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C09–M–305

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BOARD DIPLOMA EXAMINATION, (C–09)

MARCH/APRIL—2018

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. *(a)* Convert 100 °C into absolute units. 1½

(b) Convert 575 K into centigrade units. 1½

2. An ideal gas has a mass of 2 kg and occupies $3m^3$ at a temperature of 30 °C and a pressure of 300 kN/m^2. Determine the gas constant. 2+1

3. A constant volume chamber of 0·4 m^3 capacity contains 2 kg of a gas at 10 °C. Heat is transferred to the gas until the temperature is 100 °C. Calculate the initial pressure of gas. Take, C_p 1 973 kJ/kg °K and C_v 0 1511 kJ/kg °K. 2+1

4. A constant volume chamber of 0·4 m^3 capacity contains 2 kg of a gas at 10 °C. Heat is transferred to the gas until the temperature is 100 °C. Determine the change in entropy. Take, C_p 1 973 kJ/kg °K and C_v 0 1511 kJ/kg °K. 2+1

5. Write Dulong's formula for HCV. Explain the significance of '144000' in the formula. 1½+1½

6. Write Dulong's formula for HCV. What is the significance of '9270' in the formula? 1½+1½

7. Determine the efficiency of an engine working on the Carnot cycle. If heat is absorbed at 540 °C and rejected at 45 °C. 2+1

8. Determine the specific entropy of superheated steam at 12 bar and 310 °C. 2+1

9. The specific volume of steam at 9 bar pressure is recorded as 0·1659 m^3/kg. Determine the quality of the steam. 2+1

10. A refrigeration system requires 1·5 kW per ton of refrigeration. Calculate the COP of the system. 2+1

PART—B

10×5=50

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

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

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

11. A system executes a cyclic process as follows :

At point 1, 20 kJ of heat is supplied and 3 kJ of work done by the system. At point 2, 2 kJ of heat is rejected and 5 kJ of work is done by the system. At point 3, 15 kJ of heat is supplied and 9 kJ of work is done by the system. At point 4, 5 kJ of heat is supplied to the system.

Calculate what is the work done at the fourth point. 6+4

12. The values of specific heats at constant volume and constant pressure of an ideal gas are 0·73 kJ/kg °K and 0·98 kJ/kg °K respectively. If 1 kg of this fuel is heated at constant pressure from 30 °C to 250 °C, calculate *(a)* the heat added, *(b)* ideal work done and *(c)* change in internal energy. 4+3+3

13. 2 kg of air at 9 bar and 327 °C expands adiabatically to a pressure of 1 bar. Determine *(a)* the final volume, *(b)* final temperature, *(c)* work energy transferred during the process, *(d)* change in internal energy and *(e)* change in enthalpy. 2+3+3+2

14. The following is the percentage composition of a sample of coal on mass basis :

C–82; H_2–6; O_2–9; and Ash–3

Determine—

(a) the minimum mass of air required for complete combustion of coal;

(b) the volumetric analysis of the products of combustion if 10% excess air is supplied.

Assume that air contains 23% oxygen on mass basis.

15. An engine working on diesel cycel has compression ratio of 12 : 1 and expansion ratio of 8 : 1. The pressure and temperature at the beginning of compression are 2 bar and 45 °C respectively. Pressure before the heat rejection is 3·5 bar. Determine *(a)* air standard efficiency of the cycle and *(b)* maximum temperature and pressure attained in the cycle. Assume 1 4.

16. Steam at 28 bar enters boiler carrying 5% moisture. After passing through the superheater, its temperature raised to 350 °C at the same pressure. Determine the *(a)* change in enthalpy and *(b)* change in specific volume.

17. *(a)* A steel cylinder of 50 litre capacity contains carbon dioxide at 20 °C and at a pressure of 100 bar. Calculate *(a)* mass of gas and *(b)* the mole volume. Take, R_u 8 314 kJ/kg °K. 5

(b) An engineer claims his engine to develop 3·5 kW. On testing the engine consumes 0·5 kg of fuel/hour having a calorific value of 40000 kJ/kg. The maximum temperature recorded in the cycle is 1200 °C and the minimum is 325 °C. Find whether the engineer's claim is justified. 5

18. *(a)* A cold storage is supplied with 5000 kg fish at 25 °C for preserving the fish. The temperature is to be maintained at –8 °C in 10 hours.

Freezing point of fish –3 °C

Specific heat above freezing point 3 kJ/kg °K

Specific heat below freezing point 1·25 kJ/kg °K

Latent heat of freezing of fish 2200 kJ/kg

Find the capacity of the plant. 5

(b) The capacity of a refrigerator is 150 TR. Determine the quantity of ice produced at –3 °C within 24 hours when water is supplied at a temperature of 15 °C. Take specific heat of ice 2 1 kJ/kg °K. 5

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