BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION

FIRST SEMESTER 2018-2019

Course Handout (Part II)

Date: 02/08/2018

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	: **CHE F211**
Course Title	: **Chemical Process Calculations**
Instructor-in-charge	: P C Sande
Tutorial Instructor	: Bhanu Vardhan Reddy K., P C Sande.
Teaching Assistant	: Seriyala Anil Kumar

1. Course description and scope:

This course is designed for the beginner in the field of chemical engineering. It deals with calculations which form the basis of the design of a chemical industrial plant or process. It aims to inculcate conceptual knowledge as well as systematic and sound problem solving skills in the student. The macroscopic and continuum view of matter is assumed. Material and energy balances are introduced, explained and worked with. *The problems solved are prototypes of real process plants*. **Coverage includes material, and energy balances with and without chemical reaction, single and multiple units, ideal gas and real gas systems, saturation and humidity.** Fundamentals of this course are required in many other courses such as Chemical Process Technology, Chemical Reaction Engineering, Separation Processes and Process Modeling and Simulation.

2. Main objectives:

- To learn and apply important definitions and conventions in chemical processes (eg: degrees of freedom, open and closed systems, steady and unsteady processes).
- To solve material and energy balances for single and multiple units with or without chemical reaction and feedback/bypass; also solving material and energy balances simultaneously.
- To apply the relevant physics (phase diagrams, saturation, humidity etc.) in solving the balances for flow sheets

3. Text Book:

Himmelblau, D. M and Riggs, J.B. "Basic Principles and Calculations in Chemical Engineering", PHI, 7th ed., 2009.

4. Reference Book:

B. I. Bhatt, S. M. Vora, "Stoichiometry", Tata McGraw-Hill Pub. Co.., 4rd ed., 2004.

5. Course Plan:

Module Number	Lecture session/Tutorial Session (content)	Reference (Textbook chapter number)	Learning Outcome
1. Industrial relevance of process calculation. Units and conversion factors.	L1-2 Importance of process calculations in chemical industry, Units and Dimensions, Conversion of units, Dimensional consistency	1.1-1.4 (7th ed.,) 2.1, 2.2, 2.3 (8th ed.,)	Realize utility and need for CPC in process industry. Review of units.
2. Review preliminaries.	L3 The mole, density, specific gravity, flow rate, mole and mass fraction, multi-component solution and mixtures, concentration	2 (7th ed.,) 2.6, 2.8, 2.9, 2.12 (8th ed.,)	Understand these definitions and apply in calculations. Prepare to do material and energy balances.
3. Important definitions	L4-5 Temperature, Pressure, Significant figures, choosing a Basis,	4, 5, 1.5, 3 (7th ed.,) 2.10, 2.11, 2.4, 2.7 (8th ed.,)	
4. Material Balance preliminaries	L6-8 Open Vs Closed systems, Steady Vs Unsteady state systems, Multi component systems, Systems with chemical reactions, Problem solving strategy, solution validation,	6, 7, 1.6 (7th ed.,) 3.1, 3.2, 2.5 (8th ed.,)	

	Industrial example (out of text book)		
5. Material Balance for Single Unit	L9-10 Material Balance Problems without Chemical Reaction	8 (7^{th} ed.,) 4 (8^{th} ed.,)	Learn and calculate various quantities from material balances, for different types of systems
6. Chemical Reaction Stoichiometry	L11 Stoichiometry and Its Terminology	9 (7^{th} ed.,) 5.1, 5.2 (8^{th} ed.,)	
7. Material Balances with Chemical Reaction	L12 Material Balance Problems with Chemical Reaction: species, elemental and combustion	10 (7^{th} ed.,) 5.3, 5.4, 5.5 (8^{th} ed.,)	
8. Material balances involving multiple subsystems	L13-14 Material balance problems involving multiple subsystems	11 (7^{th} ed.,) 6.1, 6.2 (8^{th} ed.,)	
9. Material balances with recycle, bypass and purge	L15 Recycle bypass and purge calculations	12 (7^{th} ed.,) 6.3, 6.4, 6.5 (8^{th} ed.,)	
10. Ideal gas Vs real gas systems	L16-17 Ideal gas law calculations, ideal gas mixtures and partial pressure, real gas compressibility	13, 14 (7^{th} ed.,) 7.1, 7.3, 7.4 (8^{th} ed.,)	Learn relevant physics of single phase and multiphase systems. Learn to apply these concepts (and hence equations) in material and energy balances
11. Vapor pressure and saturation, calculation of dew point	L18 Real gas equations of state (only main concept), Phase diagram, vapor pressure estimation, saturation, condensation, vaporization	15, 16, 17 (7^{th} ed.,) 7.2, 8.1, 8.2, 8.3, 8.4 (8^{th} ed.,)	
12. Definition of partial saturation	L19 Partial saturation and humidity	18 (7^{th} ed.,) 8.5 (8^{th} ed.,)	

