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

(An Autonomous Institution affiliated to VTU, Belgaum)

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

Semester End Examination; June/July - 2015

Engineering Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **Unit**.*
ii) Thermodynamics data hand book/mollier diagram may be used.

UNIT - I

1.a. Distinguish between extensive property and intensive property. 5

b. What is a quasi-static process and how does it differ from a reversible process. 5

c. Explain what you understand by thermodynamic equilibrium. 5

d. A domestic food freezer maintains a temperature of -15ºC, air temperature is 30º. If heat leaks into the freezer at the continuous rate of 1.75 kJ/s. What is the least power necessary to pump these heat out continuously? 5

2 a. Write the thermodynamic definition of work. With a suitable example, explain how it is more general than the definition of work in mechanics. 4

b. Obtain an equation for expansion or boundary work done for a closed system undergoing change of state. Also show that for isothermal process $W_{1-2} = P_1V_1 \log_e\left[\frac{V_2}{V_1}\right]$ 8

c. A fluid at a pressure of 3 bar, and with specific volume of 0.18m^3/kg, contained in a cylinder behind a piston expands reversibly to a pressure of 0.6bar according to a law $p = \frac{C}{V^2}$, where C is constant. Calculate the work done by the fluid on the piston. 6

d. Distinguish between point function and path function. 2

UNIT - II

3 a. Explain first law of thermodynamics as applied to a closed system undergoing a closed cycle. Briefly describe an experiment to support it. 8

b. When a system is taken from state a to b, in Fig. (1) along with acb, 84 kJ of heat flow into the system, and the system does 32 kJ of work. i) How much will the heat that flows into the system along path adb be, if he work done is 10.5 kJ?, ii) When the system is returned from b to a along the curved path, the work done on the system is 21 kJ. Does the system absorb or liberate heat, and how much of heat is absorbed or liberated? iii) If $U_a = 0$ and $U_d = 42$ kJ, find the heat absorbed in the processes ad and db. 8

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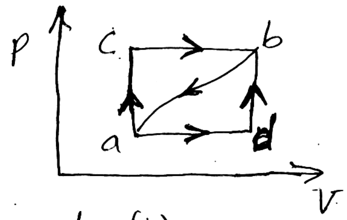

fig (1)

c. Define the specific heats t constant volume and constant pressure. 2

d. What is a PMMI? Why is it impossible? 2

4 a. Write the Kelvin –Planck and Clausius statements of second law of thermodynamics. Show that the violation of Clausius statement leads to the possibility of a perpetual motion machine of the second kind. 10

b. A heat engine works on Carnot's cycle between 900ºC and 200°C of this engine receives heat at the highest temperature at the rate of 50 kJ/s. Calculate the power of the Engine. 6

c. Prove that $(COP)_{HP}$ greater than unity. 4

UNIT - III

5.a. Define the following :

(i) Pure substance (ii) Triple point 5

(iii) critical Point (iv) Saturation state (v) Latent Heat

b. Draw pressure-Temperature and Temperature-Volume diagram for water. Name different regions and salient points. 6

c. The following observations were taken with a separating and throttling calorimeter arranged in series.

Water separated = 2 kg, steam discharged from the throttling calorimeter = 20.5 kg, temperature of steam after throttling = 110ºC, initial pressure = 12 bar abs, barometer = 760 mm of Hg, find pressure = 5 mm of Hg. Estimate the quality of steam supplied. Take; Cps = 2 kJ/kgK. 7

d. What is the difference between an ideal and a perfect gas? 2

6 a. Starting from the relation Tds = du + pdv, show that for an ideal gas undergoing reversible adiabatic process, the law for the process of given by $TU^{\gamma-1}$ = a constant 8

b. Show that the entropy change of idea gas is given by the equation of the form $S_2 - S_1 = C_p \ln\frac{V_2}{V_1} + C_v \ln\frac{P_2}{P_1}$. 8

c. A vessel of capacity $3m^3$ contains 1kg of mole of N_2 at 90ºC:

i) Calculate pressure and the specific volume of the gas 4

ii) If the ratio of specific heats is 1.4, evaluate the values of C_p and C_v.

UNIT - IV

7 a. Explain with T-S diagrams, limitations of Carnot cycle and how we can overcome the same in Rankine cycle. 8

b. Discuss the effect of : i) Boiler Pressure ii) Condenses pressure iii) Super heat on the performance of a Rankine cycle. 6

c. In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenses pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work. 6

8 a. Describe diesel cycle with P-V and T-S diagrams and derive an expression for efficiency in terms of compression ratio, cut off ratio and ratio of specific heats. 10

b. An engine working on Otto cycle has a volume of 0.45 m^3, pressure 1 bar and temperature 30ºC at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar. 210 kJ of heat is added at constant volume. Determine; 10

i) Pressures, Temperatures and volume at salient points in the cycle.

ii) Percentage clearance

iii) Efficiency

iv) Network percent

v) Mean effective Pressure.

UNIT - V

9 a. Derive the Thermal efficiency by representing schematic diagram of an ideal Brayton cycle with regenerator. 10

b. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325 kPa, 27ºC. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and the cycle efficiency. Assume W_T = 2.5 Wc, where W_T and W_C are the turbine and compressor work respectively. Take $\gamma = 1.4$. 10

10a. Define the following with respect to a reciprocating air compressor; 6

i) Isothermal efficiency ii) Isentropic efficiency and iii) Mechanical efficiency

b. Derive an expression for volumetric efficiency of compressor in terms of clearance ratio, pressure ratio and index of compression. 6

c. A double acting air compressor of 18 cm diameter and 120 cm stroke runs at 120 rpm and operates between 1 bar and 10 bar, the lower temperature being 15ºC. Estimate the power, final temperature. Temperature rise, if the compression index be 1.3. 8

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