# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**
Dundigal, Hyderabad -500 043

## AERONAUTICAL ENGINEERING

## COURSE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | **ENGINEERING CHEMISTRY** | | | | |
| **Course Code** | AHS005 | | | | |
| **Programme** | B. Tech | | | | |
| **Semester** | I | AE \| CIVIL \| CSE \| ECE \| EEE \| IT \| ME | | | |
| **Course Type** | Foundation | | | | |
| **Regulation** | IARE - R16 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | - | 3 | 2 | 1 |
| **Chief Coordinator** | Ms. V Anitha Rani, Associate Professor | | | | |
| **Course Faculty** | Dr. C Mahendar, Professor<br>Mr. M Praveen, Assistant Professor<br>Mr. B Raju, Assistant Professor<br>Ms. M Malathi, Assistant Professor<br>Mr. G Mahesh Kumar, Assistant Professor<br>Ms. T Mallika, Assistant Professor<br>Ms. M Lakshmi Prasanna, Assistant Professor<br>Ms. M Swathi, Assistant Professor | | | | |

## I. COURSE OVERVIEW:

The primary objective of an Engineering Chemistry course is to introduce the students to the concepts and applications of chemistry in engineering. It should cultivate in them an ability to identify chemistry in each piece of finely engineered products used in households and industry. It aims to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications. It deals with applied and industrially useful topics, such as water technology, engineering materials, electrode potential and cells, fuels, polymers and corrosion. Water and its treatment for various purposes, engineering materials such as plastics, composites, ceramic, abrasives, their preparation, properties and applications, conventional and non-conventional energy sources, nuclear, solar, various batteries, combustion calculations, corrosion and control of metallic materials.

## II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites |
|---|---|---|---|
| - | - | - | Basic principles of chemistry |

## III. MARKS DISTRIBUTION:

| 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 units and each unit 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 unit. 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

| Component | Theory | | Total Marks |
|---|---|---|---|
| **Type of Assessment** | CIE Exam | Quiz / AAT | |
| **CIA Marks** | 25 | 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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):**
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

## 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 | 1 | Seminar |
| 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. | 2 | 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 skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products. | 1 | Seminar |
| PSO 2 | **Problem-solving 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 (COs):

| The course should enable the students to: | |
|---|---|
| I | Apply the electrochemical principles in batteries. |
| II | Understand the fundamentals of corrosion and development of different techniques in corrosion control. |
| III | Analysis of water for its various parameters and its significance in industrial, applications. |
| IV | Improve the fundamental science and engineering principles relevant to materials. |

## IX. 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 |
|---|---|---|---|---|
| AHS005.01 | CLO 1 | Extrapolate the knowledge of electrolytic cell, electrochemical cell, electrode potential and reference electrodes. | PO 1 | 3 |
| AHS005.02 | CLO 2 | Use of primary and secondary batteries in various fields such as automobiles, railways, medical devices, aircrafts and day to day life. | PO 1<br>PO 2 | 1 |
| AHS005.03 | CLO 3 | Explain the characteristic factors of a metal and environment influencing the rate of corrosion. | PO 1<br>PO 7 | 2 |
| AHS005.04 | CLO 4 | Use appropriate methods such as protective, metallic and organic coatings to control corrosion in metals. | PO 1<br>PO 7 | 2 |
| AHS005.05 | CLO 5 | Evaluate the quality and utility of suitable water for industrial as well as domestic applications. | PO 1<br>PO 7 | 3 |
| AHS005.06 | CLO 6 | Use innovative methods to improve the quality of soft water for Potable and industrial purpose at cheaper cost. | PO 1<br>PO 7 | 2 |
| AHS005.07 | CLO 7 | Understand the concepts of polymers for viscoelastic nature of polymer materials in real-time application. | PO 1<br>PO 7 | 1 |
| AHS005.08 | CLO 8 | Demonstrate the ability to use polymeric materials for engineering problems in different domains. | PO 1<br>PO 7 | 1 |
| AHS005.09 | CLO 9 | Justify the immense importance of basic constructional material, Portland cement in civil engineering works. | PO 1 | 1 |
| AHS005.10 | CLO 10 | Describe various instruments used for measuring various properties of lubricants in industries. | PO 1 | 3 |
| AHS005.11 | CLO 11 | Understand refractory use in metallurgical furnaces, kilns and other equipments. | PO 1 | 2 |
| AHS005.12 | CLO 12 | Demonstrate comprehensive knowledge of conventional fuel properties on engine performance. | PO 1 | 2 |
| AHS005.13 | CLO 13 | Understand the importance of cracking, knocking in IC engines and operations involved in petroleum refining for real-time application. | PO 1<br>PO 2 | 2 |
| AHS005.14 | CLO 14 | Describe the physical and chemical properties of alternate fuels like natural gas, LPG and CNG. | PO 1 | 1 |
| AHS005.15 | CLO 15 | Determine efficiency of the fuel in terms of calorific value and combustion reactions of the fuel. | PO 1 | 2 |
| AHS005.16 | CLO 16 | Understand the concepts of electro chemistry in solar cell, Fuel cells and batteries for real-time application. | PO 1 | 2 |
| AHS005.17 | CLO 17 | Understand the concepts of corrosion control methods in pipeline leaks and ruptures as real-time application. | PO 1<br>PO 7 | 2 |
| AHS005.18 | CLO 18 | Understand the concepts of water technology in applications of image recognition for real-time water level and surface velocity. | PO 1<br>PO 7 | 2 |

