

COURSE CODE: EKC 316

COURSE TITLE: SEPARATION PROCESS

COURSE SYNOPSIS:

To introduce the basic and advanced concepts of separation processes to the students. This includes mass transfer and the design criteria of processes such as humidification, drying, crystallization, adsorption, filtration and membrane processes, supercritical fluid extraction and advanced distillation.

COURSE PREREQUISITES:

Nil

COURSE TEXT BOOKS:

- E.J. Henley, J.D. Seader & D.K. Rpoer, 'Separation Process Principles', 3rd Ed. John Wiley & Sons, 2011.
- C.J. Geankoplis, 'Transport Processes and Unit Operations', 3rd Edition, Prentice-Hall International, 1993.
- Mc Cabe W.L., J.C.Smith, P.Harriott, 'Unit Operations in Chemical Engineering', 7 ed., Mc Graw Hill, USA, 2005.
- Treybal, R.E., 'Mass Transfer Operations', Mc Graw Hill, USA, 2000.
- P. C. Wankat., Separation Process Engineering, 2nd Ed. Prentice Hall, 2006.
- Bird,R.B., Stewart,W.E, and Lightfoot, E.N; Transport Phenomena, 2nd Ed. Wiley& Sons, New York, 2002.
- S.I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, 4th Ed. John Wiley & Sons, 2006.
- R.W. Baker, Membrane Technology and Applications, 2nd Ed. John Wiley & Sons, 2004.

PROGRAM OUTCOMES

1. Engineering Knowledge - Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex chemical engineering problems.
2. Problem Analysis - Identify, formulate, research literature and analyses complex chemical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design/Development of Solutions - Design solutions for complex chemical engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. Investigation - Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
5. Modern Tool Usage - Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex chemical engineering problems, with an understanding of the limitations.
6. The Engineer and Society - Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex chemical engineering problems.
7. Environment and Sustainability - Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex chemical engineering problems in societal and environmental contexts.

8. Ethics - Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. Individual and Team Work - Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
10. Communication - Communicate effectively on complex chemical engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project Management and Finance - Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life Long Learning - Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE TOPICS

Topics	Contents
1	Adsorption : <ul style="list-style-type: none"> • Principles and theory of adsorption • Adsorption isotherms • Equilibrium adsorption equations • Graphical methods of adsorption and calculations • Industrial adsorption equipment
2	Drying : <ul style="list-style-type: none"> • Basic principles of drying • Diffusion theories of drying • Effect of air flow rate and pore size on drying rates • Drying equipment in industry
3	Humidification : <ul style="list-style-type: none"> • Principles and theory of humidification process • Introduction to industrial humidification and dehumidification equipment
4	Crystallization : <ul style="list-style-type: none"> • Principle and theory of crystallization • Solubility curve (equilibrium phase diagrams) • Crystallization equipment in the industry
5	Filtration : <ul style="list-style-type: none"> • Principle and theory of filtration • Definition of: (cake filtration, cake thickness, specific resistance of cake) • Development of filtration equation and its application to industrial filtration equipments • Definition of resistance filter cloth and filter press

- Industrial filtration equipment: press filter and rotary drum filter

6

Membrane Processes :

- Membrane separation processes
- Membrane materials
- Membrane modules
- Transport phenomena in membranes
- Mass transport across selectively permeable membranes
- Concentration diffusion between preexisting bulk phases
- Ultrafiltration and Reverse osmosis
- Microfiltration and ultrafiltration

7

Supercritical Fluid Extraction :

- Physical and transport properties of supercritical fluid
- Phase diagrams of supercritical fluid and estimation of solid solubility at high pressure
- Type of supercritical fluids
- Industrial applications of SFE: SFE of essential oils

8

Distillation Processes :

- Advanced distillation
- Complex Distillation Methods
- Azeotropes with Other Separators
- Binary Heterogeneous Azeotropic Distillation Processes
- Steam Distillation
- Two-Pressure Distillation Processes Complex Ternary Distillation Systems
- Extractive Distillation
- Distillation with Chemical Reaction
- Distillation Column Design

COURSE LEARNING OBJECTIVES [CO]	[PO]	TEACHING PLAN			
		COURSE TOPICS	COURSE ACTIVITIES	COURSE ASSESSMENT (Must in line with BPK)	COMPLEX PROBLEM (Only for integrated design, FYP, Plant design)
Students will acquire the ability to:					
1. Apply the basic theories of adsorption, drying, humidification, crystallization, filtration, membrane separation and supercritical fluid extraction in the separation processes.	PO1	Topic 1 – Topic 7	Recorded Lecture Online Synchronous Lecture F2F Lecture Online Assignment	Quiz, Assignment, Test, Final Exam	

