CBCS SCHEME

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15MT72

# Seventh Semester B.E Degree Examination, Feb./Mar.2022
## Thermal Engineering

Time: 3 hrs. Max. Marks: 80

***Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.***
***2. Use of heat transfer data book and thermodynamics data book are permitted.***



### Module-1

1 a. Define : (i) Intensive property (ii) Extensive property (iii) State postulate (iv) Quasi static process (v) Zeroth law of thermodynamics (vi) Thermodynamic equilibrium. **(12 Marks)**

b. Distinguish between microscopic and macroscopic approaches of thermodynamics. **(04 Marks)**

**OR**

2 a. Describe thermodynamic definition of work. **(06 Marks)**

b. Explain path function and point function. **(06 Marks)**

c. The piston of an oil engine, of area 0.0045 $m^2$, moves downwards 75 mm, drawing in 0.00028 $m^3$ of fresh air from the atmosphere. The pressure in the cylinder is uniform during the process at 80 KPa, while the atmospheric pressure is 101.325 KPa the difference being due to the flow resistance in the induction pipe and the inlet value. Estimate the displacement work done by the air finally in the cylinder. **(04 Marks)**

### Module-2

3 a. Define : (i) Pure substance (ii) Specific heat at constant volume (iii) Enthalpy and (iv) Specific heat at constant pressure. **(08 Marks)**

b. A stationary mass of gas is compressed without friction from an initial state of 0.3 $m^3$ and 0.105 MPa, the pressure remaining constant during the process. There is a heat transfer of 37.6 KJ from the gas during the process. How much does the internal energy of the gas change? **(08 Marks)**

**OR**

4 a. Define : (i) Kelvin – Planck's second law (ii) Clausius statement of second law of thermodynamics (iii) Coefficient of Performance (COP) (iv) Reversible process (v) Carnot's theorem (vi) Free expansion. **(06 Marks)**

b. Explain equivalence of Kelvin-Planks and Clausius statement of second law of thermodynamics. **(05 Marks)**

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? **(05 Marks)**

### Module-3

5 a. Derive an expression for efficiency of Carnot cycle. **(06 Marks)**

b. Give comparison of Otto, Diesel and dual cycles. **(04 Marks)**

c. An engine working on the otto cycle is supplied with air at 0.1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100 KJ/kg. Calculate maximum temperature and efficiency of the cycle. (For air, $C_p$ = 1.005, $C_V$ = 0.718 and R = 0.287 kJ/kg K) **(06 Marks)**

**OR**

6 a. Explain modes of heat transfer. **(08 Marks)**

b. The roof of an electrically heated home is 6 m long, 8 m wide, and 0.25 m thick, and is made of a flat layer of concrete whose thermal conductivity is K = 0.8 W/m°C. The temperatures of the inner and the outer surfaces of the roof one night are measured to be 15°C and 4°C respectively, for a period of 10 hours. Determine (i) The rate of heat loss through the roof that night and (ii) The cost of that heat loss to the home owner if the cost of electricity is Rs.0.08 /kwh. **(08 Marks)**

## Module-4

7 a. Derive general three dimensional conduction equation in Cartesian coordinate. **(08 Marks)**

b. Consider a 3 m high, 5 m wide and 0.3 m thick wall whose thermal conductivity is K = 0.9 W/m°C. On a certain day, the temperatures of the inner and outer surfaces of the wall are measured to be 16°C and 2 °C respectively. Determine the rate of heat loss through the wall on that day. **(04 Marks)**

c. Explain thermal boundary conditions. **(04 Marks)**

**OR**

8 The heat transfer co-efficient depends upon the buoyancy force per unit mass ($g\beta\theta$), density ($\rho$), Vertical height (L), Viscosity ($\mu$), thermal conductivity (K) and Specific heat ($C_P$). Thus derive $Nu = B \times G_r^a \times P_r^b$ through dimensional analysis. **(16 Marks)**

## Module-5

9 Explain physical significance of following dimensionless numbers :
(i) Reynold's number (ii) Prandtl number
(iii) Nusselt number (iv) Stanton number. **(16 Marks)**

**OR**

10 Explain following laws of radiation:
(i) Stefan Boltzman law.
(ii) Kircoff's law
(iii) Planck's law
(iv) Weins displacement law **(16 Marks)**

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