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C23-M–303

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BOARD DIPLOMA EXAMINATION, (C-23)

OCTOBER/NOVEMBER—2024

DME – THIRD SEMESTER EXAMINATION

THERMAL ENGINEERING – I

Time : 3 Hours] [*Total Marks* : 80

PART—A 3×10=30

Instructions : (1) Answer **all** questions.

(2) Each question carries **three** marks.

(3) Answers should be brief and straight to the point and shall not exceed five simple sentences.

1. Classify thermodynamic properties and give two examples each.

2. Write Steady Flow Energy Equation (SFEE) and state each term.

3. Calculate specific heats at constant volume and constant pressure of air, if $R = 0{\cdot}287$ kJ/kg K and $\gamma = 1{\cdot}4$.

4. Write universal gas equation and give units for each term.

5. Represent isentropic process on *p*-V and *T*-S diagrams.

6. During an isobaric process, the volume of the gas increases from $0{\cdot}02\ m^3$ to $0{\cdot}05\ m^3$ while the pressure is 200 kPa. Evaluate work done and state whether it is done by the system or on the system.

7. State the assumptions made in analysis of air standard cycle.

8. Draw *p*-V and *T*-S diagrams for an Otto cycle.

9. Define HCV of fuel and give Dulong's formula for it.

10. Give any three advantages and disadvantages of solid fuels.

PART—B

10×5=50

Instructions : (1) Answer *any* **five** questions.

(2) Each question carries **ten** marks.

(3) Answers should be comprehensive and criterion for valuation is the content but not the length of the answer.

11. In a steady flow system, the working fluid flowing at 5 kg/sec enters the system with a velocity of 300 m/sec and it has a specific enthalpy of 390 kJ/kg. The velocity, enthalpy at exit are 150 m/s and 289 kJ/kg respectively. The fluid loses 5 kJ/kg heat as it passes through the system. Determine the power of system stating whether it is from or to the system.

12. *(a)* State Clausius and Kelvin-Planc statements of second law of thermodynamics and give its applications.

(b) For certain ideal gas, $R = 0{\cdot}287$ kJ/kg K and $\gamma = 1{\cdot}25$. Determine C_P, C_V and molecular weight.

13. Acetylene gas (C_2H_2) is stored in a cylinder of 0·2 m^3 at 50 bar and 300 K. Some of the gas is used for welding, until the pressure in the cylinder reduced to 20 bar, while the temperature remained constant. Evaluate *(i)* the characteristic gas constant of acetylene and *(ii)* mass of the acetylene gas used for welding.

14. A gas initially at 603 K expands until its volume is 5·2 times the initial volume, according to $pv^n = C$. If the initial and final pressures are observed to be 8·5 bar, determine *(i)* index of expansion, *(ii)* work done per kg of gas and *(iii)* heat exchange per kg of gas. Assume $C_v = 0{\cdot}412$ kJ/kg K and $\gamma = 1{\cdot}4$.

15. 1 kg of air is contained in a frictionless piston and cylinder at a pressure of 7 bar and temperature 300 K. It expands 4 times of its original volume. The expansion is assumed to take place at constant pressure. Calculate *(a)* work done, *(b)* heat added and *(c)* change in entropy.
Take $R = 0{\cdot}287$ kJ/kg K and $\gamma = 1{\cdot}4$

16. The highest temperature of a Carnot cycle is 427°C and the cycle has a thermal efficiency of 55%. The volume ratio of the isothermal processes is 3 : 1. Determine for the cycle *(a)* the lowest temperature, *(b)* the volume ratio of the adiabatic process and *(c)* the overall volume ratio. Take $\gamma = 1{\cdot}4$.

17. Explain the working of Junker's gas calorimeter with line diagram.

18. *(a)* A sample of coal has the following composition of mass. Carbon 80%, hydrogen 5%, oxygen 6%, nitrogen 2·5%, sulphur 1·5% and ash 5%. Find its higher calorification value per kg of coal.

(b) In a diesel cycle, the compression ratio is 15, while the cut-off ratio is 2. Evaluate the air standard efficiency of the cycle. Take $\gamma = 1{\cdot}4$.

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