Code : 021407

B.Tech 4th Semester Exam., 2018

THERMODYNAMICS

Time : 3 hours

Full Marks : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are* ***NINE*** *questions in this paper.*

(iii) *Attempt* ***FIVE*** *questions in all.*

(iv) *Question No.* ***1*** *is compulsory.*

1. Choose the correct answer (any *seven*) : $2 \times 7 = 14$

(a) In an open thermodynamic system

(i) mass content of the system under consideration remains same

(ii) transfer of mass and/or energy takes place

(iii) there is only mass transfer even though there may not be any exchange of energy with the system environment

(iv) the system exchanges energy with the surroundings in the form of heat energy only

(Turn Over)

(b) Zeroth law of thermodynamics forms the basis of ____ measurement.

(i) pressure

(ii) temperature

(iii) heat

(iv) work

(c) The cyclic integral of $(\delta Q - \delta W)$ for a process is

(i) zero

(ii) positive

(iii) negative

(iv) unpredictable

(d) Which one of the following parameters remains constant in a throttling process?

(i) Pressure

(ii) Temperature

(iii) Enthalpy

(iv) Entropy

(e) The thermal efficiency of a Carnot engine is 30%. If the engine is reversed in operation to work as a heat pump (with no change in operating conditions), then what will be the COP of the heat pump?

(i) 0·3

(ii) 2·33

(Continued)

(iii) 3·33

(iv) Cannot be calculated

(f) A radiation shield should

(i) have high transmissivity

(ii) absorb all the radiations

(iii) have high reflective power

(iv) partly absorb and partly transmit the incident radiation

(g) Which of the following expressions is true for Tds?

(i) $dh - vdp$

(ii) $dh + vdp$

(iii) $dh - pdv$

(iv) $dh + pdv$

(h) With increase in saturation pressure of water vapour

(i) the saturation temperature decreases

(ii) the enthalpy of evaporation decreases

(iii) the enthalpy of evaporation increases

(iv) the specific volume of phase change increases

(Turn Over)

(i) Which of the following processes is not associated with diesel cycle?

(i) Constant volume

(ii) Constant pressure

(iii) Isothermal

(iv) Adiabatic

(j) A refrigerator based on reversed Carnot cycle works between two such temperatures that the ratio between the lowest and highest temperature is 0·8. If a heat pump is operated between same temperature range, then what would be its COP?

(i) 5 (ii) 2

(iii) 3 (iv) 4

2. (a) What is the difference between a closed system and an open system?

(b) Distinguish between the terms 'path function' and 'point function'.

(c) A mass of 8 kg gas expands within a flexible container so that the $p-v$ relationship is of the form $pv^{1\cdot 2}$ = constant. The initial pressure is 1000 kPa and the initial volume is $1 m^3$. The final pressure is 5 kPa. If specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction. 2+4+8=14

(Continued)

3. *(a)* Write the steady flow energy equation for a single-stream entering and a single-stream leaving a control volume and explain the various terms in it.

(b) Air at a temperature of 15 °C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800 °C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650 °C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500 °C. If the air flow rate is 2 kg/s, calculate *(i)* the rate of heat transfer to the air in the heat exchanger, *(ii)* the power output from the turbine assuming no heat loss, and *(iii)* the velocity at exit from the nozzle, assuming no heat loss. 4+10=14

4. *(a)* What are PMM1 and PMM2? Why are they impossible?

(b) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4·4 °C. If the work output of A is twice that of B,

(Turn Over)

find *(i)* the intermediate temperature between A and B, *(ii)* the efficiency of each engine, and *(iii)* the heat rejected to the cold sink. 4+10=14

5. *(a)* Show that heat transfer through a finite temperature difference is irreversible.

(b) Show that the efficiency of a reversible engine operating between two given constant temperatures is the maximum.

(c) A cyclic heat engine operates between a source temperature of 800 °C and a sink temperature of 30 °C, what is the least rate of heat rejection per kW net output of the engine? 5+5+4=14

6. *(a)* "Two reversible adiabatic paths cannot intersect each other", True or False. Justify with proper explanation.

(b) A fluid undergoes a reversible adiabatic compression from 0·5 MPa, $0 \cdot 2\,m^3$ to $0 \cdot 05\,m^3$ according to the law, $pv^{1 \cdot 3}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process. 4+10=14

Continued

7. (a) What are available energy and unavailable energy?

(b) What do you understand by the degree of superheat and degree of subcooling?

(c) Steam initially at 1·5 MPa, 300 °C expands reversibly and adiabatically in a steam turbine to 40 °C. Determine the ideal work output of the turbine per kg of steam. 4+4+6=14

8. (a) What is an air standard cycle? Why are such cycles conceived?

(b) State the four processes of the Diesel cycle.

(c) Derive the efficiency of the Otto cycle and show that it depends only on the compression ratio. 4+2+8=14

9. (a) With the help of $p-v$ and $T-s$ diagrams, show that for the same maximum pressure and temperature of the cycle and the same heat rejection,

$$\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$$

(Turn Over)

(b) In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15 °C and the pressure is 0·1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480 °C. Calculate (i) the cit-off ratio, (ii) the heat supplied per kg of air, (iii) the cycle efficiency, and (iv) the mean effective pressure. 6+8=14

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