

Mansoura University
Faculty of Engineering
BME & MTE Programs
Course Title: Thermodynamics
Course Code: MPE 172



Level: 100
Exam Type: Final
Date: 29 December 2018
Time: 2 Hours
Full Mark: 50

Answer all the following questions. Use of steam tables are allowed

Question (1) [12 Marks]

0.2 m³ of air at a pressure of 15 bar and 550 K is expanded isothermally to 6 times the initial volume ($V_2=4 V_1$). It is then cooled to 290 K at constant volume and then compressed back polytropically ($PV^n=C$) to its initial state. Sketch the cycle on P - v diagram and determine:

a) the index n , b) heat and work for each process, c) entropy change for each process, and d) the net work done and heat transferred during the cycle.

Take for air : $C_p = 1005 \text{ J/kg.K}$ and $C_v = 718 \text{ J/kg.K}$.

Question (2) [10 Marks]

Steam flows steadily through a reversible adiabatic turbine. The inlet conditions of the steam are 90 bar, and 450°C and the exit conditions are 0.1 bar. The mass flow rate of the steam is 15 kg/s. Determine the following:

a) the theoretical (maximum) power output, and

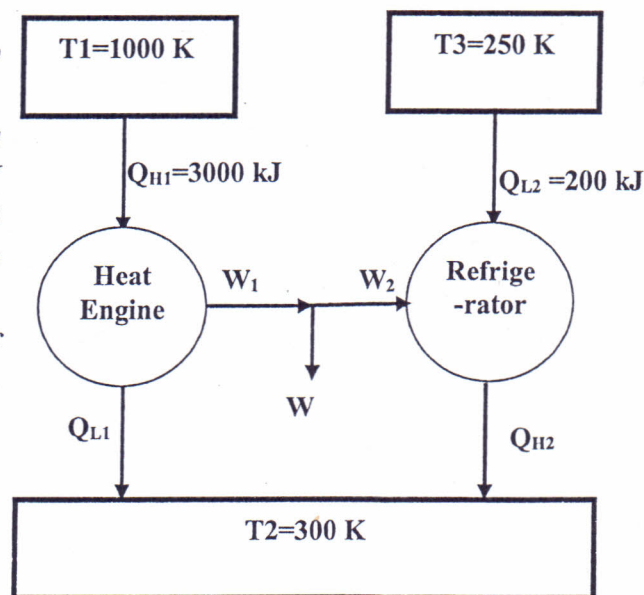
b) the actual power, rate change in entropy and the final state of the steam when the isentropic turbine efficiency is 92%.

Question (3) [10 Marks]

b) A heat engine operates between two reservoirs at temperatures 1000 K and 300 K. The engine drives a refrigerator which operates between reservoirs at temperatures of 300 K and 250 K. The heat added to the engine is 3000 kJ and the heat absorbed by refrigerator is 200 kJ. If the efficiency of the heat engine is 30% of that of the Carnot cycle and the C.O.P. of the refrigerator is one quarter of that of the reversed Carnot cycle.

Determine the following:

i) The efficiency of heat engine,



- ii) The COP of refrigerator,
- iii) The net work W .
- iv) The total heat rejection to the 300K reservoir.

Question (4) [10 Marks]

In a gas turbine plant working on Brayton cycle, the air at inlet is 300K , 1 bar . The pressure ratio is 10 and the maximum temperature is 950 °C. The compressor and turbine efficiency are 85% and 92 %, respectively. Sketch the cycle on T-s diagram and determine:

- i) The thermal efficiency of the cycle.*
- ii) The back work ratio.*
- iii) The required mass flow rate if the net output power is 100 MW.*

Question (5) [8 Marks]

Moist air at the standard atmospheric pressure, has a temperature of 30 °C and a relative humidity 50% . Determine the following:

- a) the partial pressure of dry air and the water vapor, b) the relative humidity,*
- c) the degree of saturation, d) the dew point temperature, and e) the density of moist air.*

Good Luck
Dr. Ahmed Abd-Elsalam