UNIVERSITI TEKNOLOGI MARA

CMT200: UNIT OPERATIONS

Course Name (English)	UNIT OPERATIONS APPROVED
Course Code	CMT200
MQF Credit	4
Course Description	An introductory course in unit operations which include concepts of material balances, and fundamental aspects of physical and mechanical processes such as distillation, liquid-liquid extraction, gas absorption, drying and humidification, size reduction as well as agitation and mixing.
Transferable Skills	1. Transfer fundamental knowledge and understanding of law, theories and principles on unit process commonly carried out in industries. 2. Able to manipulate, express and articulate scientific ideas in written form.
Teaching Methodologies	Lectures, Lab Work, Tutorial, Web Based Learning, Discussion
CLO	CLO1 Explain the process variables, types of processes, principles in material balances as well as physical and mechanical processes. CLO2 Perform the calculations to solve material balance problems in unit operations. CLO3 Relate the concept of physical and mechanical processes to solve quantitative problems visually and mathematically. CLO4 Demonstrate experimental findings based online laboratory related to unit operations.
Pre-Requisite Courses	No course recommendations

Topics
1. 1.0 Introduction to unit process 1.1) 1.1 System of units: SI and AE system 1.2) 1.2 Process variables 1.3) 1.2.1 Composition 1.4) 1.2.2 Concentration 1.5) 1.2.3 Flow rate 1.6) 1.2.4 Temperature 1.7) 1.2.5 Pressure 1.8) 1.3 Physical and chemical process 1.9) 1.4 Introduction, definition and types of processes: Batch, continuous and semi-batch process 1.10) 1.5 Steady and unsteady-state processes
2. 2.0 Material balance 2.1) 2.1 Introduction to material balances: Integral and differential balance 2.2) 2.2 Material balance calculations 2.3) 2.2.1 Integral material balances on batch process 2.4) 2.2.2 Differential material balances on continuous process 2.5) 2.2.3 Material balances on multiple-unit processes 2.6) 2.2.4 Material balances on recycle and bypass processes
3. 3.0 Distillation 3.1) Physical concepts of distillation 3.2) 3.2 Vapor-liquid equilibrium relationship 3.3) 3.2.1 Vapor-liquid equilibrium of a pure liquid 3.4) 3.2.2 Vapor-liquid equilibrium of an ordinary binary liquid mixture in close and open system 3.5) 3.3 Ordinary binary mixture for a closed system 3.6) 3.3.1 Boiling point diagram 3.7) 3.3.2 Vapor-liquid equilibrium diagram 3.8) 3.3.3 Vapor-liquid equilibrium compositions 3.9) 3.3.4 Relative volatility

3.10) 3.4 Single-stage distillation
3.11) 3.4.1 Flash (equilibrium) distillation.
3.12) 3.4.1.1 Equilibrium operating line
3.13) 3.4.1.2 Equilibrium composition of vapor and liquid
3.14) 3.4.2 Batch (differential) distillation
3.15) 3.4.2.1 Rayleigh equation
3.16) 3.4.2.2 Simplified Rayleigh equation
3.17) 3.5 Multi-stages distillation
3.18) 3.5.1 Rectification - definition and description of process
3.19) 3.5.2 McCabe - Thiele method of calculation including reflux ratio and the number of theoretical stages
3.20) 3.5.3 Overall plate efficiency
3.21) 3.5.4 Minimum and infinite reflux ratio

4. 4.0 Liquid-liquid extraction
4.1) Definition and cases for using liquid-liquid extraction
4.2) 4.2 Triangular phase diagram
4.3) 4.3 Liquid-liquid extraction for miscible solvent
4.4) 4.3.1 Single-stage extraction calculation for miscible solvent
4.5) 4.3.2 Multistage counter current and number of theoretical stages
4.6) 4.3.3 Minimum solvent flow rate

