INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL CAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING CHEMISTRY**					
Course Code	AHSB03					
Programme	B.Tech					
Semester	I	CSE | IT | EEE				
	II	AE | ECE | ME | CE				
Course Type	Foundation					
Regulation	IARE - R18					
Course Structure	**Theory**			**Practical**		
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**	
	3	1	4	3	1.5	
Chief Coordinator	Dr. V Anita Rani, Professor					
Course Faculty	Dr. Venkateshwar Rao, Professor Mr. B Raju, Assistant Professor Mr. M Praveen, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor					

I. COURSE OVERVIEW:

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the Intermediate level. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels; one has to base the description of all chemical processes at molecular levels.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Vital principles of chemistry

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering Chemistry	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (Pos)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Seminar
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering Sciences.	2	Term Paper
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.	2	NPTEL Video
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	1	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	Professional skillsAble to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	2	Seminar
PSO 2	Professional skills Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles	-	-
PSO 3	Practical implementation and testing skills Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-
PSO 4	Successful career and entrepreneurship To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats		

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Apply the electrochemical principles in batteries, understand the fundamentals of corrosion.
II	Analysis of water for its various parameters and its significance in industrial and domestic applications.
III	Analyze microscopic chemistry in terms of atomic, molecular orbitals and Intermolecular forces.
IV	Analysis of major chemical reactions that are used in the synthesis of molecules.
V	Understand the chemistry of various fuels and their combustion.

IX. COURSE OUTCOMES (COs):

COs	Course Outcomes	CLOs	Course Learning Outcome
CO 1	Understand the relationship between charge delivered or produced and the amount of reactant used or product formed for both galvanic and electrolytic cells.	CLO 1	Extrapolate the knowledge of electrolytic cell, electrochemical cell, electrode Potential and reference electrodes.
		CLO 2	Use of primary and secondary batteries in various fields such as automobiles, railways, medical devices, aircrafts and day to day life.
		CLO 3	Explain the characteristic factors of a metal and environment influencing the rate of Corrosion.

COs	Course Outcomes	CLOs	Course Learning Outcome
		CLO 4	Use appropriate methods such as protective, metallic and organic coatings to Control corrosion in metals.
CO 2	Ability to describe the purpose and operational steps of water treatment processes used to improve water quality.	CLO 5	Evaluate the quality and utility of suitable water for industrial as well as domestic applications.
		CLO 6	Use innovative methods to improve the quality of soft water for Potable and industrial purpose at cheaper cost.
CO 3	Recognize that molecular orbital theory is a method used by chemists to determine the energy of the electron in a molecule as well as its geometry.	CLO 7	Understand the basic tenets of molecular orbital theories.
		CLO 8	Understand the different approaches to types of chemical bonding.
CO 4	Identify the fundamental principles of stereochemistry, chemical bonding, chemical reactions and mechanism.	CLO 9	Recognize and draw structural isomers, stereoisomerisum including enantiomers and diastereomers and racemic mixture.
		CLO 10	Understand the mechanisms of major classes of organic reactions, including substitutions, eliminations and addition.
		CLO 11	Retrieve and critically review information on drugs, including how to synthesize them, from literature resources.
CO 5	Understand and analyze the combustion mechanisms of various fuels.	CLO 12	Demonstrate comprehensive knowledge of conventional fuel properties on engine performance.
		CLO 13	Understand the importance of cracking, knocking in IC engines and operations involvedin petroleum refining.
		CLO 14	Describe the physical and chemical properties of fuels like natural gas, LPG and CNG.
		CLO 15	Determine efficiency of the fuel in terms of calorific value and combustion reactions of the fuel.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB03.01	CLO 1	Extrapolate the knowledge of electrolytic cell, electrochemical cell, electrode Potential and reference electrodes.	PO1	3
AHSB03.02	CLO 2	Use of primary and secondary batteries in various fields such as automobiles, railways, medical devices, aircrafts and day to day life.	PO1	2
AHSB03.03	CLO 3	Explain the characteristic factors of a metal and environment influencing the rate of Corrosion.	PO1, PO2, PO7	3
AHSB03.04	CLO 4	Use appropriate methods such as protective, metallic and organic coatings to Control corrosion in metals.	PO1, PO2, PO4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB03.05	CLO 5	Evaluate the quality and utility of suitable water for industrial as well as domestic applications.	PO1, PO2, PO4	3
AHSB03.06	CLO 6	Use innovative methods to improve the quality of soft water for Potable and industrial purpose at cheaper cost.	PO1	1
AHSB03.07	CLO 7	Understand the basic tenets of molecular orbital theories.	PO1	1
AHSB03.08	CLO 8	Understand the different approaches to types of chemical bonding.	PO1	1
AHSB03.09	CLO 9	Recognize and draw structural isomers, stereoisomerisum including enantiomers and diastereomers and racemic mixture.	PO1	1
AHSB03.10	CLO 10	Understand the mechanisms of major classes of organic reactions, including substitutions, eliminations and addition.	PO1	1
AHSB03.11	CLO 11	Retrieve and critically review information on drugs, including how to synthesize them, from literature resources.	PO1, PO2, PO4	1
AHSB03.12	CLO 12	Demonstrate comprehensive knowledge of conventional fuel properties on engine performance.	PO1, PO2	3
AHSB03.13	CLO 13	Understand the importance of cracking, knocking in IC engines and operations involved in petroleum refining.	PO1, PO2	3
AHSB03.14	CLO 14	Describe the physical and chemical properties of fuels like natural gas, LPG and CNG.	PO1, PO2, PO7	2
AHSB03.15	CLO 15	Determine efficiency of the fuel in terms of calorific value and combustion reactions of the fuel.	PO1, PO2, PO7	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes (PSOs)
	PO1	PO2	PO4	PO7	PSO1
CO 1	3	2	1	1	1
CO 2	2	3			1
CO 3	1				
CO 4	1		1		
CO 5	3	2		1	1

