

BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR, HOW-3
B.E.(Mech) Part-IV 7th Semester Final Examination, 2012.

Subject : Solar Energy Thermal Processes (Elective – I) Paper Code : ME-705/9
Time : 3 hours Branch : Mech. Engg.
Full Marks : 70

Answer FIVE questions
The questions are of equal value

1 (a) Discuss in brief the term local apparent time (LAT) used in the field of solar energy. How is this computed in practice? Write the expressions proposed by Angstrom and Page. State the significance of each term present in the expressions.

(b) Determine the LAT corresponding to 1400 hr (IST) at Kolkata (22.34°N , 88.24°E) on July 01. In India, standard time is based on 82.5°E . Correction on that day is (-) 4min. Also compute declination, day length, and local sun-rise and sun-set hours for that day.

2. (a) Explain in brief the basic principles of thermoelectric power generation system and its functioning. State few comments on materials that can be used for the thermoelectrodes of the system.

(b) A thermo-electric generator is producing 102 kW at 110 V operating between the temperatures of 1050°C and 350°C respectively with maximum thermal efficiency. Calculate (i) maximum value of figure of merit, (ii) number of couples in series, (iii) heat addition to and heat rejection from the generator in load and no load conditions in kW and (iii) maximum thermal efficiency. The properties of thermoelements are as, Seebeck coefficient – 0.0011 V/K; Thermal conductivity – 0.032 W/cm-K; Electric resistivity – 0.014 ohm-cm. Ratio of cross sectional area and length of both thermoelements is 92.

3. (a) With the help of neat diagrams explain in brief the working of natural circulation and open type forced circulation solar water heaters. Mention few merits and demerits of these two systems.

(b) Classify fuel cells. With a neat diagram, discuss in brief the working of phosphoric acid fuel cell (PAFC). Mention the potential areas where the fuel cell can effectively be used.

4. (a) Discuss the terms surface work function, Fermi energy level, and nature of electron energy and energy level, used in case of thermionic power generating system.

(b) A thermionic power generating system operates at maximum thermal efficiency with its cathode and anode temperatures as 177 K and 900 K respectively. Estimate (i) power output per unit area, (ii) thermal efficiency and (iii) emitter area in cm^2 when it produces power of 80 kW. Assume $e = 1.602 \times 10^{-19}$ Coulomb; $k = 1.38 \times 10^{-23}$ J/molecules-K; for cathode and anode (eV/KT) as 19; emission factor as 115 amps/ $\text{cm}^2\text{-K}^2$.

5. (a) With the relevant diagrams, write few comments on types of rotors used in case of wind energy conversion system. How the forces on the blades are computed?

(b) In case of a wind energy conversion system, wind turbine is rotating at 65 rpm. The turbine blade diameter is 122m. Atmospheric pressure and temperature are 1bar and 295 K. Compute (i) total power density, (ii) maximum power density, (iii) actual power produced by the turbine and (iv) maximum axial and tangential thrusts generated in the system.. Actual efficiency of the machine is 28 %. Incoming wind speed is 11 m/sec and characteristic gas constant of air is 0.287 kJ/Kg-K.

6 Write short notes on any FOUR of the following :

- (i) Multistage thermoelectric generator
- (ii) Forced circulation closed solar water heating system
- (iii) Flat plate collector
- (iv) Wind turbine ratings
- (v) OTEC system