National Institute of Technology Agartala

Department of Chemistry

Curricula and Syllabi

for

One-Year Chemistry Course for B.Tech.

July-2019

First Semester

S.N.	Course Name	Code	Teaching hrs/week			Credit
			L	T	P	
1	Engineering Chemistry-I	CH-101	3	0	0	3
2	Engineering Chemistry Laboratory	CH-102	0	0	2	1
Total			3	0	2	4
Total contact hrs per week = 5			**Total credit = 4**			

Second Semester

S.N.	Course Name	Code	Teaching hrs/week			Credit
			L	T	P	
1	Engineering Chemistry-II	CH-201	2	0	0	2
Total			2	0	0	2
Total contact hrs per week = 2			**Total credit = 2**			

First Semester

Course: Engineering Chemistry-I Code: CH-101 L-T-P: 3-0-0 Credit: 3

Program Outcomes (POs):

Programs must validate that their students achieve the following outcomes

PO - 1	**Engineering knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO - 2	**Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO-4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO -5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO-6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and sustainability:** Understand the impact of the professional and engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibili-ties and norms of the engineering practice.
PO-9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication:** Communicate effectively on complex 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.
PO-11	**Project management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environ-ments.
PO-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 technologi-cal change.

PEOs (Program Educational Objectives):

PEO-1	Acquire the fundamental principles of chemistry with modern experimental and theoretical skills.
PEO-2	Ability to analyze the problems in the context of practical relevance to the society while maintaining environmental safety and economic factors.
PEO-3	Enhancing their professional growth along with scientific knowledge through continuing education.

PSOs (Program Specific Objectives):

Students will be able to

PSO-1	Learn and develop their concepts on a wide spectrum of basic topics in chemistry from chemical bonding, polymers, electrochemistry to control of pollution, among others.
PSO-2	Successfully apply the principles, learned as a part of this course, to different engineering aspects and practical day to day life.
PSO-3	Gauge the relevant environmental and societal issues and look for their solutions using the concepts of chemistry acquired from this course.

Course Objective:

1. Chemical bonding, which deals with different types of chemical bonds present in various chemical compounds and biological molecules, will cover bonding, structure, geometry and hybridization of various molecules.

2. Studying this topic the students will learn about the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil into several value added products.

3. To get knowledge about water quality parameters and find ways to make water suitable for domestic and industrial uses.

4. Pollution, different types of polluting agent is incorporated to make the student aware of ways to keep atmosphere pollution free.

5. Electrochemistry deals with conductance in electrolytic solutions and its applications.

6. The objective of introducing polymer is to provide an overview of the fundamentals of polymer science and engineering, including the chemical structure of polymers, their methods of preparation, and a variety of properties exhibited by polymers.

Course Content:

Unit-1: Chemical Bonding (8 L)

Ionic and covalent bonds; valence bond theory (VBT) of covalency-atomic orbitals and their overlap, hybridization of orbitals-definition, types, associated geometries, VSEPR theory, shapes of simple molecules like H_2O, CO_2, NH_3, CH_4, C_2H_6, C_2H_2 BF_3, PCl_5, SF_6, inter-halogen and noble gas compounds in the light of the hybridization state of the central atom and VSEPR effects; molecular orbital theory (MOT) - concept of molecular orbitals, molecular orbital energy level diagrams; homonuclear diatomic molecules (like He_2, O_2, N_2) and their molecular ions; bond order, bond length and magnetic properties; non-covalent interactions: van der Waals and hydrogen bonding and their effect over physical properties.

Unit-2: Fuels (6 L)
Definition and classification of fuels; characteristics of good fuel; comparison among solid, liquid and gaseous fuels; calorific value of fuels-definition, units, higher and lower calorific values, determination of the calorific value of a solid fuel by bomb calorimeter; solid fuel: coal-origin, types; proximate and ultimate analysis; liquid fuel: petroleum- origin, refining of crude oil, cracking; isomerization; catalytic hydrogenation; desulfurization; synthetic petrol; synthesis of gasoline: Fischer-Tropsch and Bergius methods knocking; octane number; cetane number. Numerical problems.

Unit-3: Water (6 L)
Introduction; hardness of water: causes, types, units, disadvantages of using hard water for domestic and industrial purposes (e.g., scale and sludge formation in boilers, caustic embrittlement, boiler corrosion, etc.); softening of hard water (lime-soda, permutit and ion-exchange processes); chemical analysis of water- estimation of free chlorine, total alkalinity, hardness and dissolved oxygen. Numericals on hardness.

Unit-4: Pollution and its Control (6 L)
Pollution-introduction, air pollutants, particulates, smog, photochemical smog, acid rain, green house effects; ozone layer depletion; analysis of gaseous effluents-oxides of nitrogen, oxides of sulphur and H_2S; chemical analysis of effluent liquid streams; BOD, COD; control of air pollution-particulate emission, gaseous pollutants.

