UNIVERSITY OF MUMBAI

Revised Syllabus for the

Bachelor of Engineering

Chemical Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019-2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande

Associate Dean, Faculty of Science and Technology

Member, Academic Council, RRC in Engineering, University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande

Associate Dean

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Member, Academic Council, RRC in Engineering

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Program Structure for B.E. Chemical Engineering (Revised 2020-2021)

Semester III

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC301	Engineering Mathematics-III	3	-	1	3	-	1	4
CHC302	Industrial and Engineering Chemistry I	3	-	-	3	-	-	3
CHC303	Fluid Flow Operations	3	-	-	3	-	-	3
CHC304	Chemical Engineering Thermodynamics I	3	-	-	3	-	-	3
CHC305	Process Calculations	3	-	-	3	-	-	3
CHL301	Industrial and Engineering Chemistry I Lab	-	3	-	-	1.5	-	1.5
CHL302	Fluid Flow Operation Lab	-	3	-	-	1.5	-	1.5
CHL303	Basic Chemical Engineering Lab	-	3	-	-	1.5	-	1.5
CHL304	Skilled Based Lab: Chemical Technology Lab	-	2*2	-	-	2	-	2
CHM301	Mini Project 1A	-	3#	-	-	1.5	-	1.5
	Total	15	16	1	15	8	1	24

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC301	Engineering Mathematics-III	20	20	20	80	3	25	-	-	125
CHC302	Industrial and Engineering Chemistry I	20	20	20	80	3	-	-	-	100
CHC303	Fluid Flow Operations	20	20	20	80	3	-	-	-	100
CHC304	Chemical Engineering Thermodynamics I	20	20	20	80	3	-	-	-	100
CHC305	Process Calculations	20	20	20	80	3	-	-	-	100
CHL301	Industrial and Engineering Chemistry I Lab	-	-	-	-	3	25	25	-	50
CHL302	Fluid Flow Operation Lab	-	-	-	-	3	25	25	-	50
CHL303	Basic Chemical Engineering Lab	-	-	-	-	-	25	-	25	50
CHL304	Skilled Based Lab: Chemical Technology Lab	-	-	-	-	-	25	-	25	50
CHM301	Mini Project 1A	-	-	-	-	-	25	-	25	50
	Total	-	-	100	400	-	150	50	75	775

***Indicates Theory class to be conducted for full class**

 # indicates work load of Learner (Not Faculty), for Mini Project;
faculty load : 1 hour per week per four groups, for Mini Project

Semester III

Course Code	Course Name	Credits
CHC302	Industrial and Engineering Chemistry – I	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hours	-	-	-	100

Prerequisites

1. Basic knowledge of Vander-Waal's forces, various bonds, octet rule, resonance theory, and hybridization.
2. Knowledge of periodic table, properties of transition metals, non-metals, oxidation state, variable valency, basic functional groups etc.
3. XII class chemistry

Course Objectives

1. To study nomenclature, shapes, stability of coordination compounds and its applications.
2. To understand structures of different bio-molecules and stereochemistry of organic molecules.
3. To study structure and bonding of organometallic compounds and its industrial applications.
4. To study applications of electrochemistry conductometrically and potentiometrically and solvent extraction technique.
5. To study the effect of temperature on stability of reactive intermediate and their reaction mechanism.
6. To understand importance of dyes, fertilizers and their effects.

Detailed Syllabus

Module No	Content	No of Hours
01	**Applications of Electrochemistry-** Conductance, specific conductance, equivalent conductance, molar conductance. Effect of dilution and temperature on conductance. Transport number, moving boundary method and numericals.	04

