

7259

BOARD DIPLOMA EXAMINATION, (C-20)  
JUNE/JULY—2022

## DME - THIRD SEMESTER EXAMINATION

## BASIC THERMODYNAMICS

Time : 3 hours ]

[ Total Marks : 80

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**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. State the Kelvin-Plank statement of second law of thermodynamics.
2. Convert the following readings of pressure to  $\text{kN/m}^2$  (a)  $3 \text{ MN/m}^2$  and (b) 5 bar.
3. Define the conditions (a) STP and (b) NTP.
4. State Joule's law and express it in mathematical form.
5. Represent the following processes on  $P$ - $V$  diagram :
  - (a) Constant volume process
  - (b) Isothermal process
  - (c) Adiabatic process
6.  $0.056 \text{ m}^3$  of air at 1.4 bar is compressed isothermally to a volume of  $0.014 \text{ m}^3$ . Determine the work required for compressed.

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7. A Carnot cycle operates between the temperature limits of 300 °C and 40 °C. the heat supplied to the system is 120 kJ. Determine (a) air standard efficiency, (b) work transfer and (c) heat rejected.
  8. Mention two limitations of Carnot cycle.
  9. A sample of coal has the following composition by mass. Carbon 80%, hydrogen 5%, oxygen 6%, nitrogen 2.5%, sulphur 1.5% and ash 5%. Find its lower calorific value per kg of coal.
  10. Compare the gaseous fuels over liquid fuels (a) calorific value, (b) transportation and (c) control of operation.

**PART—B**

8×5=40

**Instructions :** (1) Part—B consists of 5 Units. Answer any one full question from each unit.

(2) Each question carries 8 marks and may have sub questions.

(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 consists of four process 1-2, 2-3, 3-4 and 4-1 during which there are heat transfers and work done as follows. What is the work done during process 4-1?

During process 1-2, 15 kJ of heat is supplied and 5 kJ of work is done by the system.

During process 2-3, 4 kJ of heat is rejected and 3 kJ of work is done by the system.

During process 3-4, 12 kJ of heat is supplied and 8 kJ of work is done by the system.

During process 4-1, 7 kJ of heat is supplied to the system.

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(OR)

(b) In a steady flow open system, a fluid substance flows at the rate of 10 kg/sec. It enters the system at a pressure of 600 kN/m<sup>2</sup>, a velocity of 150 m/sec with internal energy 2000 kJ/kg and specific volume of 1 m<sup>3</sup>/kg. It leaves the system at a pressure of 125 kN/m<sup>2</sup>, a velocity of 100 m/sec with internal energy 1600 kJ/kg and specific volume of 2 m<sup>3</sup>/kg. During its passage through the system, the substance lose heat of 40 kJ/kg to the surroundings. Determine the power of the system stating whether it is from or to the system.

12. (a) An ideal gas is expanded from its initial state of 900 kN/m<sup>2</sup> and 0.12 m<sup>3</sup> to final state of 100 kN/m<sup>2</sup> and 0.48 m<sup>3</sup>. The temperature fell during this process was observed as 160 °C. The values of  $C_p$  and  $C_v$  are 1.025 kJ/kg K and 0.735 kJ/kg K respectively. Find (i) mass of the gas and (ii) the change in internal energy of the gas.

(OR)

(b) 2.5 kg of an ideal gas is expanded from a pressure of 700 kPa and volume 1.5 m<sup>3</sup> to a pressure of 140 kPa and volume of 4.5 m<sup>3</sup>. The decrease in internal energy is 500 kJ. Specific heat at constant volume for the gas is 0.719 kJ/kgK. Determine (i) gas constant and (ii) initial and final temperatures.

13. (a) One kg of air at 1 bar and 27° C compressed polytropically to a pressure of 15 bar and air temperature rises to 227 °C. Determine (i) the polytropic index, (ii) the final volume, (iii) the work of compression and (d) the amount of heat rejection from the air. Assume  $R = 0.287$  kJ/kg.

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(OR)

(b) A vessel of 2.5 m<sup>3</sup> capacity contains one kg-mole of nitrogen at 100 °C. If the gas is cooled 30 °C, calculate the final pressure, change in specific internal energy and specific enthalpy. Take  $\gamma = 1.4$  and one kg-mole nitrogen is 28 kg.

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14. (a) Describe the sequence of operations of Carnot cycle with  $P$ - $V$  and  $T$ - $S$  diagrams.

(OR)

- (b) In a diesel cycle, the pressure and temperature at the compression ratio is 16. The maximum temperature in the cycle is  $2500\text{ }^\circ\text{C}$ .  $C_p = 1.005\text{ kJ/kgK}$ ,  $C_v = 0.718\text{ kJ/kgK}$ ,  $\gamma = 1.4$ . Determine, (i) heat supplied, (ii) net work done per cycle and (iii) air standard efficiency of cycle.

15. (a) Explain the purpose, construction and working of bomb calorimeter with legible sketch.

(OR)

- (b) What is the purpose of analysis of fuel and explain the purpose of (i) ultimate analysis and (ii) proximate analysis of coal.

**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 2 kg of air initially at 120 kPa, and  $27\text{ }^\circ\text{C}$  is compressed adiabatically to a pressure of 1.5 MPa. During this the volume reduced to 1/5th of its original volume. Then heat is added at constant pressure to regain its original volume. Find (i) initial volume, (ii) temperature at the end of compression, (iii) work done in compression process and (iv) heat added during constant pressure. Assume for air,  $R = 0.287\text{ kJ/kg-K}$ ;  $C_p = 1.005\text{ kJ/kg-K}$ ;  $\gamma = 1.4$ .

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