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												1			
CLO 2	2												1			
CLO 3	3	2											1			
CLO 4	2	3		1			1						1			
CLO 5	3	3		2												
CLO 6	1															
CLO 7	1															
CLO 8	1															
CLO 9	1															
CLO 10	1															
CLO 11	1	1		2												
CLO 12	3	2											1			
CLO 13	3	2											1			
CLO 14	3	2					1						1			
CLO 15	3	2					1						1			

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XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2, PO4,PO7, PSO1	SEE Exams	PO1, PO2, PO4,PO7, PSO1	Assignments	-	Seminars	PO1, PO2, PO4,PO7, PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4,PSO1						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS:

Module-I	ELECTROCHEMISTRY AND BATTERIES

Electro chemical cells: Electrode potential, standard electrode potential, types of electrodes; Calomel, Quinhydrone and glass electrode; Nernst equation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery and Lithium ion battery).

Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Types of corrosion: Galvanic, water-line and pitting corrosion; Factors affecting rate of corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current; Surface coatings: Metallic coatings- Methods of coating- Hot dipping, cementation, electroplating and Electroless plating of copper.

Module-II	WATER AND ITS TREATMENT

Introduction: Hardness of water, Causes of hardness; Types of hardness: temporary and permanent, expression and units of hardness; Estimation of hardness of water by complexometric method; Potable water and its specifications, Steps involved in treatment of water, Disinfection of water by chlorination and ozonization; Boiler feed water and its treatment, Calgon conditioning, Phosphate conditioning and Colloidal conditioning; External treatment of water; Ion-exchange process;
Desalination of water: Reverse osmosis, numerical problems.

Module-III	MOLECULAR STRUCTURE AND THEORIES OF BONDING

Atomic and Molecular orbitals: Linear Combination of Atomic Orbitals LCAO), molecular orbitals of diatomic molecules; Molecular orbital energy level diagrams of N_2, O_2F_2, CO and NO molecules.

Crystal Field Theory (CFT): Salient Features of CFT-Crystal Field; Splitting of transition metal ion d-orbitals in Tetrahedral, Octahedral and square planar geometries; Band structure of solids and effect of doping on conductance.

