CBCS SCHEME

USN | | | | | | | | | | |

18RA72

Seventh Semester B.Tech. 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 Heat and Mass transfer data hand book is permitted.

Module-1

1 a. Define Thermodynamic system, differentiate between open, closed and isolated system. **(10 Marks)**

b. Define the following:
i) Mechanical equilibrium
ii) Thermal equilibrium
iii) Chemical equilibrium
iv) Cyclic process
v) Non-cyclic process. **(10 Marks)**

OR

2 a. Compare heat and work. **(06 Marks)**

b. Derive an expression for work in polytropic process. **(06 Marks)**

c. A spherical balloon of 1m diameter contains a gas at 250kpa and 300k. The gas inside the balloon is heated until the pressure reaches to 500kpa. During the process of heating, the pressure of gas inside the balloon is proportional to the diameter of the balloon. Calculate the work done by the gas inside the balloon. **(08 Marks)**

Module-2

3 a. Derive steady flow energy equation for a single stream of fluid entering and single stream of fluid leaving the control volume. **(10 Marks)**

b. A steam turbine operating under steady flow conditions receives 4500kg of steam per hour. The steam enters the turbine at a velocity of 42m/s at the elevation of 4m and specific enthalpy of 2800kJ/kg. It leaves the turbine at a velocity of 9.4m/s at an elevation of 1m one specific enthalpy of 2262kJ/kg. The heat losses from the turbine to the surroundings amounts to 16780kJ/hr. Determine the power output of the machine. **(10 Marks)**

OR

4 a. Define the two statements of second law thermodynamics. Show that violation of Clausius statement leads to violation of Kelvin-Planck statement. **(10 Marks)**

b. A reversible heat engine receives heat from a mixture of water vapour and liquid water under a pressure of 1.013 bar and rejects 50kJ of heat per second to a mixture of ice and liquid water at 0.00602 bar pressure. Determine the power delivered by the engine. **(10 Marks)**

Module-3

5 a. Derive an expression of air standard efficiency of otto cycle with neat sketch of P-V and T-S diagrams. **(10 Marks)**

b. The compression ratio of a diesel cycle is 14 and cutoff ratio is 2.2. At the beginning of the cycle, air is at 0.98 bar and 100°C. Find: i) Temperature and pressure at salient points ii) Air standard efficiency. **(10 Marks)**

OR

6 a. Define the following: i) Conduction ii) Convection iii) Radiation iv) Thermal conductivity v) Heat transfer coefficient. **(10 Marks)**

b. Explain the three types of boundary conditions used in conduction heat transfer. **(06 Marks)**

c. The heat flow rate through a 4cm thick wood board for a temperature difference of 25°C between the inner-outer surfaces is $75W/m^2$. What is the thermal conductivity of wood? **(04 Marks)**

Module-4

7 a. State the assumptions and derive general 3-dimensional heat conduction equation in Cartesian co-ordinates. **(10 Marks)**

b. What is the thickness required of a masonry wall having thermal conductivity of 0.75W/mk if the heat transfer rate is to be 80% of the heat transfer rate through a composite structural wall having a thermal conductivity of 0.25W/mk and a thickness of 100mm, both walls are subjected to the same surface temperature. **(10 Marks)**

OR

8 a. Obtain the fundamental relationship between Nusselt, Prandtl and Grashof numbers using Buckingham II-theorem. **(10 Marks)**

b. A hot square plate 50cm × 50cm at 100°C is exposed to atmosphere air at 20°C. Find the heat loss from both surfaces of the plate if i) Plate is kept vertical ii) Plate is kept horizontal. Use the following relation

$Nu = 0.13[Gr\ Pr]^{1/3}$ for vertical position

$Nu = 0.71\ [Gr\ Pr]^{1/4}$ for upper surface

$Nu = 0.35\ [Gr\ Pr]^{1/4}$ for lower surface. **(10 Marks)**

Module-5

9 a. Define the following:

i) Reynolds number
ii) Prandtl number
iii) Nusselt number
iv) Stanton number
v) Grashof number. **(10 Marks)**

b. Using dimensional analysis, obtain fundamental relation between dimensionless parameters in forced convection. **(10 Marks)**

OR

10 a. State and explain the following laws relating to thermal radiation:

i) Stefan-Boltzman law
ii) Kirchoffs law
iii) Planck's law
iv) Wein displacement law. **(12 Marks)**

b. Two parallel plates are at temperature T_1 and T_2 having emissivities $\in_1 = 0.9$ and $\in_2 = 0.6$. If the radiation shield having some emissivity $\in_3$ is applied on both sides of the surfaces between the plates, calculate the emissivity $\in_3$ of the shield to reduce the radiation loss from the system to one fifteenth of that without shield. **(08 Marks)**

* * * * *