**[Total No. of Questions - 9] [Total No. of Printed Pages - 4]**
**(2123)**

**1356**

**B. Tech 3rd Semester Examination**

**Applied Thermodynamics (O.S.)**

**ME-3002**

**Time : 3 Hours** **Max. Marks : 100**

*The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.*

**Note :** Attempt five questions in all, select one question from each section A, B, C and D. Section E (question 9) is compulsory. Use of steam table/non-programmable calculator is permitted. Assume any suitable data if not given.

## SECTION - A

1. (a) Discuss indicated power and brake power of an engine. How it can be calculated? **(10)**

   (b) A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which pv=constant. The initial density of air is 1.16 kg/$m^3$. Find the work done by the piston to compress the air. **(10)**

2. (a) Distinguish between specific humidity and relative humidity. Correlate degree of saturation with specific and relative humidity. **(10)**

   (b) Using humidity ratios from the psychometric chart, calculate the error in considering the wet-bulb line to be the line of constant enthalpy at the point of 35°C dry-bulb temperature and 50 percentage relative humidity. **(10)**

## SECTION - B

3. (a) State the First Law of Thermodynamics and prove that for a non-flow process, it leads to the energy equation $Q = \Delta U + W$. **(10)**

   (b) A frictionless piston is used to provide a constant pressure of 400 kPa in a cylinder containing steam originally at 200°C with a volume of $2m^3$. Calculate the final temperature if 3500 kJ of heat is added. **(10)**

4. (a) Derive an expression for the efficiency of the reversible heat engine. **(10)**

   (b) Steam is contained in a rigid container at an initial pressure of 600 kPa and 300°C. The pressure is reduced to 40 kPa by removing energy via heat transfer. Calculate the entropy change and the heat transfer. **(10)**

## SECTION - C

5. (a) Derive the Maxwell relations and explain their importance in thermodynamics. **(10)**

   (b) A certain gas has $C_p$= 1.968 and $C_v$ = 1.507 kJ/kgK. Find its molecular weight and the gas constant. A constant volume chamber of 0.3 $m^3$ capacity contains 2 kg of this gas at 5°C. Heat is transferred to the gas until the temperature is I00°C. Find the work done, the heat transferred, and the changes in internal energy, enthalpy and entropy. **(10)**

6. (a) Differentiate between availability function and Gibb's energy function. **(10)**

   (b) A steel flask of 0.04 $m^3$ capacity is to be used to store nitrogen at 120 bar, 20°C. The flask is to be protected against excessive pressure by a fusible plug which will melt and allow the gas to escape if the temperature rises too high.

(i) How many kg of nitrogen will the flask hold at the designed conditions?

(ii) At what temperature must the fusible plug melt in order to limit the pressure of a full flask to a maximum of 150 bar? **(10)**

## SECTION - D

7. (a) Explain "Air standard analysis" which has been adopted for I.C. engine cycles. State the assumptions made for air standard cycles. **(10)**

(b) 0.5 kg of air (ideal gas) executes a Carnot power cycle having a thermal efficiency of 50 per cent. The heat transfer to the air during the isothermal expansion is 40 kJ. At the beginning of the isothermal expansion the pressure is 7 bar and the volume is 0.12 $m^3$. Determine:

(i) The maximum and minimum temperatures for the cycle in K.

(ii) The volume at the end of isothermal expansion in $m^3$,

(iii) The heat transfer for each of the four processes in kJ.

For air $C_v$ = 0.721 kJ/kg K, and $C_p$ = 1.008 kJ/kg K. **(10)**

8. (a) How do the following two factors influence the performance of a vapour compression refrigeration system?

(i) Section vapour superheat and

(ii) Liquid sub-cooling **(10)**

(b) An R12 refrigeration system works between pressure limits 1.83 bar and 9.63 bar respectively. The heat transfer from the condenser is found to be 80 kJ/min.The refrigerant vapor leaves the evaporator in the saturated state. The condensate leaves the condenser in just saturated state. The refrigerant flow through the system is found to be 0.6 kg/min. Find a) COP, b) capacity of the plant and c) the energy input to the compressor. **(10)**

**[P.T.O.]**

## SECTION - E

9. (i) What are intensive and extensive properties?

(ii) What do you understand by thermodynamic property and thermometric substances?

(iii) How enthalpy is related to the internal energy?

(iv) Define first law of thermodynamics.

(v) What is refrigeration? How does it differ from cooling?

(vi) Comment on the statement: The entropy of the universe tends to be maximum.

(vii) What is mean effective pressure and what is its role in gas power cycles?

(viii) What do you understand by air-standard efficiency?

(ix) Write an expression for 'Atkinson cycle', explaining meaning of each term in it.

(x) How is the COP of a refrigeration system defined?

**(10×2=20)**