	Conductometry: Principle and types of titrations - Acid-base and Potentiometric precipitation titrations	
02	**Co-ordination chemistry & Organometallic compounds** Definitions: Co-ordination number/ligancy, Complex ion, Co-ordination/dative bond. Nomenclature and isomerism (only geometrical and structural) in co-ordination compounds w.r.t co-ordination number 4 and 6. MOT, Effective Atomic Number (EAN) and numericals. Crystal field theory (CFT), Application of CFT to octahedral complexes and its drawbacks. Measurement of CFSE (10Dq) and numericals. Applications of coordination compounds**.** **Organometallic compounds:** Definition, metal clusters. Chemistry of Fe-carbonyls [Fe $(CO)_5$] and [$Fe_2(CO)_9$] w.r.t preparation, properties, structure and bonding.	**08**
03	**Stereochemistry & Bio-Inorganic chemistry** **Stereochemistry:** Definition, geometrical isomers and optical isomers, Asymmetric carbon, Enantiomers and Diastereomers, different configurations – R, S, E, Z. Conformational analysis of n-Butane and Cyclohexane. **Bio-Inorganic chemistry:** Biochemistry of proteins containing Fe and Zn, oxygen atom transfer reactions of biomolecules containing Fe. Cytochrome	**06**
04	**Reactive Intermediates & Name reactions** Definition, Carbocation, Carbanion, Carbene and Free radicals-formation, structure & stability. **Name reactions with mechanism**: Carbocation – Pinacol Pinacolone rearrangement reaction, Carbanion – Michael addition reaction, Carbene - Reimer-Tiemann reaction, Free radical- Norrish type- I, Norrish type-II. **Reaction pathways.** Difference between Transition state & intermediate. Equilibrium (Thermodynamically) and Rate (Kinetically) controlled reactions-explain w.r.t. sulphonation of naphthalene, Nitration of Chlorobenzene, Friedel-Craft's reaction.	**08**
05	**Dyes and Fertilizers** **Dyes**: Nomenclature, methods of application, color and chemical constitution (chromophore-auxochrome), classification of dyes on the basis of chemical structure, diazotization and coupling for azo dye, synthesis of congo red, alizarin, methyl orange, **Fertilizers**: Definition, nutrient functions in plant growth: Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphur, Iron, Zinc, Chlorine, Role of these nutrients as: Functions, Excess supply and deficiency. Qualities of ideal fertilizers, types of fertilizers, manufacture of fertilizers- Ammonium sulphate, Superphosphate, Triple superphosphate, Pollution caused by fertilizers.	**08**
06	**Ion Exchange and solvent extraction techniques** Ion exchange resins, cation and anion exchangers. Desalination by ion exchange and separation of lanthanides. Liquid-Liquid solvent extraction, Nernst distribution law, distribution ratio. Batch, continuous and counter current extraction. Numericals based on solvent extraction.	**05**

❖ **One guest lecture from industry expert.**

Course Outcomes

On completion of the course the **students will be able to:**

1. Understand the different theories of chemical bonding, organometallic chemistry and reactive intermediate.
2. Apply knowledge of dyes, fertilizers, analytical techniques of separation, identification and quality of fertilizers.
3. Describe the reaction mechanisms, states of molecules, various types of dyes and reaction pathway in biological process.
4. Justify stability of coordination compounds, kinetics and energy of reactions and importance of organometallic compounds in biological process.
5. Express role of biomolecules, elemental constituents in fertilizers, and exchangers in industries.
6. Apply concepts of electrochemistry and its applications quantitatively.

Assessment

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 marks):

1. Weightage of each module in end semester examination will be proportional to number of respective lectures.
2. Question paper will comprise of total **six questions, each carrying 20 marks**
3. **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
4. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
5. Only **Four questions need to be solved.**

Recommended Books

1. Engineering Chemistry- Jain& Jain Dhanpat Rai & Co. (P) Ltd
2. Engineering Chemistry- Satyaprakash & Manisha Agrawal, Khanna Book Publishing
3. Organic reaction Mechanisms- V.K. Ahluwalia , Rakesh Parashar, Narosa Publication
4. Industrial Chemistry – B K Sharma, Goel Publishing House