			Tutorial		
2. Relate the understanding on separation principles such as adsorption, drying, humidification, crystallization, filtration membrane separation and supercritical fluid extraction to the design and operation of separation processes.	PO2	Topic 1 – Topic 7	Recorded Lecture Online Synchronous Lecture F2F Lecture Online Assignment Tutorial	Quiz, Assignment, Test, Final Exam	
3. Synthesize the design strategies of advanced distillation based on short-cut method and residue/distillation curves.	PO3	Topic 8	Recorded Lecture F2F Lecture Online Assignment Tutorial	Quiz, Assignment, Test, Final Exam	WP1 Integrated Design Project
4. Make effective engineering report on the design strategies in the unit operation sizing. of either distillation column, adsorption column, membrane filtration or crystallizer sizing.	PO10	Topic 8	Project Based Learning Group Discussion	Assignment	
5. Work effectively in adverse team setting in manipulating deciding the design strategies in the sizing of either distillation column, adsorption column, membrane filtration or crystallizer unit operation.	PO9	Topic 8	Group Discussion	Peer Review	

Final Exam: 60%

Test: 15% (Test 1, Test 2)

Quiz: 5%

Assignment: 20% (3 Short Assignment 5%, 1 Long Assignment 5%, Integrated Design 10%)

Detail Plan (Weekly Basis)

Week	Date	Lecturer	Topic	Activity	Uploaded Resources
1	12 – 18 October 2020	NMN	1	Lecture on: Adsorption Synchronous & Asynchronous Session	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ DISCUSSION FORUM VIA ELEARNING
2	19 – 25 October 2020	NMN	1	Lecture on: Adsorption Synchronous & Asynchronous Session Online Quiz (CO1)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ DISCUSSION FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING)
3	16 Oct – 1 November 2020	NMN	2	Lecture on: Drying Synchronous & Asynchronous Session Tutorial on: Adsorption Short Assignment (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ TUTORIAL FORUM VIA ELEARNING ✓ ASSIGNMENT MATERIALS VIA ELEARNING
4	2 – 8 November 2020	NMN	3	Lecture on: Humidification Synchronous & Asynchronous Session Tutorial on: Drying Online Quiz (CO2) Short Assignment (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ TUTORIAL FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING) ✓ ASSIGNMENT MATERIALS VIA ELEARNING
5	9 – 15 November 2020	NMN	4	Lecture on: Crystallization Synchronous & Asynchronous Session Tutorial on: Humidification Long Assignment (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ TUTORIAL FORUM VIA ELEARNING ✓ ASSIGNMENT MATERIALS VIA ELEARNING
6	16 – 22 November 2020	NMN	5	Lecture on: Filtration Synchronous & Asynchronous Session Tutorial on: Filtration	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ TUTORIAL FORUM VIA ELEARNING
7	23 – 29 November 2020	NMN	5	Lecture on: Filtration Synchronous & Asynchronous Session Online Quiz (CO1) TEST 1 (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO IN ELEARNING ✓ WEBEX RECORDING OF ONLINE LECTURE ✓ DISCUSSION FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING)

MID SEMESTER BREAK					
9	7 – 13 December 2020	NAR	6	Lecture on: Membrane Processes F2F & Asynchronous Session	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ DISCUSSION FORUM VIA ELEARNING
10	14 – 20 December 2020	NAR	6	Lecture on: Membrane Processes F2F & Asynchronous Session Tutorial on: Membrane Processes Online Quiz (CO1)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING)
11	21 – 27 December 2020	NAR	7	Lecture on: Supercritical Fluid Extraction F2F & Asynchronous Session Tutorial on: Supercritical Fluid Extraction Online Quiz (CO2) Short Assignment (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING) ✓ ASSIGNMENT MATERIALS VIA ELEARNING
12	28 Dec – 3 January 2020	NAR	7	Lecture on: Distillation Processes F2F & Asynchronous Session Tutorial on: Distillation Processes Assignment: Integrated Design (CO3,CO4,CO5)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING ✓ ASSIGNMENT MATERIALS VIA ELEARNING
13	4 – 10 January 2020	NAR	8	Lecture on: Distillation Processes F2F & Asynchronous Session Tutorial on: Distillation Processes	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING
14	11 – 17 January 2020	NAR	8	Lecture on: Distillation Processes F2F & Asynchronous Session Tutorial on: Distillation Processes Online Quiz (CO1)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING ✓ ONLINE QUIZ (ELEARNING)
15	18 – 24 January 2020	NAR	8	Lecture on: Distillation Processes F2F & Asynchronous Session TEST 2 (CO1, CO2)	<ul style="list-style-type: none"> ✓ PRE-RECORDED LECTURE VIDEO/POWERPOINT SLIDES IN ELEARNING ✓ TUTORIAL FORUM VIA ELEARNING