MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

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.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. 10×1 = 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) A solar greenhouse of
(A) uses solar energy to provide conductive conditions for growth of vegetation
(B) provides enhanced radiation for photosynthesis process
(C) prevents fresh air to come in contact with plants
(D) solar thermal pump for irrigation

(iv) Gird-connected wind generators usually have maximum penetration of
(A) 10 – 20 % (B) 20 – 30 % (C) 30 – 40 % (D) 40 – 50 %

(v) Wave energy is basically harnessed in the form of
(A) thermal energy (B) chemical energy
(C) mechanical energy (D) electrical energy

(vi) In most hydrothermal fields, hot spots occur at a depth of about
(A) 10 km (B) 10 m (C) 2 – 3 km (D) 30 km

(vii) Regenerative cycle thermal efficiency of a Rankine cycle
(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 these

(viii) Energy conservation means
(A) reducing energy consumption by reducing production
(B) reducing energy consumption without compromising the quantity or quality of production
(C) increasing the output by consuming more energy
(D) reducing energy consumption by reducing output

(ix) The most important advantage of a solar furnace is
(A) heating available throughout the day
(B) cheap low grade heating
(C) availability of both heat and light
(D) heating without contamination or electromagnetic filed

(x) In a central-tower-type solar collector, the heliostats
(A) have 1-axis tracking facility
(B) have double-axis tracking facility
(C) are fixed
(D) are adjusted seasonally

GROUP B
(Short Answer Type Questions)

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

2. (a) Bring out the main differences between solar P-V power and conventional electric power. 3

(b) Each single solar cell delivers an open circuit voltage of 560 mV under standard temperature condition of 25°C. Estimate the actual open circuit voltage of a P-V module containing 18 number of interconnected cells working at an ambient temperature of 40°C. 2

3. Discuss the advantage and limitation of tidal power generation. 5

4. What is Zenith angle, Hour angle and Solar constant. 5

5. Briefly explain the principle of operation of a photovoltaic device. 5

6. Using Betz model of a wind turbine, derive the expression for power extracted from wind. 5

GROUP C
(Long Answer Type Questions)

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

7. (a) What is the basic principle of tidal power? Explain single basin, single effect tidal energy conversion scheme. 6

(b) A single basin type tidal power plant has a basin area of 2 km^2. The tidal has an average range of 14 m. Power is generated only during the ebb cycle. The turbine stops operating when the head on it falls below 3 m. Calculate the average power generated by the plant in single emptying process of the basin if the turbine generation efficiency is 0.7. Estimate the average annual energy generation of the plant. 9

8. (a) What are the main limitations of solar thermal energy? How these limitations affect its widespread utilization? 7

(b) Estimate the monthly average of the daily global radiation on a horizontal surface at Agra (27°10′N, 78°05′E) during the month of January, if the average sunshine hour per day is 8h. 8

9. (a) How biogas can be produced from waste biomass in a digester? Describe the chemical changes involved in every stage. 6

(b) A Haryana farmer with a family of 4 adults and 2 children wants a cow-dung based biogas plant in his farmyard to provide the cooking gas required to support his family plus to light 2 Nos. of 100CP lamps 3h each day. 9

How many cows does he need?
What should be the volume of the digester?
Make use of the following data:
Biogas required for cooking = 0.227 m^3 person $^{-1}$day $^{-1}$
(2 children ≅ 1 adult)
Biogas required for lighting a 100CP (candle power) lamp = 0.126 m^3h^{-1}
Cowdung yield: 10 kg cow^{-1} day^{-1}
Only 70% of the cowdung produced can be recollected and the rest gets lost in the field
Density of cowdung slurry to be fed to the digester = 1090 kg m^{-3}.

10.(a) What is meant by energy storage? Discuss briefly the latent heat storage of solar energy. 6

(b) A hot dry rock (HRD) resource has a geothermal temperature gradient of 39° K km^{-1}. The minimum useful temperature is 120 K above the surface temperature. Water at a flow rate of 0.5 $m^3s^{-1}km^{-2}$ is used for heat extraction. The density and specific heat capacity for water may be assumed as 1000 kgm^{-3} and 4200 $Jkg^{-1}K^{-1}$ respectively. Calculate: 9
(i) The heat content per square kilometer of HRD to a depth of 10 km, assuming ρ_r = 2700 kgm^{-3} and ρ_r = 820 $Jkg^{-1}K^{-1}$;
(ii) Useful average temperature, initially and after 25 years;
(iii) Useful heat extraction rate per square km, initially and after 25 years.

11.(a) Describe with a sketch the working of a wind turbine power generator showing the main components. Also explain with a line diagram how wind power is to be supplied to the utility line. 6

(b) A wind mill with multi-blade rotor running at 40 rpm pumps 5 m^3/hr of water through a head of 25 meter when the wind speed is 6.6 m/sec. the wind is at 1 atm and 27°C. Pump efficiency is 70%, transmission efficiency is 95%. The wind turbine rotor diameter is 4 meter. Calculate, 6
(i) Power required by the pump
(ii) Power required to be generated by the windmill
(iii) the power coefficient and torque of the wind generator

(c) Explain (any *one*): 3
(i) Savonius rotor
(ii) Upwind and downwind wind machines.