CBCS SCHEME

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18IP33

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic Data hand book and steam table is permitted.***
3. ***Assume missing data suitably.***

Module-1

1 a. Differentiate between :
(i) Microscopic and Macroscopic view point.
(ii) Open system and closed system.
(iii) Intensive and Extensive properties.
(iv) Mechanical and Thermal equilibrium. **(10 Marks)**

b. An Engine cylinder has a piston of Area 0.12 m^2 and contains gas at a pressure of 1.5 MPa. The gas expands according to a process which is represented by a straight line on P-V diagram. The final pressure is 0.15 MPa. Calculate the work done by the gas on the piston if the piston strike is 0.30 m. **(10 Marks)**

OR

2 a. State the definition of work interms of thermodynamics and mechanics. **(08 Marks)**

b. The temperature t on a certain Celsius thermometric scale is given by means of a property through a relation $t = a \ln p + b$ where a and b are constants and p is the property of the fluid. If at the ice point and steam points the values of p are found to be 4 and 20 respectively, what will be the temperature reading corresponding to a reading of p = 16? **(12 Marks)**

Module-2

3 a. Write an expression for displacement work for the following process with P-V diagram:
(i) Constant pressure (ii) Constant volume
(iii) Constant temperature (iv) Polytropic process **(10 Marks)**

b. A fluid is confined in a cylinder by a spring loaded, frictionless 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 cubic metre.
If the fluid changes from an initial state of 170 KPa, 0.03 m^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 the work and heat transfer. **(10 Marks)**

OR

4 a. With a neat sketch, explain the Joules experiment to investigate the equivalence of heat and work. State the first law of thermodynamics for a closed system undergoing a cycle and a change of state. **(10 Marks)**

b. Briefly describe the different modes of energy and prove that energy is a property of the system. **(10 Marks)**

Module-3

5 a. What is a control volume and a control surface? With usual notation derive steady flow energy equation of 1st law of thermodynamics for an open system. **(10 Marks)**

b. What do you understand by Qualitative difference between heat and work? List out any four similarities and differences between work and heat. **(10 Marks)**

OR

6 a. Briefly describe the following:
(i) Kelvin Plank's II law of thermodynamics.
(ii) Clausius second law of thermodynamics.
(iii) Cyclic heat engine.
(iv) Thermal energy reservoirs. **(10 Marks)**

b. Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 KPa pressure and 0.95 m^3/kg volume and leaving at 5 m/s, 700 KPa and 0.19 m^3/kg. The internal energy of the air leaving is 90 KJ/kg greater than that of the air entering. Cooling water in the compressor jocket absorbs heat from the air at the rate of 58 kW:
(i) Compute the rate of shaft work input to the air in kW.
(ii) Find the ratio of the inlet pipe diameter to outlet pipe diameter. **(10 Marks)**

Module-4

7 a. With the help of a P-V and T-S diagrams derive an expression for the air standard efficiency of a diesel cycle. **(10 Marks)**

b. An engine working on the otto cycle is supplied with air at 0.1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100 KJ/kg. Calculate
(i) The maximum pressure and temperature of the cycle.
(ii) The cycle efficiency and
(iii)The mean effective pressure.
(For air $C_P = 1.005$, $C_V = 0.718$ and $R = 0.287$ KJ/kgK) **(10 Marks)**

OR

8 a. With P-V and T-S diagrams compare Otto diesel and dual cycles for,
(i) The same compression ratio and heat rejection.
(ii) The same maximum pressure and temperature, the heat rejection being also the same. **(10 Marks)**

b. With P-V and T-S diagrams derive an expression for thermal efficiency of a constant pressure closed cycle gas turbine in terms of Pressure Ratio (R_P). **(10 Marks)**

Module-5

9 a. A four cylinder petrol engine has a rated output of 52 kW at 2000 rpm. A Morse test is carried out and the brake torque readings are 177, 170, 168 and 174 N-m respectively. For normal running at this speed, the BSFC is 0.25 kg/kw-h and the calorific value of the fuel used is 42500 KJ/kg. Calculate the mechanical and brake thermal efficiency. **(10 Marks)**

b. Express the Vander Waals constant in terms of critical properties. **(10 Marks)**

OR

10 a. Explain the Willian's line method and Morse test for determining the frictional power. **(10 Marks)**

b. 1 kg of propane (C_3H_8) is at a pressure of 7 MPa and a temperature of 150°C. The critical properties of propane are $P_C = 4.26$ MPa, $T_C = 370$ K and $V_C = 0.00454$ m^3/kg compressibility factor = 0.54. Calculate :
(i) The reduced pressure, volume and temperature.
(ii) Specific volume of propane using ideal gas equation. **(10 Marks)**

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