Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

KT EXAMINATION, JUNE 2014.

Total Marks: 100 Duration: 4 Hours

ME (Thermal Engineering) SEM- I **TRANSPORT PHENOMENA**

M.E (TM) with

- Attempt any **FIVE** questions out of **seven** questions.
- Answers to all sub questions should be grouped together.
- Make any suitable assumption if needed with proper reasoning.
- Use of HMT data book is permitted.

MASTER

1. Evaluate the heating of 0.45 kg/s of air in a constant pressure process from 10°C to 45°C in a adiabatic chamber using four types of heaters: **20**
   1. Condensing steam at 1 atm with a change from saturated vapor to saturated liquid
   2. Using hot water entering the heat exchanger at 85°C and leaving at 60°C
   3. Using hot water entering the heat exchanger at 60°C and leaving at 35°C
   4. Using electric heater

   For all alternatives it is assumed that there are no heat losses from the heat exchanger. Evaluate the overall irreversibility for each alternatives and comment on the availability of using each in a practical situation. The lowest available temperature $T_0 = 20°C$.

2. a) What is exergy? Derive an expression to estimate exergy change of a open system. **10**
   Two 5 kg blocks of steel, one at $250^0 C$ the other at $25^0 C$, come in thermal contact. Find the final temperature and the change in entropy of the steel?
   b) Water at 25°C enters a tank at a rate of 5 kg/min. The tank contains 150 kg of water and is provided with an exit flow channel which discharges at the rate of 5 kg/min. water in the tank is well mixed. If the tank is insulated and an electric heater is suddenly placed in the tank generating heat at the constant rate of 20,000 kJ/h. calculate time required to for the exit temperature to reach 50°C. What will the exit temperature be when steady state condition is reached? Neglect mass of the tank. **10**

3. a) What is a transport phenomenon in context to a thermal system? Using Reynolds Transport Equation applied to a steady thermal system, develop appropriate governing equation. **10**
   b) Derive generalized expressions to calculate enthalpy and entropy change of a thermal system. **10**
   A counter flowing heat exchanger has one line with 2 kg/s at 125 kPa, 1000 K entering and the air is leaving at 100 kPa, 400 K. The other line has 0.5 kg/s water coming in at 200 kPa, 20°C and leaving at 200 kPa. What is the exit temperature of the water and the total rate of entropy generation? Calculate the change in exergy (kW) of the two flows.

4. a) Derive differential form of general momentum equation for an incompressible transient system. List all assumption made. **10**
   b) For a given flow field $\vec{V} = 2x\,\vec{i} - yt\,\vec{j}$ m/s where x and y are in meters and t is in seconds. **10**
      (i) What is the dimension of flow?
      (ii) Is the flow possible?

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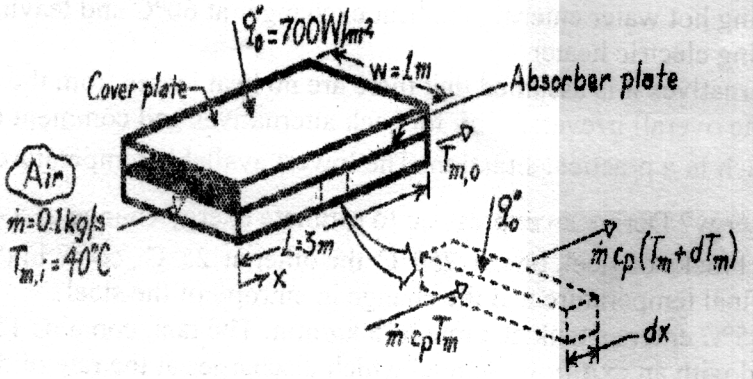
(iii)Find the equation of the streamline passing through (2,-1). Plot it on graph paper. Calculate the acceleration, the angular velocity, the vorticity vector.

5 a) Explain the concept of boundary layer and differentiate between displacement and momentum thickness: What is boundary layer approximation? Write the hydrodynamic and thermal boundary layer equation. **10**

b) A steel plate of thickness 5 cm is at 50°C. It is suddenly subjected to heat flux q = 8000 W/m^2 at one of its surfaces and is exposed to air stream at T_0 = 30°C at the other surface. Take ρ = 7800 kg/m^3, C_p = 500 J/kgK, k = 50 W/mK, h = 60 W/m^2K. Determine the temperature of the plate as a function of time. Calculate steady state temperature. **10**

6. a) What is transient conduction? Discuss and develop appropriate expression for temperature distribution for a lumped parameter model. **10**

b) A flat-plate solar collector is used to heat atmospheric air flowing through a rectangular channel. The bottom surface of the channel is well insulated, while the top surface is subjected to a uniform heat flux, which is due to the net effect of solar radiation absorption and heat exchange between the absorber and cover plates. For inlet conditions of mass flow rate=0.1 kg/s and $T_{m,i}$=40°C, what is the air outlet temperature, if L=3 m, w=1 m and the heat flux is 700 W/m^2? The specific heat of air is c_p=1008 J/kg.K **10**



7. a) Explain different mechanism of mass transport. **10**

b) Consider two long, horizontal parallel plates with a viscous incompressible fluid placed between them. The two plates moves in two opposite direction with two different constant velocities. There is no pressure gradient and the only body force due to the weight. Starting with the Navier-Stokes equation, determine an expression for the velocity profile for laminar flow between the two plates. **10**

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