5. 5.0 Gas absorption
5.1) 5.1 Definition, applications and notations used in gas absorption
5.2) 5.2 Equipment and description for gas absorption
5.3) 5.2.1 Packed tower - description and flow arrangement
5.4) 5.2.2 Packing materials - characteristic and geometrical shapes
5.5) 5.3 Multistage counter-current operation, material balance and calculation based on graphical method
5.6) 5.4 Number of theoretical stages - graphical method

6. 6.0 Drying and humidification
6.1) 6.1 Definition and principles of drying
6.2) 6.2 Typical drying rate curve
6.3) 6.3 Simple calculations related with drying
6.4) 6.4 Equipment used in drying operation
6.5) 6.5 Definition and principles of humidification
6.6) 6.6 Psychrometric chart (Humidity chart)
6.7) 6.7 Humidifier: Description and theoretical principles
6.8) 6.8 Cooling tower: Description and theoretical principles

7. 7.0 Size reduction
7.1) 7.1 Introduction to size reduction
7.2) 7.2 Methods of size reduction
7.3) 7.2.1 Compression
7.4) 7.2.2 Impact
7.5) 7.2.3 Attrition
7.6) 7.2.4 Cutting
7.7) 7.3 Types of equipment used
7.8) 7.3.1 Crushers
7.9) 7.3.2 Grinders
7.10) 7.3.3 Ultrafine grinders
7.11) 7.3.4 Cutting machines

8. 8.0 Agitation and mixing
8.1) 8.1 Introduction to agitation and mixing
8.2) 8.2 Agitation equipment used
8.3) 8.2.1 Vessel
8.4) 8.2.2 Agitators
8.5) 8.3 Flow patterns in agitated vessels
8.6) 8.4 Prevention of swirling

9. Equilibrium distillation
9.1) Lab 1: Separating unknown binary mixture by using simple distillation

10. Batch distillation
10.1) Lab 2: Separating ordinary binary mixture consisting of acetic acid and water

11. Liquid-liquid extraction
11.1) Lab 3: Single-stage liquid-liquid extraction

12. Gas absorption
12.1) Lab 4: Determination of air pressure differential across the dry column as a function of the air flow rate

13. Gas absorption
13.1) Lab 5: Determination of air pressure differential across the wet column as a function of the air flow rate

14. Size reduction
14.1) Lab 6: Introduction to Hammer Mill: Calculation percent of size reduction

15. Drying and humidification
15.1) Lab 7: Introduction to drying process: Drying of a solid

Assessment Breakdown	%
Continuous Assessment	50.00%
Final Assessment	50.00%

Details of Continuous Assessment

Assessment Type	Assessment Description	% of Total Mark	CLO
Practical	Laboratory report cover distillation, liquid-liquid extraction, gas absorption, size reduction and drying processes.	20%	CLO4
Quiz	Open Book Online Quiz 1 (Topic 7 and 8)	10%	CLO1
Test	Online Test 1 (Topic 2 and 3)	20%	CLO2

Reading List

Reference Book Resources

- **W. L. McCabe, J. C. Smith and P. Harriot 2005, *Unit operations of chemical engineering*, 7 Ed., McGraw-Hill Education New York [ISBN: 0-07-039366-4]**
- **Christie John Geankoplis 2003, *Transport processes and separation process principles (includes unit operations)*, 4 Ed., Prentice Hall New Jersey [ISBN: 0-13-101367-X]**
- **R. M. Felder, R. W. Rousseau 2005, *Elementary Principles of Chemical Processes*, 3 Ed., John Wiley & Sons, Inc. United States of America**
- **M. Coulson and J. F. Richardson 2002, *Chemical Engineering: Unit Operations*, 5 Ed., Butterworth-Heinemann Oxford**
- **D. M. Himmelblau and J. B. Riggs 2003, *Basic Principles and Calculations in Chemical Engineering: International Edition*, 7 Ed., Pearson Education Switzerland**

Article/Paper List	This Course does not have any article/paper resources
Other References	This Course does not have any other resources