NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF CHEMICAL ENGINEERING

COURSE PLAN – PART I			
Programme	**M.Tech. Chemical Engineering**		
Course Title	**Advanced Separation Techniques**		
Course Code	**CL 606**	**No. of Credits**	**3**
Course Code of Pre-requisite subject(s)	**CLPC20, CLPC 24 Mass Transfer Operations**		
Session	**Jan. 2021**	**Section**	**II Semester**
Name of Faculty	**Dr.K.M.Meera S.Begum**	**Department**	**Chemical Engg.**
Email	**meera@nitt.edu**	**Telephone No.**	**0431-2503109**
Name of other Coordinator(s) (if, applicable)	**--**		
E-mail	**--**	**Telephone No.**	**--**
Course Type	**Core course**		

Syllabus (approved in BoS 2019)

Overview of separation processes, Separation factors and its dependence on process variables, Theory of cascades and its application. Membrane Separations- Membrane materials, characterization, Concentration polarization theory, Membrane modules. Membrane Processes, Design controlling factors of membrane contactors, Operational modes, fouling and preventive measures and economics.

Sorption Separation -Principles of Chromatography and Ion exchange, chromatographic techniques, Retention theory, Band broadening and its factors, Design controlling factors, scaling-up problems, Ion exchangers, equipments, kinetics and mass transport, commercial processes, Regeneration.

Ionic Separations- Theory, mechanism and equipments for electro dialysis, electro- coagulation, electrophoresis and dielectrophoresis. Design constraints of electrodialytic stacks, Variants of electrodialysis. Electrokinetic methods-analytical methods of electrophoresis, electrophoretic mobility factors, commercial applications, Design considerations.

Thermal Separations-Thermal diffusion theory, Diffusional rate equations, phenomenological theories, Equipments and applications. Zone melting- theory, equilibrium diagrams, factors affecting the impurity distribution, zone heaters, Zone melting processes, commercial applications and design constrains.

Other Techniques-Adductive crystallization theory, clathrates and adducts, equipments, Bubble adsorption- nature of foams, stability and drainage theory, equipments, commercial applications and design controlling factors.

COURSE OBJECTIVES

1. To learn the principle and technical concepts of rate governed separation processes.
2. To understand the less energy intensive processes for down streaming applications.
3. To apply the knowledge in designing process equipments.

COURSE OUTCOMES (CO)	
Course Outcomes (CO)	**Aligned Programme Outcomes (PO)**
Upon completing the course, the student will be able to	
1. have awareness about conventional and non-conventional separation processes	**PO1, PO2**
2. acquire sufficient knowledge in less energy intensive processes for separation of components	**PO1, PO2, PO4, PO6, PO8, PO9 and PO10**
3. apply the methodologies for various industrial down streaming and bio- process applications.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO10 and PO11**
4. analyze the design constraints of process equipments in industrial applications	**PO1, PO2, PO3, PO5, PO9 and PO11**

COURSE PLAN – PART II

COURSE OVERVIEW

This course gives an insight into concepts of rate governed separation techniques and applications of less energy intensive processes for down streaming operations. Outcome of this course will enable a student to apply the methodologies for various industrial down streaming and bio- process applications.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1.	Week 1	Overview of equilibrium separation processes	Online mode
2.	Week 1	Review of separation equipments	
3.	Week 1	Rate governed separation processes - advantages	
4.	Week 2	Pressure gradient separations-principle and advantageous features	
5.	Week 2	Membrane-Types, classification, preparation and characterization	
6.	Week 2	Concentration polarization theory - factors for membrane flux	
7.	Week 3	Membrane modules-Types, description, operative features	
8.	Week 3	Design factors, Modes of operations and fouling preventive measures	
9.	Week 3	Membrane processes and their applications -MF, UF,RO, pervaporation, Materials, operation	
10.	Week 4	Gas Permeation- principle, permeators, membranes, design factors	
11.	Week 4	Sorption separation- Principle of chromatography and ion exchange, Retention theory	
12.	Week 4	Resolution- band broadening factors -design controlling factors	

