[Total No. of Questions - 9] [Total No. of Printed Pages - 4]
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B. Tech 1st Semester Examination

Basic Mechanical Engg. (N.S.)

BE-102

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, selecting one question each from section A, B, C & D. Section E is compulsory. Steam tables and non-programmable scientific calculator may be allowed.

SECTION - A

1. (a) State the Zeroth Law of Thermodynamics. How is mercury in thermometer able to find the temperature of a body using Zeroth Law of Thermodynamics? Differentiate between heat, temperature and internal energy. **(6)**

   (b) What do you mean by steady flow energy equation? Apply this equation to any engineering device and derive equation for it. **(5)**

   (c) A system contains $0.15m^3$ of air at 3.8 bar and 150^oC. A reversible adiabatic expansion takes place till the pressure falls to 1.03 bar. The gas is then heated at constant pressure till enthalpy increases by 60.7 kJ. Determine the total work done.
   If these processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states determine the index of expansion:
   C_p=1 kJ/kg^{o}K and C_v=0.714 kJ/kg^{o}K. **(9)**

2. (a) What is the standard fixed point in thermometry? Why is a gas chosen as the standard thermometric substance? What is the difference between the universal gas constant and a characteristics gas constant? **(6)**

   (b) What do you mean by specific heats? What is the relationship between the two? Explain clearly the difference between a non-flow and a steady flow process. Why only in constant pressure non-flow process, the enthalpy change is equal to heat transfer? **(6)**

(c) A cylinder contains 0.45m^3 of a gas at 1×10^5 N/m^2 and 80°C. The gas is compressed to a volume of 0.13m^3, the final pressure being 5×10^5 N/m^2. Determine

(i) The mass of gas;

(ii) The value of index 'n' for compression;

(iii) The increase in internal energy of the gas;

(iv) The heat received or rejected by the gas during compression.

Take γ = 1.4, R = 294.2 J/kg°C.

SECTION - B

3. (a) Describe the limitations of the first law of Thermodynamics giving examples. What do you mean by 'Entropy' and 'Clausius inequality'? **(6)**

(b) What are the various corollaries of second law of thermodynamics? Explain any two corollaries. **(6)**

(c) Discuss the generation of steam at constant pressure. Show the various processes on temperature-enthalpy diagram.

What is the difference between heat engine, refrigerator and heat pump? **(8)**

4. (a) Give the Clausius and Kelvin-Planck statements of second law of thermodynamics. Discuss the equivalence between the two. **(5)**

(b) Discuss thermodynamics temperature scale with the help of diagrams. Define availability and irreversibility. **(6)**

(c) 3 kg of steam at 18 bar occupy a volume of 0.2550m^3. During a constant volume process the heat rejected is 1320 kJ. Determine (i) final internal energy (ii) find dryness fraction and pressure (iii) change in entropy and (iv) work done. **(9)**

SECTION - C

5. (a) What do you mean by Air standard efficiency? What are various assumptions made for the analysis of all air standard cycles? **(5)**

(b) Compare the Otto, Diesel and Dual cycles for same compression ratios and same heat inputs. **(6)**

(c) An ideal diesel cycle operates on 1 kg of standard air with an initial pressure of 0.98 bar and a temperature of 35ºC. The pressure at the end of the compression is 33 bar and the cut off is 6% of the stroke. Determine (i) the compression ratio (ii) the percentage clearance (iii) the heat supplied (iv) the heat rejected (v) the thermal efficiency and (vi) the mean effective pressure. **(9)**

6. (a) Explain the main difference between a two stroke cycle and four stroke cycle internal combustion engine. Discuss the use of air standard cycle analysis for study of internal combustion engines. **(6)**

(b) Explain Mean effective pressure, Indicated Horse power and Brake power. Under what situation, two stroke cycle engine is preferred to four stroke cycle engine? **(6)**

(c) For air standard diesel cycle the following data is available:

Compression ratio = 16

Heat added/kg = 2500 kJ/kg

Lowest temperature in the cycle = 300ºK

Lowest pressure in the cycle = 1 bar

Calculate:

(i) Pressure and temperature at each point in he cycle.

(ii) Thermal efficiency.

(iii) Mean effective pressure, and

(iv) Power output for the cycle for air flow rate of 0.25 kg/sec.

Assume C_p=1 kJ/kgºK and C_v=0.714 kJ/kgºK **(8)**

SECTION - D

7. (a) Draw psychrometric chart and clearly show various lines representing different psychrometric properties. **(5)**

(b) Define thermal conductivity and explain its significance in heat transfer. What are the mechanisms of heat transfer? How are they distinguished from each other? **(6)**

(c) Explain Newton's law of viscosity and derive its relation. List some occurrences which can be attributed to the physics of surface tension. Why the concept of surface tension is not applied to gases. **(9)**

[P.T.O.]

8. (a) Define the following terms:

(i) Specific humidity (ii) Degree of saturation (iii) Relative Humidity (iv) Absolute Humidity (v) Humid-specific volume (vi) Due bulb temperature. **(6)**

(b) What does Stefan-Boltzman law signify? Derive its relation. **(6)**

(c) What do you mean by buoyancy? How this concept is applied to stability of immersed and floating bodies?

A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm. Both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12 Nm is required to rotate the inner cylinder at 100 rpm, determine the viscosity of the fluid. **(8)**

SECTION - E
(Compulsory Question)

9. Write short answers of the following:

(a) What is the difference between thermal equilibrium and thermodynamic equilibrium?

(b) What do you mean by mechanical equivalent of heat?

(c) Differentiate between engine, heat pump and refrigerator. What is the difference between efficiency and C.O.P.?

(d) An ordinary house hold refrigerator receives electrical work from its surroundings and discharges energy by heat transfer to the surroundings, say the kitchen. Is this in violation of the Kelvin-Planck statement of the second law of thermodynamics? Give reasons.

(e) What do you mean by phase Diagram? Show with the help of a diagram.

(f) Describe the limitations of first law of thermodynamics giving examples.

(g) Name the various processes involved in Carnot, Diesel and Otto cycle.

(h) Enumerate the differences between 2-stroke and 4-stroke engine. (Petrol)

(i) What is the difference between forced convection and free convection? Which is better and why?

(j) Find the kinematic viscosity of a liquid in stokes whose specific gravity is 0.95 and dynamic viscosity is 0.012 poise. **(10×2=20)**