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Improvement Test

Sub:	**RENEWABLE ENERGY SOURCES**							Code:	10EE836
Date:	26/ 05 / 2017	Duration:	90 mins	Max Marks:	50	Sem:	8A	Branch:	EEE

Answer Any FIVE FULL Questions

		Marks	OBE	
			CO	RBT
1. I	Describe the basic principle of wind energy conversion?	[10]	CO4	L1
2	Derive an expression for the maximum power output of a horizontal axis wind turbine with usual notations.	[10]	CO4	L1
3	Explain the working of a fuel cell.	[10]	CO5	L5
4	Describe how wave energy originate? Discuss the advantages and disadvantages of small hydro resources.	[10]	CO5	L2
5	Discuss (a)wave energy (b)Applications of wind power	[10]	CO4	L2
6	Summarize the factors affecting biogas generation?	[10]	CO5	L2
7	Analyze the environmental advantages and disadvantages related to biomass Energy.	[10]	CO5	L4
8	A propeller type wind turbine has the following data : Speed of free wind at a height of 10 m = 12 m/s, Air density = 1.226 kg/m3, $\alpha = 0.14$, height of tower = 100m, diameter of rotor = 80m, Generator efficiency = 85%, Wind velocity at the turbine reduces by 20%. V = 0.8 Vz. Calculate (a) total power available in the wind (b)power extracted by the turbine (c) electrical power generated (d)axial thrust on the turbine (e)maximum axial thrust on the turbine.	[10]	CO4	L3

Solution for Improvement Test
Renewable Energy Sources – 8th Semester
Answer any five Questions
Each Question carries 10 Marks

1. A **Wind energy conversion system** converts wind energy into some form of electrical energy.Medium and large scale WECS are designed to operate in parallel with a public or local ac grid.This is known as grid – connected system**.**A small system, isolated from the grid, feeding only to a local load is known as autonomous, remote, decentralized, stand alone or isolated power system. The turbine shaft speedis stepped up with the help of gears, with a fixed gear ratio to suit the electrical generator. Fine tuning of speedis incorporated by pitch control.This block acts as a drive for the generator.
   Use of variable gear ratioin the past was not beneficial.Hence DC, Synchronous or Induction generatorsare used for mechanical to electrical power conversion depending on the design of the system. The interface conditionsthe generated power to grid – quality power.It may consist of a power electronic converter, transformer and filter**.**The control unit monitorsand controls the interaction among various blocks.It derives the reference voltageand frequency signalsfrom the grid and receives wind speed, wind direction and wind turbine speed signals.The control unit processes them and accordingly controls various blocks for optimal energy balance. -7 Marks
   Block Diagram – 3 Marks

2. Diagram – 3 Marks

Maximum Power

Equations
Conservation of mass :
$m = \rho A_1 V_1 = \rho A_2 V_2 = \rho AVt = \text{constant}$
$F = ma = mdv/dt = \rho AVt(V_2 - V_1)$
Power and Work
Let work done = dE = Fdx
P = Power = dE/dt = Fdx/dt = FV
P = ρAV2(V1 – V2)
Using Kinetic energy $P = ½ \rho AV(V_12 - V_22)$
Combining the previous equations,
$\rho AV^2 (V1 - V2) = ½ \rho AV(V_12 - V_22)$
V(V1 – V2) = ½ (V1 + V2)(V1 – V2)
V = V1 + V2/2

$P = ½ \rho A 1/2(V1 + V2)(V_1 2 – V_2 2)$
$P = 1/4 \rho A(V1 + V2)(V_1 2 – V_2 2)$
For maximum power$dP/dV2 = 0$
Differentiating we get V2 = 1/3 V1
$Pmax = 8/27 \rho A V_1 3$ - 7 Marks

3. **Working of a Fuel cell**

A Fuel cell is a electrochemical device that converts chemical energy into electrical energy. Every fuel cell has two electrodes, one positive and one negative, called, respectively, the cathode and anode. The reactions that produce electricity take place at the electrodes.In all types of fuel cell, hydrogen is used as fuel and can be obtained from any source of hydrocarbon.

The fuel cell transform hydrogen and oxygen into electric power, emitting water as their only waste product. Every fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes.A single fuel cell generates a tiny amount of direct current (DC) electricity.A converter is used to produce AC current. In practice, many fuel cells are usually assembled into a stack. Cell or stack, the principles are the same.A fuel cell consists of two electrodes namely an anode and a cathode and sandwiched around an electrolyte. An electrolyte is a substance, solid or liquid, capable of conducting owing ions from one electrode to other.The Fuel gas (hydrogen rich) is passed towards the anode where the following oxidation reaction occurs:

$H2 (g) = 2H+ + 2e-$

The liberated electrons from hydrogen in anode side do not migrate through electrolyte.Therefore, they passes through the external circuit where work is performed, then finally goes into the cathode.On the other hand, the positive hydrogen ions (H+) migrate across the electrolyte towards the cathode.

