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C20-M–304

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BOARD DIPLOMA EXAMINATION, (C-20)

OCTOBER/NOVEMBER—2023

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. Write any three limitations of the first law of thermodynamics.

2. Heat is supplied to a heat engine at the rate of 55 kJ/s is giving an output of 15.4 kW. Calculate the thermal efficiency of the engine and the rate at which heat is rejected.

3. Determine the characteristic gas constant of N_2 gas if one kg mole of N_2 occupies 22.4 m^3 at NTP.

4. State Avogadro's law.

5. Write the mathematical expression for change in entropy and mention various terms for *(a)* constant volume process and *(b)* adiabatic process.

6. Draw the p-V diagram for *(a)* polytropic process, *(b)* constant pressure process and *(c)* constant volume process.

7. Define air standard efficiency. State any two assumptions made in the analysis of air standard cycles.

8. A researcher claims that his engine, working between the temperature limits 1310 °C and 320 °C, has an efficiency of 85%. State whether his claim is correct or not. What is the reason behind your answer?

9. Define calorific value of fuel.

10. Find the HCV of a fuel whose composition by mass is C-75%, H_2-5%, O_2-8%, N_2-4%, S-2% and Ash-6%.

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 undergoes a cycle composed of four processes and energy transfers are tabulated below.

Process	Q (kJ/min)	W kJ/min	ΔU (kJ/min)
1-2	550	230	?
2-3	230	?	380
3-4	-500	?	?
4-1	0	70	?

Complete the given table and determine the rate of work in kW. 8

(OR)

(b) *(i)* Write any three corollaries of second law of thermodynamics. 3

(ii) Draw the diagrams for a refrigerator and a heat pump. What are the differences between these two? 3+2

12. *(a)* Derive the relation between C_P, C_V and R. 8

(OR)

(b) A tank of 0.525 m^3 capacity contains air at a pressure of 0.35 bar absolute and a temperature of 363 K. What will be the mass of air that must be pumped into the tank, without changing the temperature, to increase the pressure to 100 kN/m^2 absolute. Assume R = 0.287 kJ/Kg K. 8

13. *(a)* One kg of CO_2 is contained in a frictionless piston-cylinder system and during a reversible isothermal process 26.4 kJ of energy is transferred out of the system. If the initial conditions of CO_2 are 1.4 bar and 32 °C, calculate the work and final pressure. 8

(OR)

(b) 0.12 m^3 of an ideal gas, initially at a pressure of 12 bar and temperature 200 °C, expands adiabatically to a pressure of 2.4 bar. Calculate *(i)* the final temperature and *(ii)* the work done if the adiabatic index for the gas is 1.4. 8

14. *(a)* Derive the formula for air standard efficiency of Otto cycle with the help of p-V and T-s diagrams. 8

(OR)

(b) At the beginning of compression of an ideal diesel cycle, the gas has a temperature and pressure of 40 °C and 90 kN/m^2 respectively. The compression ratio is 16 : 1. The maximum temperature of the cycle is 1400 °C. Determine *(i)* the pressure and temperature at each of the cycle process change points, *(ii)* the work done per kg of gas and *(iii)* the thermal efficiency. Take γ = 1.4, C_P = 1.004 kJ/kg K. 8

15. *(a)* Explain the procedure for the determination of calorific value using a bomb calorimeter. 8

(OR)

(b) How do you classify the fuels? What are the desired characteristics of fuels? 3+5

PART—C

10×1=10

Instructions : (1) Answer the following question.

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

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

16. 0.28 m^3 of air at 102 kN/m^2 and 27 °C is compressed to one tenth of the original volume according to the law $pV^{1.26}$ = Constant. Heat is then added at constant volume until the pressure is 5600 kN/m^2. Calculate the overall change of entropy. Assume C_P = 1.005 kJ/kg K, C_V = 0.717 kJ/kg K.

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