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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. Distinguish between intensive and extensive properties, giving at least one example for each.

2. Derive the characteristic gas equation of a perfect gas.

3. An air reservoir of volume 4·25 m^3 contains air at 650 kPa and 120 °C. The air is cooled to 40 °C. Determine the final pressure of the air.

4. Describe briefly the concept of entropy.

5. List out any three merits of liquid fuels over solid fuels.

6. What do you understand by minimum air and excess air in the context of combustion?

7. Define cut-off ratio. Draw *p-V* diagram for Diesel cycle and mark the cut-off point on the diagram.

8. Show the following processes on Mollier chart :

(a) Isentropic process

(b) Throttling process

9. Derive an expression for entropy of superheated steam.

10. State the differences between refrigerator and heat pump.

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)* Write the difference between non-flow and steady-flow processes. 3

(b) In a steady-flow system, the working fluid flowing at 4 kg/s enters the system with a velocity of 300 m/s and it has a specific enthalpy of 390 kJ/kg. The velocity and enthalpy at exit are 150 m/s and 289 kJ/kg respectively. The fluid loses 4 kJ/kg heat as it passes through the system. Neglecting potential energy, determine the power of system stating whether it is from or to the system. 7

12. *(a)* A mass of air has an initial pressure of 1·3 MN/m^2, volume 0·014 m^3 and temperature 135 °C. It is expanded until its final pressure is 275 kN/m^2 and its volume becomes 0 056 m^3. Determine *(i)* the mass of air and *(ii)* the final temperature of air. Take R 0 287 kJ/kgK.

(b) Derive an expression for air standard efficiency of Otto cycle in terms of compression ratio.

13. A cylinder contains 180 litre of gas at a pressure of 1 bar abs and temperature of 45 °C. If the gas is compressed polytropically to 1/10th of its volume and the pressure is then 20 bar, find *(a)* the mass of the gas, *(b)* temperature at the end of compression, *(c)* index of compression, *(d)* the change of internal energy and *(e)* heat transferred during the compression process. Assume ratio of specific heats = 1·4 and R 0 287 kJ/kgK.

14. 0·5 kg of gas at 3·5 bar abs and 30 °C is heated at constant volume until its pressure is 20 bar abs. The gas is then expanded isothermally until its volume is 1 m^3. Determine the change of entropy for the whole system. Assume C_p 1 05 kJ/kgK and C_v 0 755 kJ/kgK.

15. 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. Find the volumetric analysis of the products of combustion, if 10% excess air is supplied. Assume the air contains 23% oxygen on mass basis.

16. *(a)* Describe briefly a reversible cycle. State the conditions for reversible cycle.

(b) Calculate the volume expansion ratios for the isothermal and isentropic processes of a Carnot cycle operating between source and sink temperatures of 400 °C and 15 °C respectively. If the overall volume expansion ratio is 20.

17. A cylinder contains 0·03 m^3 of steam at 16 bar and 0·8 dry. The steam expands hyperbolically until the volume becomes 0 24 m^3. Calculate *(a)* the final pressure, *(b)* final dryness fraction, *(c)* work done and *(d)* the heat energy transferred.

18. A refrigerator system operates on the reversed Carnot cycle between temperature limits of 30 °C and 10 °C. The capacity is to be 10 tons. Find *(a)* COP, *(b)* heat rejected from the system per min and *(c)* power rating of the compressor motor if the overall electromechanical efficiency is 0·9.

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