Unit-5: Electrochemistry (7 L)
Arrhenius theory of electrolytic dissociation; electrolytes, classification; degree of dissociation; dissociation constant of weak acids; conductance of solutions-specific, molar and equivalent conductance, variation of molar conductance with dilution for strong and weak electrolytes; Kohlrausch’s law of independent migration of ions; Ostwald’s dilution law; Nernst equation for single electrode and electrochemical cells; concept of pH and pOH; buffer solutions; solubility product; common ion effect; indicators and theory of acid-base indicators; Photoelectric effect and solar cells. Numericals.

Unit-6: Polymer Chemistry (7 L)
Introduction; types of polymerization; classification of polymers based on chain characteristics, source, method of synthesis and molecular forces involved; mechanism of polymerization reaction; glass transition and crystalline melting point temperatures; factors influencing glass transition and crystalline melting point temperatures; preparation, properties and uses of the following-polyethylene, PVC, polystyrene, PAN, teflon, nylon-6:6, polyester, rubber-monomer, structure, compounding of rubber, vulcanization, synthetic rubbers-Buna-S, Buna-N, neoprene, butyl rubber and polyurethanes, weight average and number average molecular weight (expression and numerical problems), PDI.

Course Outcome:

CO-1	To predict the structure and properties of different materials using the knowledge of chemical bonding.
CO-2	Knowledge on conventional and non-conventional energy sources and future energy resources in sustainable development.
CO-3	Develop novel systems to analyse water for domestic and industrial use at very low cost.
CO-4	Knowledge of contemporary environmental issues and adverse effects of pollution to living forms and ways to keep problems arising from pollution at bay.
CO-5	Acquire the knowledge of electrochemistry and its principles and apply the same to various disciplines.
CO-6	Comprehend idea about the synthesis and applications of polymers.

Reference Books:

1. Shashi Chawla, A Text Book of Engineering Chemistry, 3rd Edition, Dhanpat Rai & Co., New Delhi, 2007.
2. Jain and Jain, Engineering Chemistry, 15th Edition, Dhanpat Rai Publishers.
3. Dr S. Vairam and Dr. Suba Ramesh, Engineering Chemistry, 1st Edition, Wiley-India, New Delhi.
4. S. S. Dhara, A Text book of Engineering Chemistry,11th Edition, S Chand & Co. Ltd., New Delhi.

Mapping with the POs/ PEOs: Matrix formation for attainments

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) and for No Correlation "-"

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PEO-1	PEO-2	PEO-3
CO-1	3	2		-	-	-	-	-	-	-	-	-	2	-	-
CO-2	-	2		-	-	-	-	-	-	-	-	-	2	-	-
CO-3	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5	-	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-6	-	-		-	-	-	-	-	-	-	-	3	-	2	-

To establish the correlation between COs & PSOs

2: Slight (Low) 3: Moderate (Medium) 4: Substantial (High) and for No Correlation "-"

CO	PSO-1	PSO-2	PSO-3
CO-1	-	4	-
CO-2	-	-	3
CO-3	4	-	-
CO-4	-	-	2
CO-5	2	-	-
CO-6	-	-	-

Course: Engineering Chemistry Laboratory **Code: CH-102**
L-T-P: 0-0-2 **Credit: 1**

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PO -5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO-6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
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PO-11	**Project management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environ-ments.
PO-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 technologi-cal change.

PEOs (Program Educational Objectives):

PEO-1	Adapt to work with new environments, assimilate updated information, and solve complex problems.
PEO-2	Learn the fundamental application of chemistry to set up modern experimental techniques.

PSOs (Program Specific Objectives):

Students will be able to

PSO-1	Achieve confidence in handling chemicals, glassware and instruments professionally in chemical industries and develop the modern laboratory techniques.
PSO-2	Successfully apply their practical experience to determine analytical estimation of materials applicable in our daily life.

Course Objective:

1. Students will learn laboratory techniques in chemistry, carrying out practicals and to determine the quality of water sample.
2. Analytical estimation of metal ions in supplied chemical compound..
3. By applying their practical knowledge student will get exposure to the Chemical Industry.

Course Content:

1. Preparation of primary standard solution (oxalic acid, $K_2Cr_2O_7$).
2. Preparation and standardization of solution (NaOH, HCl, $KMnO_4$).
3. Determination of total hardness of water sample by complexometric titration method.
4. Estimation of total amount of chloride present in a water sample through argentometric titration method.
5. Estimation of carbonate and bicarbonate alkalinity of a water sample by acid base titration method.
6. Determination of iron present in Mohr's salt solution by redox titration.
7. Estimation of acetic acid present in commercial vinegar sample.
8. Determination of alkali content in a given antacid tablet through acid base titration method.
9. Synthesis of aspirin.
10. Separation of caffeine from tea powder.

Course Outcome:

CO-1	Acquisition of necessary laboratory training required for measuring, weighing, transferring chemicals, data collection, while minimizing errors, etc.
CO-2	Acquire analytical skills for preparation of chemicals and estimation of material contstituents.
CO-3	Developing the knowledge to handle water related problems for domestic and industrial purposes.

