

Code : 031728

B.Tech 7th Semester Exam., 2020

DIRECT ENERGY CONVERSION

Time : 3 hours

Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
 (ii) There are **NINE** questions in this paper.
 (iii) Attempt **FIVE** questions in all.
 (iv) Question No. 1 is compulsory.

1. Choose the correct option from the following
 (any seven) : $2 \times 7 = 14$

(a) Which of the following is not a major direct energy conversion device?

- (i) Magnetohydrodynamics
 (ii) Thermionic

(iii) Geothermal

(iv) Fuel cell

(b) Cut-in speed in windmills is of the order of

- (i) 1 m/s-3 m/s
 (ii) 3 m/s-6 m/s
 (iii) around 7 m/s
 (iv) 8 m/s-10 m/s

(c) Which of the following is a conventional source of energy?

(i) Sun

(ii) Wind

(iii) Fossil fuel

(iv) Fuel cell

(d) A fuel cell in order to produce electricity burns

(i) helium

(ii) nitrogen

(iii) hydrogen

(iv) None of the above

(e) In an open cycle MHD steam power plant, the temperature at the entrance of MHD duct is (in K)

(i) 2500-3000

(ii) 2000-2500

(iii) 1500-2000

(iv) 2250

- (f) Fuel cell converts chemical energy to electrical energy using a reaction, that
- (i) eliminates combustion of fuel
 - (ii) requires combustion of fuel
 - (iii) requires no ignition of fuel
 - (iv) Fuel is not required
- (g) Thermal neutrons are
- (i) exceptionally fast neutrons
 - (ii) fast neutrons
 - (iii) moderately fast neutrons
 - (iv) slow neutrons
- (h) Heat is generated in a nuclear reactor (thermal) by
- (i) fusion of atoms of uranium
 - (ii) absorption of neutrons in uranium atoms
 - (iii) combustion of nuclear fuel
 - (iv) fission of U-235 by neutrons

- (i) Which of the following should not be the characteristic of the solar cell material?
- (a) High absorption
 - (b) High conductivity
 - (c) High energy band
 - (d) High availability
- (j) Local winds are caused by
- (i) differential heating of land and water
 - (ii) differential heating of plains and mountains
 - (iii) Any of the above
 - (iv) None of the above
2. (a) What is meant by direct energy conversion? How is it different from other energy conversion processes? 7
- (b) Sketch a simple circuit for thermoelectric power generation plant and describe its working principle. What are the suitable materials used for making thermoelectric elements? What is the utility of thermoelectric power generation? 7

3. Explain how wind energy can be converted into electricity using wind power generator with its various components. What are various limitations of wind energy conversion? 14

4. Describe the principle of fusion power generation. What are the advantages, disadvantages and limitations of fusion power? 14

5. (a) The duct of an MHD generator has a constant spacing between electrodes of 0.45 m. Each electrode has an area of 0.6 m^2 . Ionized gas with an electrical conductivity of 32 (ohm-m)^{-1} flows through the duct at an average velocity of 780 m/s . A cross-magnetic flux of 2.5 Wb/m^2 is applied, and an external resistance (load) of 0.04 ohm is connected across the electrodes. What is the theoretical power output? 7

- (b) Explain the following terms. 7

(i) Adiabatic efficiency of MHD

(ii) Solar cell materials

6. (a) Define an MHD system and its working principle. Describe combined MHD steam power plant with schematic diagram. 7

- (b) Briefly describe renewable and non-renewable energy sources with differences between them. 7

7. A thermoelectric generator is to be used as a topping unit for a steam power plant. The thermoelectric generator producing 100 kW at 115 V operates between an output temperature of 1500 K and exit temperature of 1000 K . A steam turbine and generator unit operating at an input temperature of 1020 K and an ambient temperature of 350 K has a thermal efficiency of 30% and a generator efficiency of 92% . The properties of thermoelements are given below:

$$\alpha_{p,n} \text{ at } 1250 \text{ K} = 0.0012 \text{ V/K}$$

$$k_p = 0.20 \text{ W/cm-K}, k_n = 0.030 \text{ W/cm-K}$$

$$\rho_p = 0.010 \text{ ohm-cm}, \rho_n = 0.012 \text{ ohm-cm}$$

The current density in the thermoelement is limited to 20 A/cm^2 and the thermoelectric generator is aimed to operate at maximum thermal efficiency. Calculate—

- (a) the thermal efficiency of the thermoelectric generator;

- (b) the number of thermal couples in series,
 - (c) the sizes of thermal elements,
 - (d) the open circuit voltage,
 - (e) the heat input and heat rejected from the thermoelectric generator at both full load and no-load conditions,
 - (f) the overall efficiency of the combined thermoelectric steam power plant 14
8. How is a solar cell fabricated? Draw a schematic diagram of solar cell with its idealized equivalent circuit. Explain various energy losses due to which the solar cell has very low conversion efficiency 14
9. What is fuel cell and its types? Describe the principle of working of a fuel cell with reference to H_2/O_2 cell. Also derive an expression for e.m.f. of a fuel cell. 14

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