Code : 031728

B.Tech 7th Semester Exam., 2019

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 answer (any *seven*) : 2×7=14

(a) A photovoltaic cell converts

(i) heat energy into mechanical energy

(ii) chemical energy into electrical energy

(iii) solar energy into electrical energy

(iv) electrical energy into chemical energy

(b) Which of the following is a non-conventional type of power generation without prime movers?

(i) Hydropower

(ii) Thermal

(iii) Nuclear

(iv) Thermoelectric

(c) Fuel cell performance is not limited by

(i) first law of thermodynamics

(ii) second law of thermodynamics

(iii) third law of thermodynamics

(iv) All three laws are applicable

(d) For which of the following devices negative charge carriers flow from anode to cathode in the external circuit?

(i) MHD generator

(ii) Thermionic generator

(iii) Thermoelectric generator

(iv) Fuel cell

(e) The major disadvantage with solar cells for power generation is

(i) lack of availability

(ii) large area requirement

(iii) variable power

(iv) high cost

(f) Winds, caused by greater solar heating of the earth's surface near the equator than near the northern or southern poles, are known as

(i) local winds

(ii) equatorial winds

(iii) planetary winds

(iv) trade winds

(g) Which direct energy converting systems is not limited by Carnot efficiency?

(i) Thermoelectric

(ii) Thermionic

(iii) MHD

(iv) Fuel cells

(h) A nuclear waste is generated in

(i) chemical reactions

(ii) nuclear fission

(iii) nuclear fusion

(iv) None of the above

(i) The methods of plasma heating are

(i) ohmic heating

(ii) neutral beam injection

(iii) compression heating

(iv) All of the above

(j) Thermoelectric effects are

(i) Seebeck, Thomson, Rutherford effects

(ii) Thomson, Peltier, Curie effects

(iii) Seebeck, Peltier, Thomson effects

(iv) Peltier, Curie, Seebeck effects

2. (a) What are the various energy sources? Discuss the energy conversion chart. 7

(b) Differentiate between direct energy conversion processes and other energy conversion processes for power generation. 7

3. Design a thermoelectric generator to operate from a heat source of 1000 K and to reject heat 600 K. The required output is 50 W at 6 V. The properties of the materials to be used are

$\alpha_{p,n} = 0 \cdot 001$ V/K, $k_p = 0 \cdot 03$ W/cm-K,

$k_n = 0 \cdot 02$ W/cm-K, $\rho_p = 0 \cdot 005$ ohm-cm,

$\rho_n = 0 \cdot 006$ ohm-cm

Assume the thermoelectric elements to be 1 cm in length. 14

What do you understand by 'figure of merit'? When does its value become the maximum? What is the optimum resistance ratio for *(a)* maximum power and *(b)* maximum efficiency? Explain the cascade multistage operation of thermoelectric generators. 14

5. *(a)* What are the three types of fuel-cell reactions? Give the thermo-oxygen, carbon-oxygen and methane-oxygen fuel-cell reactions. 7

(b) Explain the thermodynamics of fuel-cell reactions and give the applications of fuel cell. 7

6. *(a)* How is a solar cell fabricated? What are the factors which limit the solar cell efficiency? 7

(b) A constant velocity MHD generator operates at pressure ratio of 3. The gas used has polytropic index $\gamma = 1 \cdot 35$. Find the adiabatic efficiency of this device as a function of the loading factor and plot this. 7

Describe the working principle of magneto-hydrodynamic power generation power plant. Also describe either open cycle MHD steam power plant or closed cycle MHD steam power plant. 14

8. *(a)* What is the principle of fusion power? Discuss its various advantages and disadvantages. 7

(b) What are the various problems associated with controlled thermo-nuclear reactions? How are these problems resolved? 7

9. *(a)* What are the various wind turbines? Explain wind turbine power plant with a schematic diagram. 7

(b) Derive the formula of coefficient of performance (C_p) of wind energy conversion system. What is the maximum value of C_p? 7

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