LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Chemical Engineering

Bachelor of Engineering (B.E.) - Semester – VI

Course Code:	017083605
Course Name:	Computer Aided Process Synthesis
Category of Course:	Professional Elective – I (PEC)
Prerequisite Course:	Basics of Heat transfer, Mass transfer and Reaction engineering

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
3	**0**	**2**	**4**	**30**

Syllabus

Unit No.	Topic	Prerequisite Topic	Teaching Hours
01	**Synthesis of Heat Exchanger Networks**		**4 (13.3 %)**
	1.1 Basics of Heat Exchanger Network Synthesis (HENS)	Heat Exchanger Analysis	
	1.2 Minimum Utility Targets	---	
	1.2.1 Temperature Interval Method	---	
	1.2.2 Composite Curve Method (HCC & GCC)	---	
	1.2.3 Linear Programming Method	---	
	1.3 Minimum, Threshold & Optimum approach temperature	Effect of temp. on heat exchangers	
	1.4 Pinch Design approach to Inventing a Network	---	
02	**Maximum energy recovery for Heat Exchanger Networks**		**3 (10 %)**
	2.1 Minimum no. of Heat Exchangers	Concept of heat exchangers	
	2.1.1 Min. no. of heat exchangers by breaking the heat loops	---	
	2.2 Networks for max. energy recovery by stream matching at the pinch	---	
	2.3 Derivation of Network Superstructures for minimize of annual costs	Inventing a heat exchanger networks	
03	**Synthesis of Separation Trains**		**2 (6.6 %)**
	3.1 Criteria for selection of Separation Methods	Basics of separation methods	
	3.2 Selection of an Equipment	Basics of Mass Transfer Operations	
	3.3 Sequencing of Ordinary Distillation for the separation of nearly ideal fluid mixtures	---	
04	**Determination of Favourable sequences**		**3 (10 %)**
	4.1 Heuristics for determining favorable sequences	Concept of Distillation	
	4.2 Marginal Vapour Rate Method	Adverse vapour flow conditions	
	4.3 Sequencing of Ordinary Distillation for the separation of nearly non-ideal fluid mixtures 4.3.1 Residue Curves	---	
	4.4 Complex & Thermally Coupled distillation	Basics of Distillation	
05	**Design & Scheduling of Batch Processes**		**3 (10 %)**
	5.1 Single product Batch Plants	Basics of Batch Processes	
	5.1.1 Gantt Chart, Cycle time & Make-span time	---	
	5.1.2 Overlapping & Non-overlapping operations	---	
	5.2 Multiple product Batch Plants	---	
	5.2.1 Flow-shop plant	---	
	5.2.2 Job-shop plant	---	
06	**Design & Scheduling of Batch Processes using Transfer Policies**		**4 (13.3 %)**
	6.1 Various Transfer Policies	---	
	6.1.1 Zero-wait policy	---	
	6.1.2 No-Intermediate storage policy	---	
	6.1.3 Unlimited storage policy	---	
	6.2 Parallel Units & Intermediate Storage	---	
	6.3 Sizing of vessels in Batch Plants	Single product Batch Plants	
07	**Energy Integrated Distillation Processes**		**3 (10 %)**
	7.1 Impact of operating pressure on distillation column	---	
	7.2 Multi-Effect Distillation	Basics of Distillation	
	7.3 Heat pumping	Law of Thermodynamics	
	7.4 Vapour Recompression	---	
	7.5 Reboiler Flashing	---	
08	**Positioning of Heat Engine & Heat Pump in Heat Integration**		**2 (6.6 %)**
	8.1 Heat Engine & Heat Pump	---	
	8.2 Positioning of Heat Engines	Basics of heat engines	
	8.3 Positioning of Heat Pumps	Basics of heat pumps	
09	**Reactor Network Synthesis**		**3 (10 %)**
	9.1 Reactor Models	Type of Reactors	
	9.2 Reactor Design for Complex Configurations	Complex Reactions	
	9.3 Reactor Network Design using the Attainable Region	Concept of plug flow reactors	

10	**The Design Process**		**3 (10 %)**
	10.1 Design Opportunities	---	
	10.2 Steps in Product & Process Design	---	
	10.3 Safety Considerations 10.3.1 Safety issues 10.3.2 Design Approaches towards safe chemical plants	Pollution control, Safety & Health Management	
	10.4 Role of Computers	Basics of various software	

List of Experiments/Practical		
Sr. No.	**List of Experiments/Practical's**	**Linked to theory syllabus**
1.	Minimum utility requirements and pinch point for the given stream data by temperature interval method in MS Excel.	Unit 01
2.	Minimum utility requirements and pinch point using HCC & GCC method in MS Excel.	Unit 01
3.	Minimum utility requirements and pinch point using HINT software.	Unit 01 & 02
4.	Design a heat exchanger network using HINT software.	Unit 02
5.	Minimum utility target and pinch point using linear programming method in MS Excel solver.	Unit 01
6.	To find the optimal value of ΔT_{min} for a given problem using HINT software.	Unit 01
7.	Multicomponent distillation in DWSIM software.	Unit 03 & 04
8.	Design of batch reactor for production of methanol using DWSIM software.	Unit 03 & 04
9.	Sequencing of multiple distillation column using SCILAB software.	Unit 03 & 04

Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it is Marks Distribution)					
L:	**3**	**T:**	**0**	**P:**	**2**
Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. Each Test will be of 25 Marks. Each Test Syllabus Weightage: Range should be 20% - 30%					
Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	**3**	**4**	MCQ	21%	28
Theory			Theory Descriptive	24%	32
Theory			Formulas and Derivation	0%	0
Theory			Numerical	30%	40
Expected Theory %	**75%**		**Calculated Theory %**	**75%**	**100**
Practical	**1**		Individual Project	13%	50
Practical			Group Project	0%	0
Practical			Internal Practical Evaluation (IPE)	13%	50
Practical			Viva	0%	0
Practical			Seminar	0%	0
Expected Practical %	**25%**		**Calculated Practical %**	**25%**	**100**
Overall %	**100%**			**100%**	**200**

Course Outcome	
	Upon completion of the course students will be able to
1	Develop Heat Exchanger Network Synthesis using various tools.
2	Develop reactor network synthesis using attainable region.
3	Analyze various alternatives of heat integration of distillation columns.
4	Identify minimum utility requirements and develop the heat exchanger networks using pinch design approach.
5	Understand the Energy Integrated Distillation Processes.
6	Design and schedule the batch processes for optimal design. [Single/Multiple product plants]
Suggested Reference Books	
1	Product & Process Design Principles: Synthesis, Analysis, Evaluation, Warren D. Seider, J. D. Seader, Daniel R. Lewin, 2nd edition, Wiley.
2	Systematic Methods of Chemical Process Design, Lorens T. Biegler, E. Ignacio Grossmann, Arthur W. Westerberg, Prentice Hall International.
3	Chemical Process: Design & Integration, Robin Smith, Wiley.
4	Conceptual Design of Chemical Processes, James M. Douglas, McGraw Hill International, 1988.
List of Open-Source Software/Learning Website	
1	Students can refer video lectures available on the websites including NPTEL lecture series.
2	Students can use SCILAB/GAMS software for the solution of LP/MILP optimization problems.
3	Heat exchanger network synthesis, design & analysis can be performed in HINT software. Students can also use DWSIM open-source software also.