BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
HYDERABAD CAMPUS
FIRST SEMESTER 2023-24
Course Handout (Part II)

Date: 11/08/2023

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 F214**
Course Title **: Engineering Chemistry**
Instructor-in-charge **:** Karthik Chethan V.

Tutorial Instructors : Karthik Chethan V.

1. Scope and Objective of the Course:

Engineering chemistry is very simply a highly interdisciplinary course that permeates into all branches of chemistry, physics, thermodynamics, materials science, materials characterization, nanoscience and engineering and product development. It includes every product that we encounter in our lives, all the way from toothbrush to space shuttle components.

The main advantage about a course such as this is that every student will find something that will suit one's aptitude and sensibilities (analytics, logical reasoning, hypothesizing, identifying issues and compiling, experimenting, illustrating, modeling and simulating, product development, machine learning, artificial intelligence etc.). The disadvantage would be the breadth and rigor that is required to undertake this learning adventure.

The key is not to be overwhelmed but to maintain continuity and learn in an integrated manner by identifying the points of intersection between topics and the huge number of similarities between concepts and the rules governing the same. This is possible with a commitment to relevant and creative analogies and project based learning. In short, the approach is to reorient an academic subject such as engineering chemistry into a real-world based problem-solving and product development course.

The objective of the course is to introduce the interdisciplinary nature of science and engineering to Chemical Engineering undergraduate students. It gives a basic understanding of aspects of chemistry such as reactions and processes, physical chemistry, electrochemistry, analytical chemistry and materials science in the context of engineering applications and products.

For the students, the course should provide a strong holistic base in regards to learning, skill and personal development and should facilitate in making learning easy and meaningful for life.

Course Outcomes (CO):

CO1. To learn and gain some insights in real world chemistry and its association in engineering products (familiarity with reactions, processes, problem solving, product development and characterization of materials that are commonly encountered in adhesive, composite, aerospace, defence, soap, food, chemical and biotechnology industries).

CO2. To conduct hypothesis based discussions to solve chemistry and engineering based issues in a confident and feasible manner by combining conceptual, numerical and design based solutions learnt

during the course of the semester. The issues can be research, product development, process, quality control and application related.

CO3. To inculcate the skill of coupling micro and macro aspects of chemistry and engineering, and to apply interdisciplinary skills of science and engineering in problem-solving. The course will attempt to cover various case studies in engineering chemistry.

Student Learning Outcomes (SLO): SLOs are outcomes (a) through (l) plus any additional outcomes that may be articulated during the course.

(a) an ability to learnt to alleviate and manage fear (fear of failure, embarrassment, grades etc.) which rears its ugly head in learning and learn to connect and collaborate with peers and faculty in and out of classrooms. To develop into thinking (how and why) and collaborative individuals.
(b) an ability to apply knowledge of science and engineering.
(c) an ability to design and conduct characterization experiments, as well as to analyze and interpret results.
(d) an ability to select and apply relevant characterization techniques to meet specific desired needs within realistic constraints such as availability, expertise and economics.
(e) an ability to function on teams.
(f) an ability to identify, formulate, and solve engineering problems.
(g) an understanding of professional and ethical responsibility.
(h) an ability to communicate effectively.
(i) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(j) a recognition of the need for, and an ability to engage in life-long learning
(k) a knowledge of contemporary issues
(l) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

2. Text Book:

T1. Dr Suba Ramesh and others, Engineering Chemistry, Wiley India, , 2013, 2nd Ed. (https://www.wileyindia.com/wiley-engineering-chemistry-second-edition.html)
ISBN: 9788126543205, available on Amazon, Flipkart and Kindle

Reference Books:
R1. P. W. Atkins, Elements of physical chemistry, 8th edition, Oxford University Press.
R2. T. W. Graham Solomons and Craig B. Fryhle, Organic Chemistry, 9th edition, John Wiley and sons.

3. Course Plan:

Lect. No.	Topic	Learning Objectives	Ref. Chap./ Sec.Book)
1-2	**Introductory Concepts**	Intro to the course. A quick review with day to day examples (Atom and its constituents, electronic configuration,	TB- CH 1