Module-IV	STEREOCHEMISTRY, REACTION MECHANISM AND SYNTHESIS OF DRUG MOLECULES

Introduction to representation of 3-dimensional structures: Structural and stereoisomers, configurations, symmetry and chirality; Enantiomers, diastereomers, optical activity and Absolute configuration; Conformation analysis of n- butane.

Substitution reactions: Nucleophilic substitution reactions, Mechanism of S_N1, S_N2 reactions; Electrophilic and nucleophilic addition reactions; Addition of HBr to propene; Markownikoff and anti Markownikoff's additions; Grignard additions on carbonyl compounds; Elimination reactions: Dehydro halogenation of alkylhalides; Saytzeff rule; Oxidation reactions: Oxidation of alcohols using $KMnO_4$ and chromic acid; Reduction reactions: Reduction of carbonyl compounds using $LiAlH_4$& $NaBH_4$; Hydroboration of olefins; Structure, synthesis and pharmaceutical applications of Paracetamol and Aspirin.

Module-V	FUELS AND COMBUSTION

Fuels: Definition, classification of fuels and characteristics of a good fuels; Solid fuels: Coal; Analysis of coal: Proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Cracking: Fixed bed catalytic cracking; Knocking: Octane and cetane numbers; Gaseous fuels: Composition, characteristics and applications of natural gas, LPG and CNG; Combustion: Calorific value: Gross Calorific Value(GCV) and Net Calorific Value(NCV), calculation of air quantity required for complete combustion of fuel, numerical problems.

Text Books:
1. Bharathi Kumari, "Engineering Chemistry", VGS Book Links, 10th Edition, 2018. 2. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 16th Edition, 2017. 3. Shashi Chawla, "Text Book of Engineering Chemistry" Dhanat Rai and Company, 2017. 4. R.T. Morrison, RN Boyd and SK Bhattacharya, "Organic Chemistry", Pearson, 7th Edition, 2011.
Reference Books:
1. Prashanth rath, B.Rama Devi, Ch.Venkata Ramana Reddy, Subhendu Chakroborty, Cengage Learning Publishers, 1st Edition, 2018. 2. K. P. C. Volhardt and N. E. Schore, "Organic Chemistry Structure and Functions", Oxford Publications, 7th Edition 2010. 3. B. H. Mahan, "University Chemistry", Narosa Publishers, 4th Edition, 2009.