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## X. 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 | | | | | | | | | | | | | | | |
| CLO 2 | 2 | 1 | | | | | | | | | | | | | | |
| CLO 3 | 2 | | | | | | 2 | | | | | | | | | |
| CLO 4 | 2 | | | | | | 2 | | | | | | | | | |
| CLO 5 | 3 | | | | | | 3 | | | | | | | | | |
| CLO 6 | 2 | | | | | | 2 | | | | | | | | | |
| CLO 7 | 2 | | | | | | 1 | | | | | | | | | |
| CLO 8 | 1 | | | | | | 1 | | | | | | | | | |
| CLO 9 | 1 | | | | | | | | | | | | | | | |
| CLO 10 | 3 | | | | | | | | | | | | | | | |
| CLO 11 | 2 | | | | | | | | | | | | | | | |
| CLO 12 | 2 | | | | | | | | | | | | 1 | | | |
| CLO 13 | 3 | 1 | | | | | | | | | | | 1 | | | |
| CLO 14 | 1 | | | | | | | | | | | | | | | |
| CLO 15 | 2 | | | | | | | | | | | | 1 | | | |
| CLO 16 | 2 | | | | | | | | | | | | | | | |
| CLO 17 | 2 | | | | | | 2 | | | | | | | | | |
| CLO 18 | 2 | | | | | | 2 | | | | | | | | | |

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## XI. ASSESSMENT METHODOLOGIES – DIRECT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIE Exams | PO 1,PO 2, PO 7 | SEE Exams | PO 1,PO 2 PO 7 | Assignments | PO 2 | Seminars | PO 1, PO 2 |
| Laboratory Practices | PO 1 | Student Viva | - | Mini Project | - | Certificatior | - |
| Term Paper | - | | | | | | |

## XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

## XIII. SYLLABUS

| Unit-I | ELECTROCHEMISTRY AND BATTERIES |
|---|---|

Electrochemistry: Basic concepts of electrochemistry; Conductance: Specific, equivalent and molar conductance and effect of dilution on conductance; Electrochemical cells: Galvanic cell (daniel cell); Electrode potential; Electrochemical series and its applications; Nernst equation; Types of electrodes: Calomel electrode, quinhydrone electrode; Batteries: Classification of batteries, primary cells (dry cells) and secondary cells (lead-acid battery, Ni-Cd cell), applications of batteries, numerical problems.

| Unit-II | CORROSION AND ITS CONTROL |
|---|---|

Corrosion: Introduction, causes and effects of corrosion; Theories of corrosion: Chemical and electrochemical corrosion with mechanism; Factors affecting the rate of corrosion: Nature of the metal and nature of the environment; Types of corrosion: Waterline and crevice corrosion; Corrosion control methods: Cathodic protection- sacrificial anodic protection and impressed current cathodic protection; Surface coatings: Metallic coatings, methods of application of metallic coatings-hot dipping(galvanizing, tinning), electroplating(copper plating); Organic coatings: Paints, its constituents and their functions.

| Unit-III | WATER TECHNOLOGY |
|---|---|

Water: Sources and impurities of water, hardness of water, expression of hardness-units; Types of hardness: Temporary hardness, permanent hardness and numerical problems; Estimation of temporary and permanent hardness of water by EDTA method; Determination of dissolved oxygen by Winkler's method; Boiler troubles: Priming, foaming, scales, sludges and caustic embrittlement.

