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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. - Automobile Engineering

Semester End Examination; Dec. - 2015

Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Use of steam tables and thermodynamics data hand book permitted.

UNIT - I

1 a. Distinguish between the following with examples :
i) Thermal and Thermodynamic Equilibrium.
ii) Classical and Statistical Thermodynamics
iii) Open, Closed and Isolated systems. 9

b. What is a quasistatic process? What are its features? 3

c. The resistance of a platinum wire is found to be 11,000 ohms at the ice point, 15.247 ohms at the steam point, and 28.887 ohms at the sulphur point. Find the constants A and B in the equation. 8

$R = R_0(1 + At + Bt)$

And plot against *t* in charge 0 to 660º C.

2 a. With a neat P-V diagram, derive the work done expression for each of the following process:
i) Isobaric Process ii) Isochoric Process
iii) Isothermal Process iv) Polytrophic process. 8

b. Does heat transfer is inevitable for the temperature rise? What are the other causes for the temperature rise? 4

c. A fluid, contained in a horizontal cylinder fitter with a frictionless leak proof piston, is continuously agitated by means of a stirrer passing through the cylinder cover. The cylinder diameter is 0.40 m. During the string process lasting 10 minutes, the piston slowly moves out a distance of 0.485 m against the atmosphere. The network done by the fluid during the process is 2 kJ. The speed of the electric motor driving the stirrer is 840 rpm. Determine the torque in the shaft and the power output of the motor. 8

UNIT - II

3 a. State and derive expression for steady Flow Energy Equation of First Law of thermodynamics as applied to open system. 8

b. A milk chilling unit can remove heat from the milk at the rate of 41.87 MJ/h. Heat leaks into the milk from the surroundings at an average of 4.187 MJ/h. Find the time required for cooling a batch of 500 kg of milk from 45º C to 5º C. Take the Cp of milk to be 4.187 kJ/kg K. 4

Contd….2

c. A mass of 8 kg gas expands within a flexible container so that *p-v* relationship is according to $pv^{1.2}$ = constant. The initial pressure is 1000 kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. The specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction. 8

4 a. Describe the classic paddle wheel experiment performed by Joule. What conclusion was drawn based on experimental observations? 10

b. A turbo compressor delivers 2.33 m^3/s at 0.276 MPa, 43º C which has heated at the pressure to 430º C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.009 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. 10

UNIT - III

5 a. What is thermal energy reservoir? Explain source and sink. 4

b. Establish equivalence of Kelvin-Planck and Clausius statements. 6

c. A house hold refrigerator is maintained at a temperature of 2º C. Every time the door is opened, warm material is placed inside, introducing an average of 420 kJ, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is Rs. 2.50 per kwh. What is the monthly for this refrigerator? The Atmosphere is at 30º C. 10

6. a. Why are engineers interested in reversible processes even though they can never be achieved? 4

b. Define reversible engine. Show that of all the reversible heat engines working between any two constant but different reservoir temperatures, the reversible reversed heat engine will have the maximum COP. 8

c. A heat pump working on the Carnot cycle takes in heat from a reservoir at 5ºC and delivers heat to a reservoir at 60ºC. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840ºC and rejects heat to a reservoir at 60ºC. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5º C reservoir determine; 8

i) The rate of heat supply from the 840ºC source

ii) The rate of heat rejection to the 60º C sink.

UNIT - IV

7 a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of a diesel cycle. 10

b. An air standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1 MPa, 40º. The maximum pressure is limited to 6MPa and the het added is 1.675 MJ/kg. 10

Contd….3

Compute;

(i) The heat supplied at constant volume per kg of air

(ii) The heat supplied at constant pressure per kg of air

(iii) The work done per kg of air

(iv) the cycle efficiency

(v) The temperature at the end of the constant volume heating process

(vi) The cut-off and

(vii) The m.e.p. of the cycle.

8 a. What are the draw backs of a single stage compressor for producing high pressure? How are these overcome by multistage compression? 4

b. Derive an expression for the condition or the minimum work input, required for a two stage compressor, with perfect inter cooling. 6

c. In a 2-stage air compressor, the work out is found to be 350 kJ/kg. It is used to compress 1 kg of the free air from 1 bar pressure and 32º C initial temperature. The value of n = 1.3 and R = 0.287 kJ/kgºK. Find the intermediate pressure. 10

UNIT - V

9 a. With a neat sketch explain the working of vapour absorption refrigeration system. 4

b. Explain the effect of superheating and sub cooling on vapour compression refrigeration cycled with the help of T-S and P-H diagrams. 6

c. A R-12 vapour compression refrigeration system is operating at a condenser pressure of 9.6 bar and an evaporator pressure of 2.19 bar. Its refrigeration capacity is 15 tonnes. The values of enthalpy at the inlet and outlet of the evaporator are 64.6 and 195.7 kJ/kg. The specific volume at inlet to the reciprocating compressor is 0.082 m^3/kg. The index of compression for the compressor is 1.13 Determine; 10

i) The power input in kW required for the compressor

ii) The COP, Take 1 tonnes of refrigeration as equivalent of heat removal at the rate of 3.517 kW.

10 a. Distinguish between :

i) Summer and winter Air conditioning

ii) Dry bulb and wet bulb temperature 6

iii)Specific and relative humidity

b. Write a brief note on properties of refrigerants. 6

c. Atmospheric air at 1.0132 bar has a DBT of 32º C and WBT of 26º C. Compute the following:

i) Specific humidity ii) Relative Humidity

iii) DPT iv) Specific enthalpy. 8

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