CH8591 Heat Transfer Introduction to the Course

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### Questionnaire

- 1 A fluid flowing at a mass flow rate of  $\dot{m}_1$ , with temperature  $T_1$  is getting mixed with another fluid flowing at  $\dot{m}_2$ , and  $T_2$ . Assume that specific heats of both the fluid are nearly the same, and there is no phase change happening. What is the average temperature of mixed stream?
- 2 From the learning of Thermodynamics, you know that the process stated in question 1 is \_\_\_\_\_(reversible / irreversible). Justify your statement.
- 3 What is the normal temperature of human body in °C, and °F?
- 4 An electrical resistance heater of 2 kW rating is there in the 10 litre capacity water heater (geyser). Water at  $30^{\circ}$ C is present in full capacity and there is no with-drawl of water. How much time it takes for heating the contents to  $60^{\circ}$ C?
- 5 For what with-drawl rate (litre/min) you will get  $60^{\circ}$ C water continuously, with the inlet remaining constant at  $30^{\circ}$ C?



# Questionnaire (contd..)

- 6 Density of liquid water at  $25^{\circ}$ C is \_\_\_\_\_(kg/m<sup>3</sup>), and that of steam at atmospheric pressure and  $100^{\circ}$ C is about \_\_\_\_\_(kg/m<sup>3</sup>).
- 7 Look at the figure below.



Ethanol vapor is turning to liquid at saturation conditions. Cooling water enters at  $30^{\circ}$ C and leaves at  $40^{\circ}$ C. Draw the variation of temperature of ethanol and water along the length of condenser.

# Questionnaire (contd..)

- 8 In summer seasons, walking barefoot over white color soil, one feels comfortable than that over black color soil. What is the reason for this phenomena?
- 9 Ooty is at a MSL of 2200 m. Boiling temperature of water in open pot there is \_\_\_\_\_(less / more ) than 100°C.
- 10 For fluid flow through pipeline, with increase in velocity, pressure drop \_\_\_\_\_(increases / decreases).



#### Specific heat of soil (dry): 0.2 cal/g.°C; wet: 0.35 cal/g.°C.



### Syllabus Topics

#### CH8591 Heat Transfer

4 credits

75 periods

Unit-I Conduction (20 hrs)

Unit-II Convection (10 hrs)

Unit-III Condensation and Boiling (8 hrs)

Unit-IV Evaporation and Radiation (12 hrs)

Unit-V Heat Exchangers (15 hrs)



#### CH6504 Heat Transfer

#### Unit-I Conduction:

Importance of heat transfer in Chemical Engineering operations Modes of heat transfer Fourier's law of heat conduction One dimensional steady state heat conduction equation for flat plate, hollow cylinder Heat conduction through a series of resistances Thermal conductivity measurement Effect of temperature on thermal conductivity Heat transfer in extended surfaces.



# Syllabus Contents (contd..)

#### **Unit-II Convection:**

Concepts of heat transfer by convection - Natural and forced convection

Analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Colburn analogy

Dimensional analysis in heat transfer

Heat transfer coefficient for flow through a pipe, flow past flat plate, flow through packed beds.

#### Unit-III Condensation & Boiling:

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation Nusselt equation for vertical and horizontal tubes, Condensation of superheated vapours Heat transfer to boiling liquids - mechanism of boiling, nucleate

boiling and film boiling.



# Syllabus Contents (contd..)

#### **Univ-IV Evaporation & Radiation:**

Theory of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation.

Radiation heat transfer - Black body radiation, Emissivity, Stefan-Boltzmann law, Plank's law, radiation between surfaces.



# Syllabus Contents (contd..)

#### Unit-V Heat Exchangers:

Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; Use of correction factor charts; Heat exchangers effectiveness; number of transfer unit - Chart for different configurations Fouling factors



#### Books

• Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984



- Holman, J. P., Heat Transfer, 8th Edn., McGraw Hill, 1997.
- Cengel, Y. A., Heat Transfer: A Practical Approach, 2nd Edition, McGraw Hill, 2002.
- Kern, D.Q., Process Heat Transfer, McGraw Hill, 1950.



### Contact Hours

Day	Period
Mon	4
Tue	8
Wed	1, 5
Thurs	5
Fri	3



### Importance of Heat Transfer in Chemical Engineering

- Heat transfer mechanism forms the heart of industries based on energy conversion.
- One of the main objectives of an engineer is to minimize the energy losses.
- Heat exchanger design.
- Design of heat transfer enhancement mechanisms.
- Electronic circuit cooling.



# Difference between Thermodynamics and Heat Transfer

#### Thermodynamics tells us:

- How much heat is transferred (Q)
- How much work is done (W)
- Final state of the system

#### Heat transfer tells us:

- How (with what modes) Q is transferred
- At what rate Q is transferred
- Temperature distribution inside the body