13. Humidity chart	L20 Terminology, properties from humidity chart	29 (7^{th} ed.,) 11 (8^{th} ed.,)	
14. Energy balance preliminaries	L21 Terminology, Types of Energy, Energy balance for: Closed system (steady and unsteady), Open system (steady and unsteady)	21,22 (7^{th} ed.,) 9 (8^{th} ed.,)	Learn and calculate various quantities from energy balances of different types of systems
15. Calculation of enthalpy changes, use of equations and tables	L22-24 Calculation of enthalpy changes, heat capacity equations, **Research Assignment**	23 (7^{th} ed.,)	
16. Enthalpy balances	L25-27 Energy balances in the absence of chemical reactions	24 (7^{th} ed.,) 9.3 (8^{th} ed.,)	
17. Energy balance with chemical reaction,	L28-30 Heat of formation, Heat of Reaction, heat of combustion	25 (7^{th} ed.,) 10 (8^{th} ed.,)	
18. Heats of solution and mixing	L31-33 Heat of solution, dissolution and mixing	28 (7^{th} ed.,)	
19. Solving simultaneous material and energy balances	L34-36 Analysis of the degrees of freedom, solving material and energy balances simultaneously	26 (7^{th} ed.,)	Learn to integrate the calculations
20. Presentation of Research Assignments	L37-38 The best research assignments will be assessed and presented.	Class ppt.	Assignment outcomes is to be able to carry out literature survey and link textbook concepts to today's research
21. Revision	L39-41Problem solving	All chapters	

5. Evaluation Scheme:

Components	Duration	Marks (Weight age)	Remarks
Mid Semester Test	90 min	90 (30%)	CB, 9/10 2:00 - 3:30 PM
Beginner's test[#], Tutorial Tests[*]	10 min	5+ (5×10) = 55 (18%)	CB
Classroom tests/ group assignments etc.[&]		20 (7%)	-
Classroom research paper presentation[$]		5+10 (5%)	-
Comprehensive Examination	3 hours	120 (40%)	CB/OB , 3/12 FN

[#]This is an announced test, usually held in the first tutorial class. This beginner's test will be for 5 marks and will have no 'best of' option. It will cover units, conversions and dimensions.

[*]Tutorial tests will be surprise in nature. All tests will be conducted in the tutorial hours, unless otherwise announced in class, and will be of 10 marks each. Best five performances (out of six) will be considered. To avoid having assignment and tutorial tests towards the end, more number of tutorial tests will be conducted before mid-semester. **No make-up for tutorial tests for any reason since 'best of option' is provided.**

[&] **Classroom components are surprise in nature and will be conducted during regular lecture hours and could cover any testing mode, such as paper quiz, group work etc.** This component aims to benefit students who remain proactive and regular throughout the course.

[$] This component is research oriented and will be announced and guided. Each student group must choose a research paper and make a short presentation of the same by linking-up CPC concepts from text book with the research paper. The component aims to link text book concepts with current research.

6. Make-up Policy:
Make-up for Mid-sem will be granted only in case of illness requiring hospitalization and justified by warden of the respective bhavan with accompanying medical certificate. **Only medical certificate will NOT be considered**. Make-up for comprehensive examination must be obtained from ID. **There will be no make-up for tutorial tests**.

7. Chamber Consultation Hour:
To be announced in the class.

8. Notices: all announcements will be made in class/ nalanda only.

Instructor-in-charge

CHE F211