Treatment of water: Internal treatment of boiler feed water- carbonate, calgon and phosphate conditioning, softening of water by Zeolite process and Ion exchange process; Potable water-its specifications, steps involved in the treatment of potable water, sterilization of potable water by chlorination and ozonization, purification of water by reverse osmosis process.

| Unit-IV | MATERIALS CHEMISTRY |
|---|---|

Materials chemistry: Polymers-classification with examples, polymerization-addition, condensation and co-polymerization; Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Rubbers: Natural rubber its process and vulcanization; Elastomers: Buna-s and Thiokol rubber; Fibers: Characteristics of fibers, preparation properties and applications of Dacron; Characteristics of fiber reinforced plastics; Cement: Composition of Portland cement, setting and hardening of Portland cement; Lubricants: Classification with examples; Properties: Viscosity, flash, fire, cloud and pour point; Refractories: Characteristics and classification with examples.

| Unit-V | FUELS AND COMBUSTION |
|---|---|

Fuel: 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. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 15th Edition, 2015.

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|---|
| 2. Shashi Chawla, "Text Book of Engineering Chemistry" Dhanat Rai and Company, 1st Edition 2011 |
| **Reference Books:** |
| 1.B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015.<br>2. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006.<br>3. C. V. Agarwal, C. P. Murthy, A. Naidu, "Chemistry of Engineering Materials", Wiley India, 5thEdition, 2013.<br>4.R. P. Mani, K. N. Mishra, "Chemistry of Engineering Materials", Cengage Learning, 3rd Edition, 2015. |

## XIV.COURSE PLAN:

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

| Lecture No | Topics to be covered | CLOs | Reference |
|---|---|---|---|
| 1 | Understands the concept of electrochemistry. Differentiate the electronic conductors and electrolytes. | CLO 1 | T1:5.1,6.3 |
| 2 | Define the terms specific, equivalence and molar conductance. Explain the dilution effect on these conductance | CLO 1 | T1:5.5 |
| 3 | Understands the concept of specific, equivalence and molar conductance. Define the EMF of the cell.<br>Demonstrate the Daniel cell. | CLO 1 | T2:6.1,6.2, 6.3 |
| 4 | Describe the construction and chemical reactions of different electrodes.<br>Use the Calomel | CLO 1 | T2:11,12.2.1 |
| 5 | Quinhydrone electrodes in calculation of potential of the single electrode. | CLO 1 | T1:6.7(4) |
| 6 | Derive the relation between cell reaction and emf of the single electrodes. | CLO 1 | T2:3.4 |
| 7 | Use the standard potential values of elements from electrochemical series. | CLO 1 | T2:5,5.1 |
| 8 | Define the battery; differentiate the primary and secondary batteries. Demonstrate the construction of the dry cell. | CLO 2 | T2:16,17.1 |
| 9 | Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries. | CLO 2 | T2:17.3 |
| 10 | Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries. | CLO 2 | T2:17.4 |
| 11 | Define corrosion and its disadvantages. | CLO 3 | T2:1.1 |
| 12 | Explain the mechanism of oxidation corrosion when dry gases attack on metal. | CLO 3 | T2:2.1 |
| 13 | Explain the mechanism of hydrogen evolution type and oxygen absorption type corrosion. | CLO 3 | T2:2.2 |
| 14 | Distinguish the types of corrosion. | CLO 3 | T2:2.4.5 |
| 15 | Analyze the effect of different factors on rate of corrosion. | CLO 3 | T2:5,5.1,5.2 |
| 16 | Explain the process of cathodic protection with examples. | CLO 4 | T2:6.4 |
| 17 | Use the methods of application of metallic coatings and Relate the galvanization and tinning | CLO 4 | T1:17.1 |
| 18 | Explain the process of electroplating.<br>Apply the organic coatings for control of corrosion. | CLO 4 | T1:8.6<br>T2:6.3.3 |
| 19 | List the various sources of water, Differentiate the temporary and permanent hardness and give its units. | CLO 5 | T2:3,4,5 |
| 20 | Calculate the total, permanent and temporary hardness of | CLO 5 | T2:6 |

