CBCS SCHEME

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18MT72

# Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
## Thermal Engineering

Time: 3 hrs. Max. Marks: 100

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



### Module-1

1 a. Define following with respect to thermodynamics :
i) Closed system ii) Open system iii) Adiabatic process
iv) Diathermic wall v) property. **(10 Marks)**

b. Distinguish between microscopic and macroscopic approaches of thermodynamics. **(10 Marks)**

**OR**

2 a. Write thermodynamic definition of work. Explain displacement work in brief. **(10 Marks)**

b. Obtain an expression for displacement work done by polytrophic process writing P-V diagram. **(10 Marks)**

### Module-2

3 a. Define first law of thermodynamics. Explain Joules experiment with suitable diagram. **(12 Marks)**

b. Show that energy is a property of a system. **(08 Marks)**

**OR**

4 a. Explain the equivalence between Kelvin – Planck statement and clauses statement of second law of thermodynamics. **(10 Marks)**

b. Define : i) Thermal reservoir ii) Heat engine iii) PMM1
iv) PMM2 v) Carnot principles. **(10 Marks)**

### Module-3

5 a. Derive an expression for efficiency of the air standard otto cycle. **(12 Marks)**

b. A diesel engine has a compression ratio of 14 and cut off takes place at 6% of the stroke. Find the air standard efficiency. **(08 Marks)**

**OR**

6 a. Explain different modes of heat transfer with suitable governing equation and examples. **(10 Marks)**

b. A 2m long, 0.3cm diameter electrical wire extends across a room at 15°C. Heat is generated in the wire as a result of resistance heating and the surface temperature of the wire is measured to be 152°C in steady operation. Also, the voltage drop electric current through the wire are measured to be 60V and 1.5A, respectively. Disregarding any heat transfer by radiation, determine the convection heat transfer co-efficient for heat transfer between the outer surface of the wire and the air in the room. **(10 Marks)**

### Module-4

7 a. Derive general three dimensional conduction equation in Cartesian coordinate system. **(10 Marks)**

b. Explain the concept of thermal contact resistance. **(10 Marks)**

**OR**

8 a. Explain the physical significance of following dimension less numbers :
i) Reynolds number
ii) Prandtl number
iii) Grashof number
iv) Biot number **(10 Marks)**

b. The maximum allowable surface temperature of an electrically heated vertical plate 15cm high and 10cm wide is 140°C. Estimate the maximum rate of heat dissipation from both sides of the plate in an atmosphere at 20°C. The radiation heat transfer coefficient is 8.72 $W/m^2K$. For air at 80°C take $\gamma = 21.09 \times 10^{-6} m^2/s$, $P_r = 0.692$, and $K = 0.03 W/mK$. **(10 Marks)**

## Module-5

9 a. Apply dimensional analysis to forced convection heat transfer to obtain a relation $N_u = B\ R_e^{\ a}\ P_r^{\ b}$ (symbols with their usual notation). **(12 Marks)**

b. Given : nitrogen gas at 0°C is flowing ones a 1.2m long, 2m wide plate maintained at 80°C with a velocity of 2.5m/s. for nitrogen, $\rho = 1.142\ K_g/m^3$, $C_P = 1.04 kJ/kg\ K$, $\gamma = 15.63 \times 10^{-6} m^2/s$, and $K = 0.0262 W/mK$. Find :
i) The average heat transfer co-efficient
ii) The total heat transfer from the plate. **(08 Marks)**

**OR**

10 a. State and explain following radiation laws :
i) Plank's law
ii) Wien's displacement law
iii) Stefen – Bottzmann law
iv) Kirchhoff's law. **(10 Marks)**

b. Define :
i) Irradiation
ii) Thermal radiation
iii) Radiation intensity
iv) Black body radiation
v) Emissive power. **(10 Marks)**

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