Reference Books:

1. S. Chawla, Essentials of Experimental Engineering Chemistry, Dhanpat Rai & Co., 3rd Edition, 2010.
2. A. I. Vogel, G. H. Jeffery, Vogel's Text Book of Quantitative Chemical Analysis, Published by Longman Scientific & Technical, 5th Edition, 1989.
3. A. J. Elias, A Collection of Interesting Gneral Chemistry Experiments, Universities Press, 2002.
4. A. K. Nad, B. Mahapatra and A. Ghoshal; An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd, 3rd Edition, 2011.

Mapping with the POs/PEOs: Matrix formation for attainments

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) and for No Correlation "-"

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	-	-	-	-	-	-	-	-	-	-
CO-2	-	2	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	2	-	-	-	-	-	-	-	-	-

To establish the correlation between Cos & PSOs

2: Slight (Low) 3: Moderate (Medium) 4: Substantial (High) and for No Correlation "-"

CO	PSO-1	PSO-2
CO-1	4	-
CO-2	3	-
CO-3	-	4

Second Semester

Course: Engineering Chemistry-II Code: CH-201 L-T-P: 2-0-0 Credit: 2

Program Outcomes (POs):

Programs must validate that their students achieve the following outcomes

PO - 1	**Engineering knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO - 2	**Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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PEO-2	Ability to analyze the problems in the context of practical relevance to the society while maintaining environmental safety and economic factors.
PEO-3	Enhancing their professional growth along with scientific knowledge through continuing education.

PSOs (Program Specific Objectives):

Students will be able to

PSO-1	Acquire the concepts of chemistry involved in various engineering materials that will find relevance to their engineering programs.
PSO-2	Apply their knowledge of chemistry, acquired from this course, to different engineering problems.
PSO-3	Assess the practical solutions to problems in day to day life.

Course Objective:

1. To introduce the principles of corrosion, common corrosion types, corrosion control methods, and material selection to reduce corrosion cost.

2. The students will learn about cement, its large-scale industrial manufacturing process, the mechanism of setting and hardening of cement, and various types of cement.

3. The topic on refractories will discuss about the manufacturing process, properties, types of refractories, their uses in heat treatment systems in industry and in society.

4. The purpose of incorporating lubricants is to make students aware of different types of lubricants and of their uses in machine parts to reduce the wear and tear and running cost of engine.

Course Content:

Unit-1: Corrosion (6 L)

Introduction, definition, classification; dry corrosion-factors affecting dry corrosion, mechanism, types; oxidation corrosion; Pilling-Bedworth rule; corrosion by other gases; hydrogen related corrosion; liquid metal corrosion; wet corrosion-types; chemical corrosion; factors affecting chemical corrosion; mechanism of wet corrosion-electrochemical mechanism; evolution of H_2 and absorption of O_2; differential aeration theory, passivity, pitting, waterline and stress corrosion; corrosion control- purification, alloying, application of protective coatings, cathodic protection, etc.

Unit-2: Cement (4 L)

Introduction, classification; Portland cement-definition, raw materials, manufacture, ideal composition and physical requirement according to I.S code; setting and hardening of cement; heat of hydration; special cements: high-alumina cement, white Portland cement, water-proof cement, Sorel cement, barium and strontium cement.

Unit-3: Refractories (5 L)

Definition, objective of using, classification based on chemical nature; properties-refractoriness, strength, dimensional stability, chemical inertness, thermal expansion, thermal conductivity, porosity, spalling, electrical conductivity, etc., and interrelations between them; selection of good refractory; common refractory bricks: silica, fireclay, high-alumina, carbon and carborundom bricks, properties and uses.

Unit-4: Lubricants (5 L)

Introduction; mechanism-thick-film, thin-film and extreme pressure lubrication; classification of lubricants-lubricating oils, greases and solid lubricants, their properties, uses and additives required (e.g., antioxidants, corrosion preventers, etc.); properties of lubricating oils: viscosity, flash and fire-point, cloud and pour point, aniline point etc.; cutting fluids.

Course Outcome:

CO-1	Understand electrochemical reaction fundamentals, different types of corrosions and their prevention methods.
CO-2	Relate physical, chemical and other properties of different cements as modern building block materials for numerous applications.
CO-3	Usefulness of refractory materials in metallurgical furnaces and other heat treatment equipment were also understood.
CO-4	Understanding the role of lubrication in reducing friction, wear and tear of machinery parts in engines, and so on.

Reference Books:

1. Shashi Chawla, A Text Book of Engineering Chemistry, 3rd Edition, Dhanpat Rai & Co., New Delhi, 2007.
2. Jain and Jain, Engineering Chemistry, 15th Edition, Dhanpat Rai Publishers
3. Dr S. Vairam and Dr. Suba Ramesh, Engineering Chemistry, 1st Edition, Wiley-India, New Delhi.
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	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PEO-1	PEO-2	PEO-3
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CO-2	-	-	2	-	-	-	-	-	-	-	-	-	-	2	3
CO-3	-	-	2	-	-	-	-	-	-	-	-	-	-	2	3
CO-4	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-

To establish the correlation between COs & PSOs

2: Slight (Low) 3: Moderate (Medium) 4: Substantial (High) and for No Correlation "-"

CO	PSO-1	PSO-2
CO-1	3	-
CO-2	-	4
CO-3	-	4
CO-4	3	-