| Lecture No | Topics to be covered | CLOs | Reference |
|---|---|---|---|
| | sample hard water by using EDTA | | |
| 21 | Calculate the dissolved oxygen in water by Winkler's method | CLO 5 | T1:1.14(4) |
| 22-23 | Recognize the boiler troubles. | CLO 5 | T2:9.2,9.5 |
| 24 | Discuss the internal treatment methods of boiler feed water. Name the different chemicals used in internal treatment. | CLO 6 | T2:12,12.4, 12.2,12.3 |
| 25 | Explain the process of zeolite and analyze the advantages and disadvantages. | CLO 6 | T2:11.2 |
| 26 | Explain ion-exchange process. | CLO 6 | T2:11.3,13 |
| 27 | Demonstrate the treatment of potable water Purification of potable water. Describe the process of reverse osmosis | CLO 6 | T2:13,14 (d) |
| 28 | Define monomer and polymer Explain the mechanism of different types of Chain and step growth polymerization. | CLO 7 | T2:2,2.2,4,4.1,4.2,4.7 |
| 29 | Distinguish the thermoplastic and thermo set plasitcs. Illustrate the compounding of plastics. | CLO 7 | T1:3.14,3.13.12 |
| 30 | Identify the preparation, properties and applications of different thermo and thermo set plastics. | CLO 8 | T2:2.3,2.7,2.8 |
| 31 | Identify the preparation, properties and applications of thermo set plastics. Explain about natural rubber. | CLO 8 | T2:3,3.1,3.2, 3.3 |
| 32 | Explain the preparation, properties and applications of synthetic rubbers. | CLO 8 | T1:3.24 T2:4.2 |
| 33 | Explain the preparation, properties and applications of fibers. | CLO 8 | T1:3.28 R4:114 |
| 34 | Generalize the process of setting and hardening reactions of cement | CLO 9 | T2:9.3.2, 9.3.3 |
| 35 | Define the term lubricant and it's classification. | CLO 10 | T2:7.4 |
| 36 | Compare the different types of lubricants based on their properties. | CLO 10 | T2:7.5 |
| 37 | Name the different types of refractories. Discuss the characteristics and applications of refractories. | CLO 11 | T2:8.2,8.3 |
| 38 | Define the fuel with examples. Categorize the different types of fuels. | CLO 12 | T2:5.2,5.3 |
| 39 | Analyze the different types of coals. Explain the significance of proximate analysis of coal. | CLO 12 | T2:5.7,5.8,5.8.1 |
| 40 | Explain the significance of Ultimate analysis of coal. | CLO 12 | T2:5.8.2 |
| 41 | Identify the chemical constituents of petroleum. Describe the refining of petroleum. Define the term cracking. Distinguish the fixed bed and catalytic cracking. | CLO 13 | T1:2.18,2.19 2.19(a) |
| 42 | Evaluate the octane and cetane rating of the petrol and diesel. | CLO 13 | T1:2.23 |
| 43 | Identify the chemical constituents of the gaseous fuel. Discuss the characteristics of natural gas. Compare the LPG and CNG. | CLO 14 | T1:2.28,2.26 T2:5.14.1 R4:247 |
| 44 | Explain the combustion process of different chemical constituents present in the fuel. Differentiate the HCV and LCV. | CLO 15 | T2:5.4,5.5 |
| 45 | Evaluate the air quantity required for complete combustion of fuel. | CLO 15 | T2:5.4.1, 6.5 |

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

| S No | Description | Proposed actions | Relevance with POs | Relevance with PSOs |
|---|---|---|---|---|
| 1 | Galvanic cell, batteries-lead acid cells, Crevice corrosion, cathodic protection, galvanizing, Electroplating. | Seminars / Guest Lectures / NPTEL | PO 1 | PSO 1 |
| 2 | Softening techniques, plastics, cement, refining of petroleuim. | Seminars / Guest Lectures / NPTEL | PO 1 | PSO 1 |
| 3 | Thiokol rubber, EDTA method, Dissolved oxygen, Viscosity, $P^H$ meter. | Assignments / Laboratory Practices | PO 1 | PSO 1 |

**Prepared by:**
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**HOD, FRESHMAN ENGINEERING**