Centre for Energy Studies
Major Test
ESL : 730: Direct Energy Conversion

Note Answer Section A and Section B of separate Sheets

Time : 2 hrs. (Section A & B)
M.M. : 50

Section B

1. a) Draw a diagram showing the electronic processes taking place in a thermionic generator. (2)

   b) Draw potential diagrams for basic thermionic generator (neglecting space charge effects) for fixed ϕ_c and ϕ_a in the following two cases :
   i) $\phi_c > \phi_a + eV_L$
   ii) $\phi_c < \phi_a + eV_L$
   where ϕ_c and ϕ_a are work functions of cathode and anode respectively and V_L is the voltage developed across the load. Whieh case you recommend for a practical generator? Justify your answer. Also drive expressions for maximum power for the above mentioned cases. (6)

   c) A thermionic generator has cathode work function 2.7 eV; Cathode space charge barrier energy 0.3 eV, anodc work function 1.5 cV, anode space charge barrier energy 0.5 eV, Cathode tcmperature 1900°K, anode temperature 1056°K. Universal constant for Cathode material is $.04 \times 10^6$ Amp/$m^2.K^2$, universal constant for anode material $.001 \times 10^6$ amp./$m^2.k^2$. Boltzman contt. = 1.38×10^{-23} J/°K and Electron charge 1.6×10^{-19} Coulomb.
   Find the emitter area needed to produce 100 W_c. Also ealculate generator thermal efficiency neglecting the radiation and conduction losses. (4)

2. Suggest whether the following statements are truc or false : (½ x 10 = 5)

   a) To achieve a large power output in MHD gcnerators the applied magnctic flux density must be as largc as possible.
   b) Thermionie generator is a low current, high voltage device.
   c) The best thermionie material has high valuc of thermal conductivity
   d) The inter-electrode distance in thermionie generator is kept large.
   e) To achieve a large power output in MHD generators gas must have a low vclocity.
   f) The best thermoelectric material has low value of electrieal eonduetivity.
   g) The thermoclcctric power is positive for p type material and negative for n type material.

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h) The thermoeleetric generators are best suited for low temperature applications and thermionic generators for high temperature applieations.

i) As the density of eharge carriers is increased, the figure of merit first rises and then decreases.

j) In Hall MHD generator eurrent is extracted in the direction of gas flow.

3. a) Explain the principle of MHD power generation. Drive the expressions for the eurrent required to investigate MHD generator. How MHD generator are classified? Write down equations for electrical power extracted per unit volume in case of Faraday and Hall generators. (8)

b) A MHD Faraday generator has electrode area of 0.25 m^2, magnetic flux density 2 Weber/m^2, average gas veloeity 1000 m/sec., gas eonduetivity 10 mhos/m and distanee between the electrodes is 0.5 m. Calculate the open eireuit voltage and maximum power output. (3)

4. a) Describe a thermoelectric generator with diagram and derive an expression for the thermal efficiency of the generator. (8)

b) Write short notes on :

i) Multistage cascaded thermoelectric generator (4)