C20-M–304

7259

BOARD DIPLOMA EXAMINATION, (C-20)

JUNE/JULY—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. State the Kelvin-Plank statement of second law of thermodynamics.

2. Convert the following readings of pressure to kN/m^2 *(a)* 3 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 m^3 of air at 1·4 bar is compressed isothermally to a volume of 0·014 m^3. Determine the work required for compressed.

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^2, a velocity of 150 m/sec with internal energy 2000 kJ/kg and specific volume of 1 m^3/kg. It leaves the system at a pressure of 125 kN/m^2, a velocity of 100 m/sec with internal energy 1600 kJ/kg and specific volume of 2 m^3/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^2 and 0·12 m^2 to final state of 100 kN/m^2 and 0·48 m^3. 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^3 to a pressure of 140 kPa and volume of 4·5 m^3. 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^3 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 γ = 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 °C. C_p = 1·005 kJ/kgK, C_v = 0·718 kJ/kgK, γ = 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 °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 kJ/kg-K; C_p = 1·005 kJ/kg-K; γ = 1·4.

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