Air density= 1.226 kg/m^3;
Hub height from the ground= 80 m;
Rotor diameter= 60 m;
Downstream wind velocity is half that of upstream wind.
Find (i) power available in the wind (ii) power extracted by the turbine (iii) axial force on the turbine

(b) Write short notes on
(i) Desilting Tank (ii) Penstock (iii) spillway.

6 + (2 + 2 + 2) = 12

Group - E

8. (a) State three advantages and three limitations of biomass energy use.

(b) A 0.5 *km* thick hot aquifer is located at a depth of 3 *km* and has a porosity of 6 %. The density of the under sediments is 3000 kgm^{-3} and its specific heat is 750 $J\ kg^{-1}K^{-1}$. The temperature gradient in the overlying material in 40°*C* km^{-1}. Assuming the density and specific heat of water as 1000 $kg\ m^{-3}$ and 4200 $J\ kg^{-1}\ K^{-1}$ respectively, find the
(i) Heat content per square kilometre above 42°*C* and the initial temperature of the aquifer, if the average surface temperature is 10°*C*
(ii) Time constant for useful heat generation with pumped water extraction at a rate of 0.5 $m^3 s^{-1} km^{-2}$.

(3 + 3) + 6 = 12

9. Write short notes on **(3 × 4) = 12**
(i) Tidal energy conversion: single basin schemes
(ii) Heaving float-type wave device
(iii) Open cycle OTEC plant.

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) The best way to generate electrical power from hydrogen is through
(a) conversion of hydrogen to a liquid fuel for use in a generator-coupled IC engine
(b) hydrogen-fired turbine coupled to a generator
(c) direct conversion using fuel cell
(d) none of the above.

(ii) Energy storage is required to
(a) match energy supply and demand in time domain
(b) conserve energy
(c) increase energy consumption
(d) supply energy for many years to come.

(iii) A solar thermal water pump uses solar thermal energy
(a) to evaporate water (b) to circulate hot water
(c) to drive the pump (d) none of these.

(iv) 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.

(v) Closed cycle OTEC systems use working fluid having
(a) high boiling point (b) low boiling point
(c) high viscosity (d) low viscosity.

(vi) Recycling of waste
(a) Encourages production of second-grade product
(b) Conserves both material and energy
(c) Causes environmental pollution
(d) Highly energy-intensive.

(vii) The temperature in the crust increases with depth at a rate about
(a) 300°C/km (b) 30°C/km
(c) 10°C/km (d) 3°C/km.

(viii) Yaw control for wind turbines is used to
(a) change the wind speed
(b) keep the rotor aligned in wind direction
(c) keep the rotor misaligned with wind direction
(d) stop the wind rotor.

(ix) Two basin tidal schemes
(a) are more economical than single basin schemes
(b) generate on flood cycle
(c) generate on ebb cycle
(d) generate on both flood and ebb cycles.

(x) Pumping of water from ocean to basin during high tide
(a) increases the net energy generation
(b) decreases the net energy generation
(c) helps in uniform power generation
(d) decreases the net tidal range.

Group - B

2. (a) What are conventional energy resources? State <u>two</u> advantages and <u>two</u> disadvantages of conventional energy resources.

(b) An industry has a daily requirement of 210 tonnes coal to meet its electrical energy and thermal energy requirements of 1.5×10^6 MJ and 2.0×10^6 MJ respectively. It uses a cogeneration plant for this purpose. Calculate 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? Consider the efficiency of the individual electrical and thermal plants as 28% respectively, and the heating value of coal as 20 MJ/kg.

(1 + 2 + 2) + (4 + 3) = 12

3. (a) What is meant by energy storage? On what basis are energy storage forms classified?

(b) Explain the terms: (i) energy management (ii) energy strategy (iii) energy policy (iv) energy planning.

(2 + 2) + 8 = 12

Group - C

4. (a) Distinguish between beam radiation and diffused radiation.

(b) Explain the basic principle of superconducting magnetic energy storage.

(c) Which type of energy storage method is suitable to improve the transient stability of an electric power grid?

(d) What do you understand by the earth's *albedo*?

2 + 3 + 2 + 5 = 12

5. (a) Define the terms (i) altitude angle (ii) solar azimuth angle (iii) zenith angle.
Depict all these angles within a single neat sketch.

(b) State four major limitations of solar thermo-mechanical systems.

(6 + 2) + 4 = 12

Group - D

6. (a) A PV system feeds a DC motor to produce 2 HP output at the shaft. The motor efficiency is 85%. Each module has 36 multi-crystalline silicon solar cells arranged in 9 × 4 matrix. The cell size is 125 mm × 125 mm and the cell efficiency is 18%. Calculate the number of modules required in the PC array. Assume global radiation incident normally to the panel as 1.5 kW/m^2.

(b) What is the principle of solar photovoltaic energy conversion? Briefly explain the principle of enhancing electrical conductivity by doping an intrinsic semiconductor.

6 + (2 + 4) = 12

7. (a) The following data were recorded for a two-blade HAWT
Average free wind speed at a standard height of 10 m = 8 m/s, α = 0.13;