		octet pair, electronegativity, dipoles, hydrogen bonding, hybridization, bonding and molecular orbitals).	
3-5	**Organic Chemistry:** Important Functional Groups	To learn about structure, synthesis and reactions of functional groups (Alcohols, carboxylic acids, amines, aldehydes and ketones, ethers).	TB- CH 9
6-7	Identifying Functional Groups in Our Lives (environment and our bodies, in household items and industry products)	To learn to work hands-on with functional groups and learn about its significance in real world products and applications (both biological and synthetic scenarios)	Project or activity based learning (experiential learning)
8-10	Reactions that are Responsible for Real-World Products	To learn about reactions such as, Acid-alcohol esterification, Epoxy crosslinking, Phenolics condensation, Grafting by free radical reaction, Silane-coupling agent reaction, Catalytic reaction, Aldol condensation and Protein reactions.	class notes and TB-CH 9
11-12	Some Real-World Product Based Reactions (used in adhesives, aerospace and defence composite products, soaps, food, textiles, paints, tarmac/roads etc.)	To practically conduct Epoxy-crosslink, Unsaturated polyester crosslink, phenolics reaction, grafting on natural rubber and silicone rubber reaction (to develop core-shell nano rubber) etc.	Project or activity based learning (experiential learning)
13-15	**Physical Chemistry** Thermo-Physical and Thermodynamic Properties	To understand entropy, enthalpy and free energy in a conceptual and tangible context. (Heat capacity, Enthalpy of vaporization and fusion, thermal conductivity, thermal diffusivity and thermal expansion and surface tension properties).	TB- CH 4 and lab visit (Central Analytical Lab-1 [CAL-1])

16-17	Thermo-Physical and Thermodynamic Properties	To learn to identify engineering properties in thermodynamics. To work on mathematical puzzles to gain better insight on Boltzmann entropy. To study the behavior of rain or water drops as it falls off different surfaces.	Project or activity based learning (experiential learning)
18-19	Phase Diagrams and its Engineering Relevance	To learn about Phase diagrams (one-component and two component systems).	TB- CH 6
20-21	Adsorption in Engineering (membranes, chromatography etc.)	To learn about the driving force and mechanisms of Adsorption, Adsorption isotherms, Equilibrium relation for adsorbents, Breakthrough concentration curves and Applications of Adsorption.	TB- CH 8 and lab visit (CAL-1)
22-23	Membrane Technology	To study membrane materials by using microscopy. To conduct membrane making and electrospinning.	Project or activity based learning (experiential learning)
24-26	Electrochemistry	To learn the principles of electrochemistry, Electrochemical cells, Electrode potential, Nernst equation, Measurement of EMF, Types of electrodes and Concentration cells.	TB- CH 7
27-28	Batteries and Dielectric Materials	To develop simple battery. To conduct Dielectric constant measurement of various materials and its interpret the results.	Project or activity based learning (experiential learning)
29-33	**Analytical Chemistry** Instrumental Methods of Analysis	To learn the principles, instrumentation, operation, results and analysis and troubleshooting of various instruments (Infrared-IR	TB- CH 12 and lab visits (CAL-1 and CAL-2)

		spectroscopy, UV-Visible, NMR spectroscopy and Chromatography).	
34-35	Instrumentation Case Studies	To show the evidence of grafting functional groups by using IR. To show evidence of fish oil in pharma by using UV-Vis. To identify the fatty acids types in vegetable oils by using NMR.	Project or activity based learning (experiential learning)
36-37	Instrumental Methods of Analysis	Dynamic Laser Scattering (DLS) and Thermal Gravimetric Analysis (TGA)	Class notes, TB- CH 12 and lab visits (Pharma Lab and CAL-1)
38-39	Instrumentation Case Studies	To study the stability of emulsions by using DLS. To study the thermal degradation of various materials by using TGA.	Project or activity based learning (experiential learning)
40	**Industrial & Engineering Chemistry** Engineering Materials (ceramics)	To learn about Ceramics (Intro to ceramics and its properties. To collect and study various ceramic products in campus in regards to composition and some important properties).	TB- CH 14 and project or activity based learning (experiential learning)
41	Engineering Materials (metals)	To learn about Metals (Intro to metals and its properties. To collect and study various metallic products in campus in regards to composition and some important properties).	TB- CH 15 and project or activity based learning (experiential learning)
42	Engineering Materials (polymers)	To learn about Polymers (Intro to polymers, classification of polymers, types of polymerization, molecular weight of polymers. To collect and study various polymeric products in campus in regards to composition and some important properties).	TB- CH 13 and project or activity based learning (experiential learning)

4. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Remarks
Midterm	90 mins	20%	13/10 - 2.00 - 3.30PM	Open Book
Continual Evaluation*	NA	45%		NA
Comprehensive Exam.	3 hours	35 %	19/12 FN	Open book

*Continual evaluation will involve the following:
1. Brainstorming and interacting in class (attending classes and maintaining continuity is highly encouraged). For the instructor it will allow for clear assessment of students and provide relevant opportunities for students to continually learn and improve.
2. Lab visits and learning in hands-on manner (attending labs and experimenting is highly encouraged).
3. Each student will work on a group project for the semester (the projects will be part of the project or activity based learning (experiential learning) listed in the table) (the groups will contain a maximum of 3 students and the freedom to choose group members and projects will be provided to the students). More details about the projects will be discussed when we meet in class.
4. Last but not least, for a fair continual evaluation, attending classes and interacting in class and conducting project activities is imperative.

Chamber Consultation Hour: To be announced later.
Notices: All notices related to the course will be uploaded in CMS.
Make-up Policy: Make-up will be granted for genuine cases with prior approval.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Karthik Chethan V.
INSTRUCTOR-IN-CHARGE