Total number of printed pages:03 **PG/1st/PGET101**

2022

GREEN ENERGY TECHNOLOGY

Paper Code: PGET 101

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

Answer all the questions.

1. Answer ***any fifteen (15)*** of the following. [2 x 15=30]
   a) What are the major components of lignocellulosic biomass?
   b) Write the most favorable C/N ratio range of feedstock for anaerobic digestion (AD). What is the effect of lower C/N ratio during AD process?
   c) Write the four major gasification reactions?
   d) Mention the main composition of producer gas.
   e) Define the term 'pyrolysis''. What are the main product of this process?
   f) What do you mean by the term '*ebb*'? Define tidal range.
   g) What are the spring and neap tides?
   h) Mention any two factors that cause the wind.
   i) What does the mechanical energy of a flowing fluid consist of? Express each term in an equation and explain. Which part of mechanical energy is used in wind power conversion?
   j) What do you mean by Betz limit? What is its maximum value?
   k) Mention any two names of a working fluid used in a geothermal binary cycle power plant.
   l) An absorption refrigeration system provides 15 kW of cooling by receiving heat in the generator at a rate of 21 kW. What is the COP of this system?
   m) What is the difference between a run-of-river plant and a waterwheel?
   n) Draw a schematic diagram of a closed-cycle ocean thermal energy conversion plant.
   o) Define the term 'solar constant'. What is its value?
   p) What do you understand by the concentration factor (CR) of a concentrating solar collector? What is the physical meaning of the greater value of CR?
   q) Define latitude (ϕ). What is the value of declination (δ) on 21st June and 21st March?
   r) What is the value of extraterrestrial radiation on the 3rd of March 2022?

2. Explain briefly ***any four (4)*** of the following. [5 x 4 = 20]
   a) The basic biochemical process of anaerobic digestion (AD).
   b) First-generation ethanol production processes.

c) Single Basin: single and double effect OTEC scheme.
d) Geothermal base ammonia-water cooling system.
e) Mechanism of solar radiation received at earth's surface.
f) Low-temperature power generation cycle using liquid flat-plate collectors.

3. Answer ***any five (5)*** of the following. [8 x 5 =40]

a) Determine the local apparent time (LAT) corresponding to 1430 h (IST) at Mumbai (19°07′ N, 72°51′ E) on June 21, 2021. In India, standard time is based on 82.50 °E.

Hints. *Use the equation of time correction:*

$E = 229.18\,[0.000075 + 0.001868\cos B - 0.032077\sin B - 0.014615\cos 2B - 0.04089\sin 2B]$

Where, B= [(n-1) 360/365], n = Day of the year. [8]

b) Calculate the angle made by the beam radiation with the normal to a flat-plate collector on 23rd January 2023 at 1000 h (LAT). The collector is located at CIT Kokrajhar (26°28′ N, 90°18′ E). It is tilted at an angle of 30° with the horizontal and is pointing due south. ***Hints***. *Use the following relation:* [8]

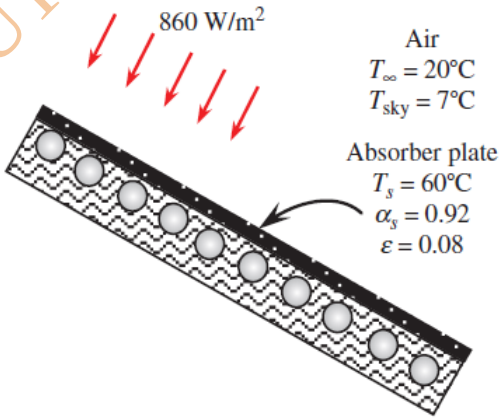
$$\cos\theta = \sin\delta \sin(\phi-\beta) + \cos\delta \cos\omega \cos(\phi-\beta)$$

c) i) Determine the average temperature of the sun using the following data: [3]

Radius of sun =0.619 x 10^9 m, I_{sc} =1367 W/m^2

Mean earth distance =1.5x10^{11}m, σ =5.67x10^{-8}W/m^2.K^4

ii) The absorber surface of a solar collector is made of aluminium coated with black nickel oxide (α_s = 0.92 and ε = 0.08). Solar radiation is incident on the surface at a rate of 860 W/m^2. The air and the effective sky temperatures are 20 and 7 °C, respectively, and the convection heat transfer coefficient is 15 W/m^2·K. For an absorber surface temperature of 60 °C, determine the net rate of solar energy delivered by the absorber plate to the water circulating behind it. [5]



d) A single basin type tidal power plant has a basin area of 3 km^2. The tide has an average range of 10 m. Power is generated during the ebb cycle only. The turbine stops operating when the head on it falls below 3 m. Calculate the average power generated by the plant in a single emptying process of the basin if the turbine generator efficiency is 0.65. Also, estimate the average annual energy generation of the plant. Given, density of sea water =1025 kg/m^3. [8]

e) A wind turbine with a blade diameter of 25 m is to be installed in a location where the average wind velocity is 6 m/s. If the overall efficiency of the turbine is 34%, determine- [8]

i. The average electric power output
ii. The amount of electricity produced by this turbine for an annual operating hour of 8000 h
iii. The revenue generated if the electricity is sold at a price of Rs.7/kWh. Take the density of air to be 1.3 kg/m^3.

f) (i) Geothermal liquid water from a well is available at 105 °C at a rate of 170,000 kg/h and is to be used for space cooling using an absorption cooling system. Geothermal water leaves the generator of the absorption system at 85 °C. If the COP of the absorption system is 0.72, determine the rate of cooling provided by the system. The specific heat of water at room temperature is *Cp* = 4.18 kJ/kg.°C. [3]

(ii) Calculate the radius of a rotor for a wind turbine operating at a wind speed of 6 m/s to pump water at a rate of 4.5 m^3/h with a lift of 4.5 m. Use the following data: [5]

Water density = 1000 kg/m^3,
Water pump efficiency = 50%,
Efficiency of motor to pump= 80%,
Power coefficient, C_p = 0.3,
Air density = 1.2 kg/m^3

4. Prove that the power potential of tidal energy for a single-pool tidal system is

$$P_{av} = 0.225AR^2$$

where A is the pool's surface area, R is the tidal range. [10]

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