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10MT71

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Thermodynamics and Heat Transfer

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO full questions from each part.*
2. Use of Thermodynamic and Heat Transfer Data Handbook permitted.

PART – A

1 a. Define Thermodynamics. Different between classical and statistical thermodynamics approach. **(06 Marks)**

b. Explain quasistatic process with neat sketch and PV diagram. **(06 Marks)**

c. State Zeroth law of thermodynamics. Derive an expression for centigrade scale and Fahrenheit scale relation. **(08 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. Derive an expression for steady flow energy equation with assumption. **(08 Marks)**

b. State the firstlaw of thermodynamic for a open system. **(02 Marks)**

c. Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30m/sec where its temperature is raised to 800°C. It then enters a turbine with same velocity of 30m/sec and expands until the temperature falls to 650°C. On leaving the turbine air is taken at a velocity of 60m/sec to a nozzle where it expands until the temperature has fallen to 500°C. If air flow rates 2kg/sec. Find:
i) Rate of heat transfer.
ii) Power output from the turbine assuming no heat loss.
iii) Velocity at exit of the nozzle assuming no heat loss. **(10 Marks)**

4 a. State and prove Classius and Kelvin-Planck statement and its equivalences. **(08 Marks)**

b. Write the causes of irreversibilities. **(02 Marks)**

c. Derive an expression for COP of refrigerator and COP of heat pump with sink and source figure. **(10 Marks)**

PART – B

5 a. Derive an expression for governing laws of conduction, convection, radiation. **(08 Marks)**

b. Explain three kind of boundary condition. **(04 Marks)**

c. A plane wall is composed of 20cm of layer refractory bricks. Thermal conductivity K = 1.392W/m°K and 5cm layer of insulating material K = 0.58W/m°K. The inside of refractory brick is at 1200°C and outside surface temperature of the insulating material is at 40°C. Calculate the temperature of the brick find the heat transfer / unit area per hour. **(08 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.

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

7 a. Define Hydrodynamics and thermal boundary layer incase of flow over a flat plat. **(06 Marks)**

b. An approximate expression for the temperature, profile in thermal boundary layer is given by $\theta_{(x.y)} = \frac{T_{(x,y)} - T_\infty}{TW - T_\infty} = \frac{3}{2}\frac{y}{st(x)} + \frac{1}{2}\left(\frac{y}{st(x)}\right)^3$ where st(x) in thermal boundary layer thickness which is given by

$$st(x) = 4.53\frac{x}{Re^{1/2}\,Pr^{1/3}}$$

Develop an expression for local heat transfer coefficient. **(08 Marks)**

c. Define:

i) Reynolds number
ii) Grashof number
iii) Nusselt number
iv) Prandtl number
v) Local heat transfer coefficient
vi) Overall heat transfer coefficient. **(06 Marks)**

8 a. Define:

i) Black body
ii) Plank's law
iii) Wein displacement
iv) Lambert's law. **(08 Marks)**

b. Prove that Emissive power of a black body in a hemispherical enclosure is π times the intensity of radiation. **(08 Marks)**

c. State and prove Stefan Boltzmann law. **(04 Marks)**

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