UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: Int. B.Tech. – ET+IPR **Semester – V**

Subject (Course): Solar Energy Technology **Max. Marks : 100**
Course Code : ETEG 304 **Duration : 3 Hrs**
No. of page/s: 2

Section A [4 marks x 5 = 20]

Q.1) (CO3) With the help of diagram explain the underground aquifer storage concept.

Q.2) (CO5) With the help of block diagram, explain the operations of stand-alone SPV system.

Q.3) (CO4) Compare the relative merits and demerits of LiBr-water and aqua-ammonia vapour absorption cooling system.

Q.4) (CO2) For a parabolic collector of length 2 m, the angle of acceptance is 15°. Find the concentration ratio of collector.

Q.5) (CO4) With the help of schematic diagram, explain the working of distributed collectors solar thermal electric power plant.

Section B [10 marks x 4 = 40]

Q.6) (CO5) A 120V, 60 Hz AC motor is to be operated by day from a solar cell array and by night from the 120 V public utilities. A DC to AC converter is available that changes the array DC output into a 120 V, 60 Hz AC with 90% efficiency independent of a load phase angle while the running motor has a DC resistance of 300 Ω and an inductance of 0.3 H. How much power output must the array provide?

Q.7) (CO5) Draw and explain an equivalent circuit of a practical solar PV cell.

Q.8) (CO2) For a collector with a top loss coefficient of 3.79 W/m2-K. Calculate overall loss coefficient using following data:
Back insulation thickness = 8 cm
Insulation conductivity = 0.05 W/m-K
Side insulation thickness = 4 cm
Size absorber plate = 1.90 m x 0.9 m
Height of collector casing = 0.16 m

Q.9) (CO1) An inclined surface, facing due south, tilted at 30° with horizontal, is location is at location $28°51' N$ on January 1 at 12 noon (solar time). The reflection coefficient of ground, ρ is 0.2. Calculate the values of R_b, R_r and R_d.

Section C [20 marks x 2 = 40]

Q.10) (CO3) Describe followings for a thermochemical storage for a solar application

(i) Criteria used for judging the suitability of a thermochemical reaction
(ii) Schematic representation of a thermochemical reaction
(iii) Thermochemical storage reactions, temperatures of forward and reverse reaction and energy stored

Q.11) (CO5) A residential house has a power requirement of 400 W for4 hours every night. It is proposed to meet the requirement by using a PV array, a battery storage system and an inverter. The whole system is over designed so that it can meet one extra night's requirement even if there has been no sunshine during the day. Draw block diagram and calculate the number of PV modules and batteries required.
Given:
(i) Solar radiation is available for an average of six hours daily and the average hourly global radiation flux incident on the array is 650 W/m2.
(ii) Battery rating = 12 V; 120 Ah. Depth of discharge = 0.7, Charging and discharging efficiency = 0.9
(iii) Inverter efficiency at full load = 0.85
(iv) Module size = 1.191m x 0.533m, conversion efficiency under operating conditions = 10 %

OR

Q.11) (CO1) With the help of diagram, discuss basic features of pyrheliometer.

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Section A [4 marks x 5 = 20]

Q.1) (CO3) With the help of diagram explain arrangements of spaces and tubes in container for latent heat storage.

Q.2) (CO5) With the help of block diagram, explain the operations of grid interactive SPV system.

Q.3) (CO4) Briefly explain "solar green house".

Q.4) (CO2) For a cylindrical parabolic concentrator of 2.5 m width and 9 m length, the outside diameter of the absorber tube is 6.5 cm. Find the concentration ratio of collector.

Q.5) (CO1) Calculate the zenith angle for air mass 1.5

Section B [10 marks x 4 = 40]

Q.6) (CO5) A solar cell array is required to deliver 100W peak output at 120V DC bus voltage. The solar cells to be used are rated for 0.1W peak output at 0.4V. Assuming that there are no assembly looses, define the array.

Q.7) (CO5) Explain in detail the I-V characteristics of a solar cell.

Q.8) (CO4) Give a neat diagram of a central tower receiver power plant and explain its operation.

Q.9) (CO1) Determine the sunset hour angle for Allahabad (longitude 81°58´E, latitude 24°25´N) for following dates: January 1, March22, july15.

Section C [20 marks x 2 = 40]

Q.10) (CO3) Explain in detail the standard procedures for the testing of solar thermal storage devices.

Q.11) (CO2) A cylindrical parabolic focussing collector is used for heating a thermic fluid (Cp = 2.2 kJ/ kg-K) which enters with a temperature of 160°C. The concentrator has an aperture of 1.6 m and a length of 2.8 m. The absorber tube has an inner diameter of 2.8 cm and outer diameter of 3.2 cm and has a concentric glass cover around it.

Given that: Specular reflectivity of concentrator surface: 0.82
Intercept factor: 0.91
$(\alpha\tau)_b$: 0.8
Beam radiation incident normally on aperture plane: 550 W/m^2
Diffuse radiation incident on aperture plane: 150 W/m^2
Overall loss coefficient: 9.5 W/m^2-K
Convective heat transfer coefficient on inside of absorber tube: 325 W/m^2-K
Ambient temperature: 27°C
Mass flow rate of fluid: 360 kg/h
Calculate the useful heat gain rate, the exit temperature of the fluid and the instantaneous efficiency.

OR

Q.11) (CO2) Estimate the collector area required for a 80 MW line focusing solar thermal power plant producing electricity for 8 hours every day. The collector is operating at a temperature of 400°C.
Make following assumptions:
1..The Rankine cycle has an efficiency of 0.36.
2.The electrical generator efficiency is 0.96.
3.The solar insolation during a typical day is 6 kWh/m^2.

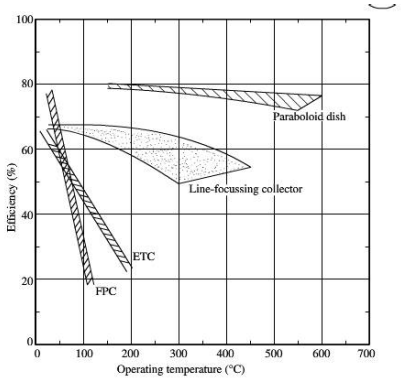

Fig. 2.6 *Efficiency of various types of collectors as a function of operating temperature (Adapted from Gehlisch et al. [1] and Rabl [2])*