# CBCS SCHEME

USN | | | | | | | | | | |  **18MT72**



## Seventh Semester B.E. Degree Examination, June/July 2024
## Thermal Engineering

Time: 3 hrs. Max. Marks: 100

***Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.***
***2. T.D. Handbook permitted.***



### Module-1

1 a. Define the following: i) System ii) Surroundings iii) Boundary iv) Universe. **(06 Marks)**

b. Distinguish between Micro scopic and Maco scopic approach. **(06 Marks)**

c. Explain with neat sketch quasi static process with example. **(08 Marks)**

**OR**

2 a. Define work and heat. **(04 Marks)**

b. Explain the following work transfer: i) Shaft work ii) Electrical work iii) Stretching of a wire. **(08 Marks)**

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

### Module-2

3 a. State that $1^{st}$ law of thermodynamics for cyclic process and show that internal energy is a property of a system. **(10 Marks)**

b. Derive the expression in heat trans per unit mass for reversible polytropic process taking place in closed system. **(10 Marks)**

**OR**

4 a. Define the following: i) Thermal reservoir ii) Source iii) Sink iv) Heat engine v) Heat pump. **(05 Marks)**

b. Prove that (COP) heat pump = 1 + (COP) refrigerator. **(05 Marks)**

c. A reversible heat engine operates between two reservoirs at 820°C and 27°C. Engine drives a reversible refrigerator which operates between reservoirs at temperatures of 27°C and -15°C. The heat transfer to the engine is 200kJ and the network available for the combined cycle is 300kJ.

i) How much heat is transferred to the refrigerator and also determine the total heat rejected to the reservoir at 27°C.

ii) If the efficiency of heat engine and COP of refrigerator are each 40% of their maximum values. Determine heat transferred to refrigerant and total heat rejected. **(10 Marks)**

### Module-3

5 a. With P-V and T-S diagram explain stirling cycle and expression for its efficiency. **(10 Marks)**

b. Compare among OHO, Diesel and dual cycle. **(10 Marks)**

**OR**

6 a. Define heat transfer and explain different modes of heat transfer. **(10 Marks)**

b. A surface having an area of $1.5m^2$ and maintained at 300°C exchanges heat by radiation with another surface at 40°C. The value of factor due to the geometric location and emissivity is 0.52. Determine: i) Heat lost by radiation ii) The value of thermal resistance iii) The value of equivalent convection coefficient. Take $\sigma = 6.67 \times 10^{-8} W/m^2\text{-}k^4$. **(10 Marks)**

## Module-4

7 a. Derive general 3-D heat conduction equation in Cartesian coordinate. **(10 Marks)**

b. A reactors wall 320mm thick is made up of an inner layer of fire brick [K = 0.84 W/m°C] covered with a layer of insulation [K = 0.16W/m°C]. The reactor operates at a temperature of 1325°C and the ambient temperature is 25°C as shown in Fig.Q.7(b).

i) Determine the thickness of fire brick and insulation which gives minimum heat loss.

ii) Calculate the heat loss presuming that the insulating material has a maximum temperature of 1200°C. **(10 Marks)**

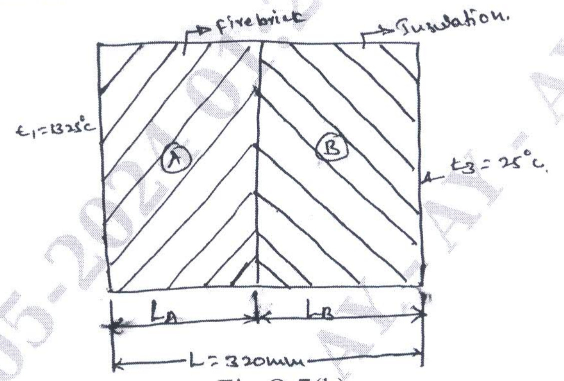


Fig.Q.7(b)

**OR**

8 a. Explain the following: i) Natural convection ii) Local heat transfer coefficient iii) Grasshoff number iv) Nusselt number v) Drag coefficient. **(10 Marks)**

b. Using dimensional analysis for free convection heat transfer S.T $Nu = c[G_r^n . P_r^n]$ with usual notations. **(10 Marks)**

## Module-5

9 a. Explain the physical significance of following:

i) Reynolds number

ii) Prandtl number

iii) Nusselt number

iv) Stanton number. **(10 Marks)**

b. Calculate the approximate Reynolds number and state of the flow is laminar (or) turbulent for the following:

i) A 10m long yatch sailing at 13kmph in sea water $\int = 1000 kg/m^3$ and $\mu = 1.3 \times 10^{-3}$kg/m.s.

ii) A compressor disc of radius 0.3m rotating at 1500rpm in air at 5 bar and 400°C, take $\mu = \frac{1.46 \times 10^{-6} T^2}{110 + 7}$ kg/m.s. **(10 Marks)**

**OR**

10 a. State and explain the following:

i) Planks law

ii) Wein's displacement law

iii) Stefen-Boltman law

iv) Kirchoff's law. **(10 Marks)**

b. Air at 20°C flows over a thin plate with a velocity of 3m/s, the plate is 2m long and 1m wide. Estimate the boundary layer thickness at the trailing edge of the plate and the total drag force experienced by the plate. **(10 Marks)**

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