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10MT71

Seventh Semester B.E. Degree Examination, June/July 2023
Thermodynamics and Heat Transfer

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Explain what do you understand by thermodynamic equilibrium **(06 Marks)**

b. What are intensive and extensive properties? Give examples for each. **(06 Marks)**

c. Define a new temperature scale of °B in which the boiling and freezing points of water are 500°B and 100°B respectively. Correlate this temperature scale with centigrade scale of temperature. **(08 Marks)**

2 a. Compare Heat and Work. Prove that work and heat are path functions. **(08 Marks)**

b. Explain the following : i) Electrical work ii) Shaft work iii) Paddle wheel work iv) Flow work. **(12 Marks)**

3 a. Prove that energy is a property of a system. **(06 Marks)**

b. State and explain the first law of thermodynamics. Explain with reference to a cyclic and non cyclic process. **(08 Marks)**

c. A domestic refrigerator is loaded with food and the door closed. During a certain period of time the machine consumes 1 kWh of energy and the energy of the system decreases by 5000 kJ. Determine the magnitude and direction of heat transfer for the process. **(06 Marks)**

4 a. State and explain Kelvin – Plank statement and Classius statement. **(06 Marks)**

b. Define Thermodynamic temperature scale prove that $\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$. **(08 Marks)**

c. A reversible heat engine operates with two environments. In first it drawn 12000kW from a source at 400°C and in the second it draws 25000 kW from a source at 100°C. In both the operations the engine rejects heat to a thermal sink at 20°C. Determine the operation in which the engine delivers more power. **(06 Marks)**

PART – B

5 a. Derive the general three dimensional heat conduction equation in Cartesian coordinates and state assumptions made. **(10 Marks)**

b. Determine the steady state heat transfer through a double pane window, 0.8 m high, 1.5 m wide. Consisting of two 4 mm thick glass layers (K = 0.78 W/mc), separated by a 10 mm thick stagnant layer of air (K = 0.026 W/mc) inside temperature of room air is maintained at 20°C with a convective heat transfer coefficient of h_a = 10 W/m^{2}c, outside the temperature of air is -10°C, and the convective heat transfer coefficient on outside is h_b = 40 W/m^{2}c. Also determine the overall heat transfer coefficient. **(10 Marks)**

6 a. Derive an expression for temperature distribution and heat transfer from the end of the short fin insulated. **(10 Marks)**

b. A wire of 6.5 mm dia of a temperature of 60°C is to be insulated by a material having K = 0.174 W/m°C. Convection heat transfer coefficient h_0 = 8.722 W/m^2°C, The ambient temperature is 20°C. For maximum heat loss, what is the minimum thickness of insulation and heat loss per meter length? Also find percentage increase in the heat dissipation too? **(10 Marks)**

7 a. Explain Velocity dan Thermal Boundary layers. **(05 Marks)**

b. Air stream at 27°C moving at 0.3 m/s across 100W incandescent bulb, glowing at 127°C. If the bulb is approximated by a 60mm diameter sphere, estimate the heat transfer rate and percentage of power cost due to conversion. Use $Nu_D = 0.37$, Re_D 0.6. **(05 Marks)**

c. Prove that Nu = f(Gr , Pr) using Buckingham π - theorem Dimensional Analysis method. **(10 Marks)**

8 Explain any five:

a. Stefan – Boltzman Law.

b. Plank's Law.

c. Weins Displacement Law.

d. Krichhoff's Law.

e. Shape Factor.

f. Radiation Shield. **(20 Marks)**

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