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Concept of Electro chemical cells	CLO 1	T1:3.1 R1:2.1
2	Numerical problems on EMF: Galvanic Cells	CLO 1	T1:3.3.1 R1:2.7.1
3	Types of Electrodes: Calomel, Quinhydrone and Glass electrode.	CLO 1	T1:3.4.3 R1:2.7.4
4	Nernst equation and its applications.	CLO 1	T1:3.4.2 R1:2.15
5	Batteries: Primary cells (dry cells).	CLO 2	T1:3.11 R1:2.16
6	Secondary cells (lead-Acid cell, lithium-ion battery) Applications of batteries	CLO 2	T1:3.12 R1:2.17
7	Corrosion-Definition ,Causes and effects of corrosion, Theories of corrosion – Chemical corrosion and electrochemical corrosion	CLO 3	T1:3.13 R1:2.19
8	Types of corrosion (water line and pitting), Factors affecting rate of corrosion	CLO 3	T1:3.18 R1:2.21
9	Corrosion control methods – Cathodic protection and metallic coating.	CLO 4	T1:3.20 R1:2.3
10	Hardness of water, expression of hardness-units; Types of hardness: Temporary hardness, permanent hardness and numerical problems.	CLO 5	T1:2.1 R1:4.1
11	Estimation of temporary &permanent hardness of water by EDTA.	CLO 5	T1:2.6 R1:4.3
12	Potable water and its specifications, steps involved in its treatment of water.	CLO 6	T1:2.6.5 R1:4.8
13	Numerical problems on EDTA	CLO 6	T1:2.7 R1:4.6
14	Treatment of boiler feed water – Internal treatment (Phosphate, carbonate and calgon conditioning)	CLO 6	T1:2.9 R1:4.6
15	Ion exchange process, steps involved in the treatment of this process.	CLO 6	T1:2.8 R1:4.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
16	Sterilization of potable water by chlorination and ozonization,	CLO 6	T1:2.6.5 R1:4.8
17	purification of water by reverse osmosis process. Numerical problems	CLO 6	T1:2.10.2 R1:4.7
18	Shapes of Atomic Orbitals.	CLO 7	T1:1.3.4 R1:4.9
19	Linear combination of Atomic orbitals (LACO)	CLO 7	T1: 1.4 R1:4.10
20	Molecular orbitals of diatomic molecules N_2 O_2 and F_2.	CLO 7	T1: 1.4.3 R1:1.10
21	Molecular orbitals diatomic CO and NO molecule	CLO 7	T1:1.4.3 R1:1.10
22	Crystal Field Theory (CFT), Salient Features of CFT-Crystal Fields	CLO 7	T1:1.5 R1:1.16
23	Splitting of transition metal ion d- orbitals in Tetrahedral	CLO 7	T1: 1.5.3 R1:1.16
24	Splitting of transition metal ion Octahedral and square planar geometries	CLO 7	T1: 1.5.2 R1:1.16
25	Band structure of solids and effect of doping on conductance.	CLO 8	T1: 1.6 R1:1.11
26	Introduction to representation of 3-dimensional structures	CLO 9	T1:4.1 R1:5.2
27	Structural and stereoisomers of organic compounds	CLO 9	T1: 4.1 R1:5.2
28	Configurations, symmetry and chirality.	CLO 9	T1: 4.3 R1:5.10
29	Enantiomers, diastereomers, optical activity and Absolute configuration	CLO 9	T1: 4.4 R1:5.2.3
30	Conformation alanalysis of n- butane	CLO 9	T1: 4.2.2 R1:5.2.4
31	Nucleophilic substitution reactions, Mechanism of S_N1, S_N2 reactions	CLO 9	T1: 4.5 R1:5.4
32	Electrophilic and nucleophilic addition reactions; Addition of HBr to Propene; Markownikoff and anti Markownikoff's additions	CLO 10	T1: 4.6 R1:5.5
33	Grignard additions on carbonyl compounds, Eliminationreactions Dehydro halogenations of alkylhalides	CLO 10	T1: 4.9 R1:5.6
34	Oxidation reactions: Oxidation of alcohols using $KMnO_4$ and chromicacid.	CLO 10	T1: 4.12
35	Reduction reactions: Reduction of carbonyl compounds using $LiAlH_4$ & $NaBH_4$	CLO 10	T1: 4.13
36	Hydroboration of olefins.	CLO 10	T1: 4.14
37	Structure, synthesis and pharmaceutical applications of Paracetamol and Aspirin.	CLO 11	T1: 4.15
38	Classification of fuels and characteristics of a good fuels.	CLO 12	T2:2,4 T3:2
39	Solid fuel: Coal, analysis of coal- proximate analysis.	CLO 12	T2:13 T3:7
40	Analysis of coal -ultimate analysis.	CLO 12	T2:13 T3:7
41	Liquid fuels: Petroleum and its refining Cracking: Fixed bed catalytic cracking;	CLO 13	T2:19 T3:15,21
42	Knocking: Octane and cetane numbers	CLO 13	T2:23 T3:17
43	Gaseous fuels: Composition, characteristics and applications of Natural gas, LPG and CNG	CLO 14	T2:28 T3:9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
44	Compare Gross calorific value(GCV) and net calorific value(NCV)	CLO 15	T2:3 T3:4
45	Calculation of air quantity required for complete combustion of fuel, numerical problems.	CLO 15	T2:3 T3:10

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Galvanic cell, batteries-Ni-Cd Batteries, Crevice corrosion, Fuel cells and its applications	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
2	Softening techniques, plastics, cement, Flue gas Analysis	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
3	Synthesis of nano material and its applications, spectroscopic techniques for analysis of organic molecules.	Assignments / Laboratory Practices	PO 1	PSO 1

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