Reference Books

1. Principles of Physical Chemistry- B. R. Puri, L. R. Sharma, M.S. Pathania.
2. Principles of Inorganic Chemistry- Puri, Sharma, Kalia ,Milestone Publishers
3. Advanced Inorganic Chemistry – J. D. Lee
4. Organic Chemistry - I L Finar volume I and II.
5. Organic Chemistry – J. Clayden, Greeves, Warren, Wothers. Oxford university press
6. Principles Of Bioinorganic Chemistry- S.J. Lippard & J.M. Berg
7. Stereochemistry: Conformation and Mechanism by Kalsi, P.S, New Age International. Delhi
8. Stereochemistry of carbon compounds- Ernest Eliel, Tata McGraw Hill.
9. A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991)
10. Technology of Textile Processing Vol. 2: Chemistry of Dyes and Principles of Dyeing- Prof. V. A. Shena

Semester III

Course Code	Course Name	Credits
CHL301	Industrial and Engineering Chemistry Lab-I	1.5

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/OR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	25	--	50

Prerequisites

1. Basic knowledge of quantitative terms, Mole fractions, Normality, Morality etc.
2. Basic identification of salts, acids, bases, indicators etc.
3. Basic introduction of lab safety and handling of glass wares.

Lab Objectives

1. To enable students to prepare the standard solutions, carry out volumetric analysis to check their accuracy and present the outcome of the experiment in statistical format to calculate standard deviation.
2. To provide students an insight of titrimetry to determine contents of solution quantitatively.
3. To enable students to apply knowledge of instrumental analysis to carry out acid-base titrations without indicators, to calculate solubility product etc.
4. To make students learn the estimation of organic compound from given solution quantitatively.
5. To make students understand the concept and importance of gravimetric analysis in determination of amount of element in given solution.
6. To enable students carry out synthesis of chemicals by laboratory methods

Lab Outcomes

On completion of the course the **students will be able to:**

1. Prepare standard solutions, check their accuracy and present results in statistical format to calculate standard deviation.
2. Perform titrations and determine contents of solution quantitatively.
3. Apply knowledge of instrumental analysis like Conductometry and Potentiometry.
4. Learn methods of estimation of organic compounds quantitatively.
5. Carry out gravimetric analysis systematically with proper understanding.
6. Carry out synthesis of chemicals in laboratory.

List of Experiments (Minimum Eight)

Experiment no.	Details of Experiment	Lab Hours
1	**Volumetric analysis:** Preparation of standard solutions and to find normality and deviation factor.[Any two]	3
2	**Titrimetric analysis:** Analysis of talcum powder for Mg content by EDTA method	3
3	Analysis of Aspirin as per I.P. or USP	3
4	Estimation of Glycine by non aqueous titration using perchloricacid	3
5	**Conductometric Titrations.** Titration of strong acid with strong base.	3
6	Weak acid against strong base.	3
7	Titration of mixture of weak acid and strong acid against strong base	3
8	**Potentiometric Titrations** Titration of strong acid and strong base potentiometrically.	3
9	Determination of solubility and solubility product of AgCl.	3
10	**Organic estimations** Estimation of aniline	3
11	Estimation of phenol	3
12	Estimation of Acetamide	
13	**Gravimetric estimation of** Barium as $BaCl_2$	3
14	Tin as $SnCl_2$	3
15	Nickel as Ni D.M.G.	3
16	**Preparation.** Preparation of Methyl Salicylate	3
17	Preparation of Azo dye (benzene diazonium salt and 2- naphthol from aniline/ nitroaniline)	3
18	Estimation of sodium by Ion Exchange chromatography.	3
19	Determination of Partition coefficient of iodine in water and carbon tetra chloride.	3

Assessment

Term Work (25 marks):

Distribution of marks will be as follows:

Laboratory work: 15 marks

Assignments: 05

Attendance: 05

End Semester Practical Examination/orals (25 marks):

Practical Examination will be on experiments performed in the laboratory

Reference Books

1. Vogel's Quantitative Chemical Analysis- David J. Barnes J. Mendham, R.C. Denney, M.J.K Thomas Pearson Education; 6 edition
2. Laboratory Manual Engg. Chemistry- Anupma Rajput, Dhanpat Rai & Co.

3. Vogel’s Textbook of Practical organic chemistry.