13.	Week 5	Types of chromatographic techniques- Principles and their applications, Detectors	Online Mode
14.	Week 5	Band Broadening –Causing factors – preventive measures, Scaleup problems	
15.	Week 5	Ion exchange, Super critical fluid and Chiral chromatography- Applications	
		Assessment I	
16.	Week 6	Dialyser types, membranes, design, applications	
17.	Week 6	Plasma membranes for Hydrogen production Enzymatic Membranes for biological applications	
18.	Week 6	Affinity and Gel permeation chromatography- Biological applications	
19.	Week 7	Ionic separations- Electrodialytic principle, advantages, applications	
20.	Week 7	Electrodialytic stack operation and design factors	
21.	Week 7	Technical problems and variants in electrodialytic operations	
22.	Week 8	Application of ED for ionic replacement	
23.	Week 8	Effluent treatment by ED	
24.	Week 8	Electro kinetic methods – Principles and advantages, applications	
25.	Week 9	Capillary, Moving boundary	
26.	Week 9	Gel electrophoresis-principle, method and biomedical applications	
27.	Week 9	Zone electrophoresis- Influencing Factors and applications	
		Assessment - II	
28.	Week 10	Thermal gradient separations, Thermal diffusion flux equations –phase diagrams	
29.	Week 10	Thermal diffusion equipments- design factors	
30.	Week 10	Isotopic separations by TD for Nuclear industry	
31.	Week 10	Zone melting- types- phase diagrams, Types of zone heaters	
32.	Week 11	Arc Zone melting in Metallurgical industries	
33.	Week 11	Temperature gradient Zone refining in semiconductor Industry	
34.	Week 11	Floating Zone melting, vapor zone refining for organic compounds	
35.	Week 11	Foam separation, Adductive crystallization - Principle, theory and advantages	

		Compensation Assessment	Online Mode
36.	Week 12	Foam structure, Foaming agents-stability and drainage factors –thermodynamic equilibrium,	
37.	Week 12	Equipments, Foam fractionation in Protein separation	
38.	Week 12	Isomers separation by Adducts, Design Factors	
		Final Assessment	

COURSE ASSESSMENT METHODS (shall range from 4 to 6)

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Assesssment I	After 5th week	1 hour	25%
2	Assessment II	After 9th week	1 hour	25%
3	Assessment III – (Seminar)	After 6th week to start	20 minutes/ student	20 %
	CPA Compensation Assessment*	After 11th week	1 hour	25%
4	Final Assessment**	At the end of course	2 hours	30%

***Will be taken up by only absentees in any I and II assessments due to genuiene medical grounds on provision of medical certificate and with the decision of course faculty.**
****Mandatory; on Academic guidelines.**

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

Text Books :

1. H.M. Schoen, *New Chemical Engineering Separation Techniques*, Wiley Interscience, New York, 1972.
2. C.J. King, Separation Processes, McGraw Hill, NY, 1980
3. B. Sivasankar, *Bioseparations – Principles and Techniques*, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Kaushik Nath, *Membrane Separation processes*, PHI, New Delhi 2008.

Reference Books:

1. J.D. Seader, Ernest J.Henley and D. Keith Roper, *Separation Process Principles*, 3rd edition, John Wiley & Sons Australia, Limited, 2010.
2. M. Mulder, *Basic Principles of Membrane Technology*, Kluwer Academic Publishers, London, 1996.
3. Ronald W.Roussel, *Hand book of Separation Process Technology*, John Wiley, New York, 1987.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1) Feedback will be collected during the class committee meetings and one at the end of course completion.
2) Suitable mapping of COs with POs will be made and attainment will be calculated.

COURSE POLICY (preferred mode of correspondence with students, policy on attendance, compensation assessment, academic honesty and plagiarism etc.)

MODE OF CORRESPONDENCE (email/ phone etc)

Email: meera@nitt.edu

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- At least 75% attendance in the course is mandatory.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

COMPENSATION ASSESSMENT

One Compensation assessment will be conducted only for absentees in either the Assessments under Medical reasons.

ACADEMIC DISHONESTY & PLAGIARISM

- Marks will be deducted for the offenders **if Plagiarism is found more than 15%.**
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and **action being taken if the student is found guilty. The report shall be submitted to the Academic office.**

ADDITIONAL INFORMATION

NIL

FOR APPROVAL

Course Faculty: Dr.K.M.Meera S. Begum **CC-Chairperson: Dr.T. Sivasankar**

HOD: Dr.P. Kalaichelvi **(Approved by CC Chairman and HOD)**