VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: MEE1003 - Engineering Thermodynamics
Class NBR(s): 1819 / 2253
Time: Three Hours
Slot: A2+TA2+V3
Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

General Instructions:

i) Use of steam table and Mollier chart are permitted
ii) Standard constant values should be assumed suitably.

PART – A (8 X 2 = 16 Marks)
Answer any EIGHT Questions

1. What do you mean by thermodynamic temperature scale?
2. Deduce steady flow energy equation for throttling process.
3. Mention the reasons for a Carnot cycle not having 100% efficiency.
4. What is the significance of critical point?
5. State the effects of decreasing condenser pressure in Rankine cycle.
6. Compare air standard efficiency of different cycle based on same compression ratio.
7. Brief Amagat's law.
8. What do you know about Joule Thomson coefficient?
9. State Zeroth law of thermodynamics.
10. Define second law efficiency of a steam turbine and a heat pump.

PART – B (7 X 12 = 84 Marks)

Answer any SEVEN Questions

11. 10 kg of a gas are compressed at a constant pressure of 14 bar from a value of 1.5 m^3 to a volume of 0.3 m^3. If the internal energy increase is 3068 kJ and the temperature changes from 20°C to 146°C, find
    a) Work done during compression
    b) Heat transferred
    c) Change of enthalpy
    d) The average value of the specific heat at constant pressure
12. An air compressor draws in air at 1 bar, 0.5 m^3/kg, 5 m/s and delivers at 7 bar, 0.15 m^3/kg, 7.5 m/s. At delivery, enthalpy is 170 kJ/kg more than that at inlet and the rate of air flow is 15 kg/min. Estimate
    a) The power required to drive the compressor
    b) The ratio of the pipe diameters at inlet and outlet

    Assume a heat loss of 7200 kJ/min to the cooling water and surrounding air.

13. A heat engine working on Carnot cycle absorbs heat from three thermal reservoirs at 1000 K, 800 K and 600 K. The engine does 10 kW of network and rejects 400 kJ/min of heat to a heat sink at 300 K. If the heat supplied to the reservoir at 1000 K is 60% of the heat supplied by the reservoir at 600 K,

a) Make calculations for the quantity of heat absorbed by each reservoir

b) Maximum thermal efficiency

c) Actual thermal efficiency

14. One kg of steam at 20 bar and 300°C undergoes a constant internal energy process to 10 bar.

a) Draw the process in Mollier chart.

Using Mollier chart only, find

b) The specific enthalpy change

c) The specific entropy change

d) Condition of the steam at the end of the process

e) The specific volume at the end of the process

15. An air standard Otto cycle is designed to operate with the following data:

Maximum cycle pressure and temperature: 5 MPa and 2250 K

Minimum cycle pressure and temperature: 0.1 MPa and 300 K. Determine

a) Compression ratio

b) Heat supplied per unit mass of working fluid

c) Network output per unit mass of working fluid

d) Air standard efficiency of the cycle

e) Mean effective pressure

16. 8 kg of nitrogen at 160°C and 100 kPa are mixed with 4 kg of carbon dioxide at 40°C and 0.14 MPa bar to form a mixture at a final pressure of 70 kPa. The process occurs adiabatically in a steady flow apparatus. Calculate :

i) The final temperature of the mixture

ii) The change in entropy

Take value of Cp : for CO_2 = 0.85 kJ/kg K and N_2 =1.04 kJ/kg K

17. A steam power plant operates on an ideal reheat Rankine cycle between the pressure limits of 15 MPa and 10 kPa. The mass flow rate of steam through the cycle is 12 kg/s. Steam enters both stages of the turbine at 500°C. The moisture content of the steam at the exit of the low pressure turbine is not to exceed 10 percent. Show the cycle on a T-s diagram with respect to saturation lines. Determine

a) The pressure at which reheating takes place

b) The total rate of heat input in the boiler

c) The thermal efficiency of the cycle

18. Give the expression for cyclic relation and prove that ideal gas equation obeys for cyclic relation.

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