- Explanation -7 Marks, Diagram – 3 Marks

4. **Wave energy** : Differential warming of the earth causes pressure differences in the atmosphere, which generate windsAs winds move across the surface of open bodies of water, they transfer some of their energy to the water and create waves. The amount of energy transferred and the size of the resultingblows, the distance over which the wind blows, or fetch. Therefore, coasts that have exposure to the prevailing wind direction and that face long expanses of open ocean have the greatest wave energy levels.Waves retain energy differently depending on water depthLose energy slowly in deep water. Lose energy quickly as water becomes shallower because of friction between the moving water particles and the sea

bed. Wave energy conversion devices are designed for optimal operation at a particular depth range. – 5 Marks

Advantages of Hydro resources

- 75% of costs are site specific
- High initial costs
- But civil works and equipment can last >50 years
- Very low operating and maintenance costs
- One part-time operator is usually sufficient
- Periodic maintenance of major equipment requires outside contractor
- High head developments tend to be less costly
- Typical range: $1,200 to $6,000 per installed kW

- 5 Marks

5. **Wave Energy** : Renewable energy technologies provide alternatives to fossil-fueled power plants for the generation of electricity.It is an essential step towards reducing our nation's dependence on fossil fuels.One category of emerging renewable energy technologies relates to ocean energy. Differential warming of the earth causes pressure differences in the atmosphere, which generate winds
As winds move across the surface of open bodies of water, they transfer some of their energy to the water and create waves. The amount of energy transferred and the size of the resulting wave depend onthe wind speed, the length of time for which the wind blowsthe distance over which the wind blows. – 5 Marks

Applications of Wind power :

- The wind energy is used to propel the sailboats in river and seas to transport men and materials from one place to another.

- Wind energy is used to run pumps to draw water from the grounds through wind mills.

- Wind energy has also been used to run flourmills to grind the grains like wheat and corn into flour.

- Now-a-days wind energy is being used to generate electricity.

- Wind energy may be considered as the world’s fastest growing energy source.

- 5 Marks

6. Factors affecting Biogas Generation

- ✖ pH or the hydrogen ion concentration(6.5-7.5)
- ✖ Temperature (33-35°C)
- ✖ Total solid content of the feed material
- ✖ Loading rate
- ✖ Seeding
- ✖ Uniform feeding
- ✖ Diameter to depth ratio
- ✖ Carbon to nitrogen ratio
- ✖ Nutrients
- ✖ Mixing or stirring or agitation of the digester
- ✖ Retention time or rate of feeding
- ✖ Type of feed stocks
- ✖ Toxicity due end product
- ✖ Pressure
- ✖ Acid accumulation inside the digester

- 10 Marks

7. Environmental Advantages of Biomass Energy

- Renewable resource
- Reduces landfills
- Protects clean water supplies

- Reduces acid rain and smog
- Reduces greenhouse gases
  - Carbon dioxide
  - Methane

- Biomass emits carbon dioxide when it naturally decays and when it is used as an energy source
- Living biomass in plants and trees absorbs carbon dioxide from the atmosphere through photosynthesis
- Biomass causes a closed cycle with no net emissions of greenhouse gases

Environmental Disadvantages of Biomass Energy

- Biomass has a smaller energy content for its bulk than fossil fuels
- Costs of labor, transportation, and storage would then be higher
- It will intensify air pollution.
- It may cause saltilization and decrease to total size of the arable land.

- 10 Marks

8. (a)$Pav = (\pi/8)\rho D^2 V_1^3$

$Pav = (\pi/8)$ X 1.226 X $(80)^2$ X $(16.56)^3$ = 13.99MW - 2 Marks

(b)Pmax = power extracted by the turbine = $(8/27)\rho A V_1^3$= 8.29MW

$a = V_1 – V / V_1 = 16.56 – 13.25 / 16.56 = 0.1998$

$Cp = 4(0.1998)(1 – 0.1998)^2 = 0.512$

PT = CpPav = 0.512 X 13.99MW = 7.15 MW

η = Output / Input - 2 Marks

© Pelec = 0.85 X PT = ηPT = 0.85 X 7.15 = 6.085 MW – 2 Marks

(d)FA = $(1/8)\rho\ \pi\ D^2(V_1^2 - V_2^2)$

$a = (V_1 - V_2)/2V_1$

V2 = V1 – 2aV1 = 16.56(1-0.4)= 9.936 m/s

FA = (1/8) X 1.226 X π X $80^2(16.56^2 - 9.936^2) = 5.4 \text{ X } 10^5$ N

- 2 Marks

(e)Maximum axial thrust ,Fmax = $(\pi/9)\ \rho\ D^2\ V_1^2 = (\pi/9)$ X 1.226 X 80^2 X 16.56^2= 7.51 X 10^5 W - 2 Marks