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10MT71

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
Thermodynamics and Heat Transfer

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define thermodynamic system. Explain briefly different thermodynamic systems with example. **(07 Marks)**

b. Differentiate between :
i) Extensive and intensive properties
ii) Reversible and irreversible processes
iii) Homogeneous and heterogeneous system. **(07 Marks)**

c. State and explain Zero'th law of thermodynamics. **(06 Marks)**

2 a. Define thermodynamics work. Show that work is a path function. **(08 Marks)**

b. With diagram show the sign convection of work and heat. **(03 Marks)**

c. A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bar. When heated diameter is increases to 30cm during heating pressure is found that to be propotional to diameter calculate workdone. **(09 Marks)**

3 a. Explain first law for a closed system undergoing a cyclic process. And show that energy is a property of the system. **(10 Marks)**

b. In a steam power station, steam flows steadily through a 0.2m diameter pipeline from the boiler to the turbine. at boiler end, the steam conditions are found to be : P = 4MPa, T = 400°C, h = 3213.6 kJ/kg, ad V = 0.073 m^3/kg. At the turbine end, the conditions are found to be : P = 3.5MPa, T = 392°C, h = 3202.6 kJ/kg, and v = 0.084 m^3/kg. There is a heat loss of 8.5 kJ/kg from the pipe line. Calculate the steam flow rate. **(10 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 12000 KW 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. State and explain the laws governs the modes of heat transfer. **(06 Marks)**

b. Derive 3-D general heat conduction in Cartesian co-ordinates. **(08 Marks)**

c. A stream pipe of 50mm inside diameter and 65mm outside diameter is insulated with 27.5mm radial thickness of high temp insulation (K = 1.1 W/mk). The surface heat transfer co-efficient for inside of outside surfaces are 4650 W/m^2k and 11.5 W/m^2k respectively. the thermal conductivity of pipe material is 45 W/mk, if steam temperature is 200°C and ambient air temp is 25°C determine : i) heat loss per meter length of pipe ii) temperature at the interface iii) over all heat transfer co-efficient. **(06 Marks)**

6 a. Define critical thickness of insulation. Derive an expression for the critical thickness of insulation for the cylinder. **(10 Marks)**

b. Derive an expression for short fin end loosing energy by convection and prove.

$$Q = \sqrt{hpkA}\,(Th - Ta)\left(\frac{\frac{h}{mk}\cosh mL + \sinh mL}{\cosh mL + \frac{h}{mk}\sinh mL}\right)$$ **(10 Marks)**

7 a. Define : i) displacement thickness ii) momentum iii) thickness iv) energy thickness v) thermal boundary layer v) critical Raynold's number **(10 Marks)**

b. The heat transfer coefficient(h) of free convection depends upon the buoyancy force per unit mass ($gB\theta$), density(ρ), vertical height(L), viscosity (μ), thermal conductivity (K) and specific heat (C_p). Derive $N_u = G_r^a\, P_r^b$ through dimensional analysis. **(10 Marks)**

8 a. State and explain :

i) Stefan – Boltzman law
ii) Kirchoff's law
iii) Plank's law
iv) Wein's displacement law. **(10 Marks)**

b. Write a note on block body. **(05 Marks)**

c. Two block discs of diameter 50 cm are placed parallel to each other concentrically at a distance of 1m. The discs are maintained at 727°C and 227°C respectively. Calculate the heat transfer between eh discs/hr, when no other surfaces is present except the discs. **(05 Marks)**

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