Indian Institute of Technology New Delhi
II Semester – 2006 - 2007

MEL 140 ENGINEERING THERMODYNAMICS

MAJOR TEST

Time: 2 hrs Max. Marks: 60

Problem 1a

State the Fourth law of thermodynamics and explain the same with an example.

5 marks

Problem 1b

Why an ideal vapour compression refrigeration cycle is NOT exactly a reversed Rankine cycle?

5 marks

Problem 2a

1000 MW of thermal power is available from a nuclear source. It is proposed to use this thermal power to generate Mechanical power using Rankine cycle. following are the allowable extreme values of parameters of the cycle.

Maximum pressure : 15 MPa.

Maximum Temperature: 600 $^{\circ}c$.

Minimum Temperature : 40 $^{\circ}C$.

Minimum quality of steam at the exit of turbine : 0.84.

Design a Reheat Rankine cycle having maximum possible efficiency using above data. Also calculate the mass flow rate of steam required to use 1000 MW of nuclear power. Also calculate the capacities of steam generator (hoiler), turbine and pump. Assume an euthalpy of 182.6 kJ/kg at the exit of pump.

20 marks

Problem 2b

All the heat rejected in condenser is carried away by cooling water taken from a river. The temperature of river water is 30$^{\circ}C$ and maximum allowable increase in cooling water temperature is 6 $^{\circ}C$. Calculate mass flow rate of cooling water and Rate of entropy generation.(Specific heat of cooloing water = 4.18 kJ/kgK.)

5 marks

P.T.O.

Problem 3

Prove that the efficiency of an irreversible heat engine working between given reservoirs will be always less than that of reversible engine working between same reservoirs.

10 marks

Problem 4

Heating of a room (to keep at a temperature $25°C$) during winter is done using a furnace with a temperature (SOURCE) 400 $°C$. The furnacce is capable of suplying a heat flow rate of $25kW$. This is called as direct heating of room. It is proposed to use this heat to drive a reversible heat engine working between furnace temperature and ambient temperature (SINK) (Winter : $5°C$). This reversible heat engine drives a reversible heat pump that delivers heat to the room from ambient air.

(a) Draw the schematic diagram of the set up with temperatures of source and sink, rate of heat addition and rate of heat rejection.

(b) Find the rate of heat that can be supplied to the room using this compound engine–pump system. Is this a better set-up than direct room heating from the furnace?

(c) How do you quanitify the performance of this setup?

15 marks