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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. - 2014

Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note** : i) Answer **FIVE** full questions, selecting **ONE** full question from each Unit.*
ii) Assume suitable missing data if any iii) Use of Thermodynamic data hand book is permitted.

Unit - I

1 a. Distinguish between:
i) Intensive and extensive properties.
ii) Point and path functions. 8
iii) Thermal and Thermodynamic Equilibrium.
iv) Microscopic and Macroscopic approach.

b. State zeroth law of thermodynamics. How does this form the basis of temperature measurement? 6

c. A new scale N of temperature is divided in such a way that the freezing point of ice is 100º N and the boiling point is 400º N. What is the reading on this new scale when the temperature is 150º C. 6

2 a. What are the characteristics common between heat and work? 4

b. Derive an expression for displacement work during polytrophic process. 4

c. A fluid undergoes the following processes in sequence to complete a cycle.
i) Heated reversible at constant pressure of 1.05 bar until it has a volume of 0.02 m^3.
ii) It is then compressed reversible according to the law PV = const, to a pressure of 4.2 bar.
iii) It is then allowed to expand reversible according to a law $PV^{1.3}$ = C. 12
iv) Finally, it is heated at constant volume back to initial conditions.
If the work done during constant pressure process is 515 N–m. Calculate the net work done on or by the cycle.

Unit - II

3 a. Show that energy is a property of the system. 6

b. A fluid is confined in a cylinder by a spring loaded friction less piston, so that the pressure in the fluid is a linear function of the volume (P = a + bv). The internal energy of the fluid is given by the following equation u = 34 + 3.15 PV, where u is in kJ, P in kPa and V in m^3. If the fluid changes from an initial state of 170 kPa , 0.03m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on the piston. Find the direction and magnitude of work and heat transfer. 14

4 a. Derive steady flow energy equation for an open system. 8

b. In a gas turbine installation, the gases enters the turbine at the rate of 5 kg/s with a velocity of 50m/s and enthalpy of 900 kJ/kg and leaves the turbine with 150 m/s, enthalpy of 400 kJ/kg. the loss of heat from the gases to the surroundings is 25 kJ/kg. Assume R = 0.285 kJ/kg-K and inlet conditions to be 100 kPa and 27ºC. Determine the power developed by the 12

Unit - III

5 a. Give Kelvin – Plank and Clausius statement of second law of thermodynamics and show that they are equivalent. 12

b. A domestic food freezer maintains a temp of -15° C. The ambient air temperature is 30ºC. If heat leaks into the freezer at a continuous rate of 1.75 kJ/s. What is the least power necessary to pump this heat out continuously? 8

6 a. Define Perpetual machine of second kind. 2

b. Explain the factors that make the process irreversible. 8

c. A reversible heat engine operates between three heat reservoir 100 K, 800 K and 600 K and rejects heat to a reservoir at 300 K. The engine develops 10 kW and rejects 412 kJ/min. If the heat supplied by the reservoir at 100 K is 60% of heat supplied by the reservoir at 600 K, find the quantity of heat supplied by each reservoir. 10

Unit - IV

7 a. Derive the expression for the air standard efficiency of a Dual cycle. 10

b. Two engines are to operate on otto and diesel cycles with the following data.
Maximum temperature : 1400 K, Exhaust temperature = 700 K, state of air at the beginning of compression 0.1 MPa, 300 K. Estimate the compression ratio, maximum pressure and thermal efficiency. 10

8 a. Derive the condition for minimum work output to a two stage reciprocating air compressor with perfect inter cooling. 6

b. Obtain an expression for the volumetric efficiency of an single stage air compressor in terms of the pressure ratio, clearance and 'n' the exponent of expansion and clearance. 6

c. A multi stage compressor comprising air is to be designed to elevate the pressure from 1 bar to 120 bar, such that the stage pressure ratio, should not exceed 4. Determine; 8
i) The number of stages, ii) Exact stage pressure ratio iii) intermediate pressure.

Unit - V

9 a. With a neat sketch, explain the working of vapour absorption refrigeration system. 8

b. An Ammonia In plant operates between a condenser temperature of 30º and an evaporator temperature of – 15ºC. It produces 10 tons of ice per day from water at 30ºC to ice at - 5ºC. Assume the state at the end of compression process as dry saturated determine; 12
i) Mass flow rate of refrigerant ii) Capacity of refrigeration plant
iii) COP, use the following data:
C_p of water = 4.186 kJ/kg-K, C_p of solid ice = 1.94 kJ/kg-K
Latent heat of fusion at 0ºC for water = 335 kJ/kg.

10 a. On a particular day, the atmospheric air was found to have a DBT of 30º and WBT of 18ºC. The barometric pressure was observed to be 1.01325 bar. Using the tables of psychometric properties of air, determine Relative humidity, the specific humidity, dew point temperature, enthalpy and volume of mixture/kg of dry air. 10

b. Indicate the following pressure on psychometric chart: 10
i) Adiabatic Humidification ii) Adiabatic De–Humidification
iii) Adiabatic mixing of air iv) Sensible heating.

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