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C20-M–304

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BOARD DIPLOMA EXAMINATION, (C-20)

FEBRUARY/MARCH — 2022

DME - THIRD SEMESTER EXAMINATION

BASIC THERMODYNAMICS

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. Define the following thermodynamic system :

(a) System

(b) boundary

2. State the Second law of thermodynamics.

3. The value of C_p and C_v for a gas are 1.02 kJ/kg-K and 0.72 kJ/kg-K respectively. Find the density of this gas at STP condition.

4. Derive the relationship connecting the two specific heats and characteristic gas constants.

5. Represent the adiabatic process on *P-V* and *T-S* diagram.

6. Derive an expression for work done in a constant temperature process.

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

8. Compare the otto cycle and diesel cycles in terms of *(a)* heat addition and *(b)* compression ration.

9. Define *(a)* LCV and *(b)* HCV related to fuels.

10. What is combustion? Why is excess air used for combustion of fuels?

PART—B

8×5=40

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

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

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

11. *(a)* A system executes a cyclic process during which there are four heat transfers, namely, Q_1 = 20 kJ, Q_2 = –4 kJ, Q_3 = 15 kJ, Q_4 = 4 kJ. At four points work is done three of which are w_1 = 3.6 kJ, w_2 = -2.6 kJ and w_3 = 4 kJ. What is the fourth quantity? State whether work is done by the system or on the system.

(OR)

(b) In a steady flow open system, a fluid flows at the rate of 4 kg/s. It enters the system at a pressure of 600 kN/m^2, a velocity of 220 m/s, internal energy 2200 kJ/kg and specific volume 0.42 m^3/kg. It leads the system at a pressure of 150 kN/m^2, a velocity of 145 m/s, internal energy 1650 kJ/kg and specific volume 1.5 m^3/kg. During its passage through the system, the substance has a loss by heat transfer of 40 kJ/kg to the surroundings. Determine the power of the system, stating whether it is from or to the system. Neglect any change of gravitational potential energy.

12. *(a)* An ideal gas is an expanded from 400 kN/m^2 and 0.04 m^3 to 120 kN/m^2 and 0.1 m^3. The temperature fell down during this process was observed as 1500 C. With the values of C_p and C_v are 1.025 kJ/kg-K and 0.726 kJ/kg-K respectively. Find *(i)* the change in internal energy and *(ii)* the mass of gas.

(OR)

(b) Derive the characteristic gas equation.

13. *(a)* Explain the following processes with examples :

(i) Throttle process

(ii) Free expansion process

(OR)

(b) 1 kg of air is compressed adiabatically so that its pressure increases from 1 bar to 10 bar. The work of 200 kJ is done on the air. Calculate the initial and final temperatures of air. Assume C_v =0.718 kJ/kg-K for air, and ratio of specific heats 1.4.

14. *(a)* In an ideal otto cycle the pressure and temperature at the beginning of isentropic compression is 1 bar and 15 C. The ratio of compression is 8. The heat added is 1008 kJ/kg during constant volume process. Take γ = 1.4; C_v = 0.714 kJ/kg-K, Determine—

(i) Maximum temperature in the cycle

(ii) The air standard efficiency

(iii) The work done per kg of air

(iv) The heat rejected per kg of air

(OR)

(b) Derive an expression for air standard efficiency of diesel cycle in terms of compression ratio and cut-off ratio.

15. *(a)* Explain the working of junkers gas calorimeter with a line diagram and write an expression to find the higher calorific value.

(OR)

(b) The following data were recorded during an experiment conducted to find the calorific values of a sample of coal by using a bomb calorimeter unit : Mass of coal burnt = 1.15 grams; Mass of fuse wire = 0.05 grams; Temperature of water before ignition 18 °C, Final temperature of water = 21.5 °C; Mass of water in the calorimeter = 3 kg; Water equivalent of the calorimeter = 0.6 kg; Calorific value of fuse wire = 6000 kJ/kg;

Determine the higher calorific value of the sample of the coal.

Also find the lower calorific value if the coal contains 4.3% hydrogen by mass. Take specific heat of water as 4.187 kJ/kg-°C and cooling correction = 0.016 °C.

PART—C

10×1=10

Instructions : (1) Answer the following question.

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

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

16. A cylinder contains 180 L of gas at a pressure of 1 bar abs. and temperature of 45 C. If the gas is compressed polytropically to 1/13th of its volume and the pressure is then 20 bar abs Take R = 0.287 kJ/kg-K and r = 1.4. Find—

(a) the mass of the gas

(b) the temperature at the end of compression

(c) the change of internal energy

(d) heat rejection during the compression

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