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

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Industrial and Production Engineering

Semester End Examination; May / June - 2018

Engineering Thermo Dynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Define the following representing the same on a PV diagram : 6

i) Reversible process ii) Irreversible Process iii) Reversible cycle

b. What is the thermodynamic definition of work? Derive an expression for PDV work for a process in which the pressure and volume are related by PV = constant. Represent this process on a PV diagram. 6

c. Determine the total work done by MJ by a gas system which is undergoing an expansion process as shown in Fig. Q1(C). 8

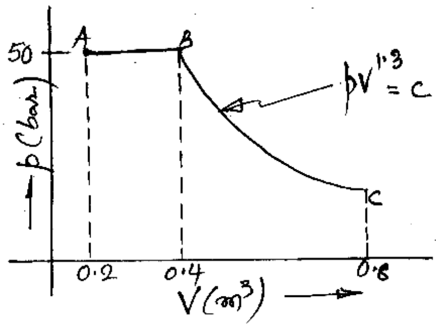

Fig. Qn1(c)

2 a. Differentiate between the following : 9

i) Process and Path ii) Path and Point functions

iii) Microscopic and Microscopic view points

b. List the common points about work and heat transfer. 3

c. A certain fluid at 10 bar is contained in a cylinder behind a piston, the initial volume being 0.05 m^3. Calculate the workdone by the fluid when it expands reversibly according to law $P = \left(\frac{A}{V^2}\right) - \left(\frac{B}{V}\right)$ to final volume of 0.1 m^3, and a final pressure of 1 bar where *A* and *B* are constants. 8

UNIT - II

3 a. Write the first law of thermodynamics as applied to a cycle, process. Explain the terms. 4

b. Show that entropy is a property. 8

c. A refrigerator that operates on a carnot cycle removes 540 kJ of heat per minute from a low temperature reservoir at -12°C and transfers heat to a higher temperature reservoir at 40°C. Determine the COP of the refrigerator and the power required by it in kJ/min and kW. 8

4 a. Define the following and write mathematical expression wherever applicable : 6

i) COP of a heat pump ii) Clausius inequality iii) Carrots theorem

b. Write the first law of thermodynamics as applied to a flow process and explain the terms. 4

c. A turbine operating under stready flow conditions receives steam at the following conditions: Pressure 13.8 bar, specific volume 0.143 m^3/kg, internal energy 2590 kJ/kg, velocity 30 m/s. The state of steam leaving the turbine is: Pressure 0.35 bar, specific volume 4.37 m^3/kg, internal energy 2360 kJ/kg, velocity 90 m/s. Heat is lost to the surrounding at the rate of 0.25 kJ/s. If the rate of steam flow is 0.38 kg/s, what is the power developed by the turbine? 10

UNIT - III

5 a. Representing a typical vapour dome on a T-S plane for a pure substance, show the following on the same : i) Any two isobars ii) Any two constant quality lines iii) Compressed liquid region iv) Superheated vapour region 8

b. With usual notations, prove that $Cp\text{-}C_v = R$. 4

c. A vessel contains 3 kg of water at 200°C. If the volume of the vessel is 0.3 m^3. Determine; 8

i) The pressure ii) Quality iii) Specific enthalpy of water vapour in the vessel

6 a. Define: i) Pure substance ii) Dryness fraction iii) Triple Point. 6

b. For an ideal gas extending a reversible adiabatic process, show that the temperature and volume are related by the equations $TV^{\gamma-1} = C$. 6

c. 10 kg water at 450°C is heated at constant pressure of 10 bars until it becomes super heated vapour at 300°C. Find the change in volume, enthalpy, internal energy and entropy. 8

UNIT - IV

7 a. Represent a regenerative Rankine cycle with a single feed heater on a T-S diagram and explain briefly. Assume the steam is superheated conditions at the entry to the turbine. 8

b. Define the following as applied to gas power cycle : 6

i) Air standard efficiency ii) Mean effective pressure

c. Define 'Mean temperature of heat addition' representing to the same on a simple Rankine cycle on a T-S plane. Show that for a given T_2, Rankine cycle efficiency depends on the mean temperature of heat addition. 6

8 a. Represent: i) Otto cycle

ii) Diesel cycle on PV diagram and name the various processes; also write the expression for air standard efficiency of the same. 8

b. For the same compression ratio and heat rejections, which cycle is more efficient: Otto, diesel or Dual? Substantiate your answer with the help of a PV diagram. 6

c. An engine 200 mm bore and 300 mm stroke works on the cycle. If the clearance volume is 0.0016 m^3. Find the air standard efficiency of the engine. 6

UNIT - V

9 a. With usual notations, derive an expression for air standard efficiency of a Brayton cycle representing the same on PV and TS diagrams. 8

b. Represent the indicator diagrams for a single stage, single acting reciprocating air compressor with clearance. Write the expression for the work done on air and explain the terms. 6

c. Represent on a T-S diagram, ideal regenerative gas turbine cycle with two stage compression and reheat. Assume the inter cooling and reheating processes are ideal. 6

10 a. Which of the compression process needs minimum work input and which the maximum? Support your answer with the help of the PV diagram. 6

b. Draw a PV diagram representing a two stage compression process showing the saving in work. Also indicate the isothermal line. 6

c. An air compressor compresses airs from 0.98 bar and 20°C to 9.8 bar according to the law $Pv^{1.2} = C$ and delivers it to a receiver at constant pressure.

Compute; 8

i) The temperature of air at the end of compression

ii) Work required during compression of 1 kg of air

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