what will be the combined overall efficiency? The efficiency of the individual electrical and thermal plants is 30% respectively. The heating value of coal is taken as 20 MJ/kg. 7

   (b) What is meant by energy storage? Describe the thermal energy-storage system of solar energy. 2+6

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