CBCS SCHEME

USN | | | | | | | | | | 15MT72

Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020
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 thermodynamic/heat transfer data books is permitted.*

Module-1

1 a. Distinguish between followings:
   i) Microscopic and macroscopic approaches
   ii) Closed system and open system
   iii) Intensive and extensive properties
   iv) Process and cycle **(12 Marks)**
  b. Explain thermodynamic equilibrium in detail. **(04 Marks)**

OR

2 a. Define thermodynamic work. Explain displacement work with an example. **(04 Marks)**
  b. Describe following types of work transfer:
   (i) Electrical work (ii) Shaft work
   (iii) Stirring work (iv) Flow work **(12 Marks)**

Module-2

3 a. Define: (i) First law of thermodynamics (ii) Pure substance (iii) Two property rule (iv) Specific heat at constant volume (v) Enthalpy (vi) Specific heat at constant pressure. **(12 Marks)**
  b. Gas from a bottle of compressed helium is used to inflate an inelastic flexible balloon, originally folded completely float to a volume of 0.5 m^3. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process. **(04 Marks)**

OR

4 a. Explain the concept of heat engine, heat pump, and thermal reservoir. **(08 Marks)**
  b. A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoir at temperatures of 40°C and −20°C. The heat transfer to heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40°C. **(08 Marks)**

Module-3

5 a. Explain Otto cycle and derive an expression for its efficiency. **(08 Marks)**
  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 the constant pressure process is 1480°C. Calculate:
   (i) The cut-off ratio
   (ii) The heat supplied per kg of air
   (iii) The cycle efficiency. **(08 Marks)**

OR

6 a. Explain basic laws governing different modes of heat transfer. **(12 Marks)**

b. A small, thin metal plate of area A m^2 is kept insulated on one side and exposed to the sun on the other side. The plate absorbs solar energy at a rate of 500 W/m^2 and dissipates it by convection into the ambient air at T_∞ = 300 K with a convection heat transfer coefficient h_c = 20 W/(m^2°C) and by radiation into a surrounding area which may be assumed to be a blackbody at T_{Sky} = 280 K. The emissivity of the surface is E = 0.9. Determine the equilibrium temperature of the plate. **(04 Marks)**

Module-4

7 a. Discuss the mathematical representation of three commonly used different types of boundary conditions. **(10 Marks)**

b. Consider a slab of thickness L. A fluid at a temperature $T_{\infty 1}$ with a heat transfer coefficient h_1 flows over the surface at x = 0, and another fluid at a temperature $T_{\infty 2}$ with a heat transfer coefficient h_2 flows ones the surface at x = L of the plate.
Develop an expression for the heat flow ϕ through an area A of the plate. Calculate the heat transfer rate through A = 1 m^2 of the slab for $T_{\infty 1}$ = 130°C, $T_{\infty 2}$ = 30°C, $h_{\infty 1}$ = 250 W/(m^2°C), $h_{\infty 2}$ = 500 W/(m^2°C), L = 4 cm, K = 20 W/(m°C). **(06 Marks)**

OR

8 a. The heat transfer coefficient (h) of free convection depends upon the buoyancy force per unit mass ($g\beta\theta$), density (ρ), vertical height (L), viscosity (μ), thermal conductivity (K) and specific heat (C_p). Through dimensional analysis obtain $Nu = BG_r^a P_r^b$. **(10 Marks)**

b. A vertical cylinder 1.5 m high and 180 mm in diameter is maintained at 100°C in an atmosphere environment of 20°C. Calculate heat loss by free convection from the surface of the cylinder. Assume properties of air at mean temperature as, ρ = 1.06 kg/m^3, $\gamma = 18.97 \times 10^{-6}$ m^2/s, C_p = 1.004 kJ/kg°C and K = 0.1042 kJ/hm°C. **(06 Marks)**

Module-5

9 a. Explain physical significance of Reynolds number, Prandtl number, Nusselt number and Stanton number. **(08 Marks)**

b. Air at atmospheric pressure and 40°C flows with a velocity of U = 5 m/s over a 2m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1m wide of the plate. (Air at 1 atm and 80°C, $\gamma = 2.107 \times 10^{-5}$ m^2/s, K = 0.03025 W/mK, Pr = 0.6965) **(08 Marks)**

OR

10 a. Define following terms used in radiation heat transfer:
(i) Emissivity
(ii) Absorptivity
(iii) Gray body
(iv) View factor **(08 Marks)**

b. Explain:
(i) Stefan-Boltzman law
(ii) Kircoff's law
(iii) Planck's law
(iv) Wein's displacement law **(08 Marks)**

* * * * *