KIT 252/3 – Unit Operation

Course Objective : To introduce the basic concepts of energy and material balances, fluid dynamics and heat transfer and their industrial applications

Topic	Content	Number of lecture hours	Expected outcome – upon completion of this course, the student should be able to:
1. Units and Conversion	• SI unit and British unit systems (feet, lb etc) • Dimension unit • Conversion coefficient	2	• Convert from SI unit to British unit system and vice versa. • Understand the dimension concept. • Understand of conversion coefficient concept. • Use conversion coefficient.
2. Material Balance	• Basic concepts of material balance such as system, system border, batch system, continuous system etc. • Material balance on steady state and recycle state • Material balance concept based on chemical processes	5	• Determine and draw system for any process in order to come out with material balance equations. • Write material balance equations. • Identify among the batch process, continuous process and recycle process. • Understand the material balance in a chemical reaction process. • Write a stoichiometric equation for the chemical reaction equilibrium. • Use the stoichiometric equation to solve the material balance problems.
3. Energy Balance	• Basic concept of energy balance such as inner energy, kinetic energy, potential energy, etc. • Application of the steam table • Calculation of heat reaction • Energy balance concept based on chemical processes (including stoichiometric chemical reaction equation)	5	• Relate heat concept with the energy and work concepts. • Distinguish between positive work and negative work. • Use the steam table. • Solve problems on heat of reaction from a given chemical equation. • Apply energy balance concepts for open and closed systems. • Use the stoichiometric equation in solving problems of energy balance.
4. Fluid Pressure	• Pressure in liquid • Measuring pressure in liquid by using piezometer and manometer	2	• Calculate the pressure on the top and bottom levels of a liquid reservoir and pressure difference. • Understand the concept and application of manometer in calculating the pressure difference in a pipe or reservoir.

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5. Fluid Dynamics	• Conservation of mass and energy flow through a control volume of a liquid, continuity equation • Bernoulli equation and application for liquid flow	3	• Calculate mass flow rate, speed, discharge rates and other flow parameters. • Know how to represent energy in terms of energy height. • Deduce Bernoulli's equation and apply it in problem solving involving liquid flow.
6. Liquid Flow Measurement	• Instrument for liquid flow measurement • Pitot tube, Prandlt tube, Venturi meter and orifice	3	• Understand the concept used in measuring liquid flow. • Calculate the flow properties of a liquid.
7. Liquid Flow Through Pipes	• Reynolds number • Energy losses (head losses) in pipe systems: along the pipe, pipe connection, diameter change, outlet and inlet, pipe in parallel and series	4	• Determine the type of flow by Reynolds number. • Calculate energy loss in terms of head loss for each system mentioned and in the pipe line systems.
8. Introduction to Heat Transfer	• Transfer processes and fundamental equations of transfer processes • Temperature (T)-distance (dx) relationship with heat transfer • Modes and mechanisms of heat transfer • Fluid boundary-layer analogy • Steady and unsteady state transfer • Thermal conductivity	3	• Explain and identify various transfer processes. • Explain differences between various transfer processes via fundamental transfer equations. • Identify and describe various modes and mechanisms of heat transfer. • Explains heat transfer process using T-dx relationship and fluid boundary layer analogy. • Differentiate between steady and unsteady state heat transfers. • Understand basic concept of thermal conductivity and their relationships with heat transfer processes.

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9. Steady States Heat Transfer	• Parallel and serial heat transfer in homogenous and non-homogenous cubes, blocks and layered pipes • Derive equations for parallel and serial arrangement heat transfer in homogenous and non-homogenous systems • Overall heat transfer coefficient and its significance	6	• Derive heat transfer and heat flux equations based on a specific shape of the items for conduction and convection modes. • Use equations to calculate heat transfer and heat flux of the different shapes of a particular object. • Illustrate the basic concept of heat transfer (i.e convection and conduction single modes) at multiple layers with different materials and/or combination of modes of heat transfer systems. • Calculate the amount of heat transfer for a given specific problem.
10. Heat Exchangers	• Concept of heat exchangers • Heat exchangers in industry • Examples of 'simplified' heat exchanger • Derivation of heat transfer equations for concentric tubes and tubes and shell heat exchangers	3	• Relate the concept of heat transfer in a real system particularly the concentric tube heat exchanger. • Gain a brief understanding of the application of heat transfer in industries or related machinery. • Derive heat transfer equations of a cooling system normally used in industries (concentric tube heat exchanger).
TOTAL		**36**	