ENGINEERING CHEMISTRY - II

Subject Code : **No. of Credits :** 2 (TH:2,T:1,P:2)

I. RATIONALE :

The role of chemistry and chemical products in every branch of engineering is expanding greatly. Chemistry is considered as one of the core subjects for Diploma Engineering students. The subject Engineering Chemistry creates foundation for understanding basic concepts and principles to solve broad based engineering problems. The comprehension of concepts metal and alloy, engineering material, chemistry of fuel various aspects with regard to lubricants and catalysis. This course will develop basic understanding and skill in diploma of engineering students.

II. INDUSTRY/ EMPLOYER EXPECTED OUTCOME :

The aim of this course is to attain following industry/ employer expected outcomes through various teaching learning experiences. Apply the principles of chemistry to solve broad- based engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS) :

Students will be able to achieve and demonstrate the following COs on completion of course based learning:

CO1 - Solve the engineering problems using knowledge of metal and alloy properties.

CO2 - Solve the engineering problems using knowledge of engineering materials and properties.

CO3 - Use relevant fuel for domestic and industrial applications and able the concept of green fuel application for various application.

CO4 - Solve the engineering problems using concept of corrosion.

CO5 - Use of lubricants for domestic and industrial applications.

CO6 - Use of catalyst in various industrial application.

IV. THEORY LEARNING OUTCOME AND ALIGNED COURSE CONTENT:

Sr. No	Theory Learning Outcomes (TLOs) aligned to COs	Learning content mapped with Theory Learning Outcomes (TLOs) and COs.	Suggested Learning Pedagogies.	No of Lecture	CO
1	**TLO1.1:** Describe the extraction process of the ore. **TLO1.2:** Explain the different term used in metallurgy. **TLO1.3:** Explain mechanical properties of metals. **TLO1.4:** State purposes of alloy making. **TLO1.5:** Describe methods of preparation of alloys **TLO1.6:** State composition, properties and applications of ferrous and non-ferrous alloys.	**UNIT 1: Metal and Alloy** Ancient Indian Metallurgy, Natural occurrence of metals – minerals, ores of iron, aluminum and copper, Basic concepts Mineral, ore, gangue (matrix), flux, slag, Metallurgy: Extraction processes of metal from ore Concentration of ores, Gravity separation, electromagnetic separation, froth flotation, roasting, calcinations, Reduction: smelting and reefing as applied in relation to various metallurgical operation). **Extraction of –** Iron from hematite ore using blast furnace, aluminum from bauxite along with reactions. Mechanical properties of metals: hardness, ductility, malleability, tensile strength, toughness, machinability, weldability, forging, soldering, brazing, castability. **Alloys –** Definition, purposes of alloying, ferrous alloys and non-ferrous with suitable examples, properties and applications (Ferrous alloys stainless steel, Nickel steel etc. and non-ferrous alloy aluminum and copper alloys). General chemical composition, composition-based applications (elementary idea only details omitted)	Chalk-board demonstration, Case study and Video demonstration	10	CO 1
2	**TLO2.1:** Identify the raw material use in the manufacture of Portland cement.	**UNIT 2: Engineering Material** Manufacture of Port land cement and hardening and setting (No equation), Glass definition, manufacture of glass, varieties of glass Optical glass, windshield glass and photo chromatic glass. Refractory and Composite materials.	Simulation, Demonstration, on-site visit, chalk and board	06	CO 2

	TLO2.2: Describe the various uses of glasses and its industrial application. **TLO2.3:** Differentiate the given types of structural polymer. **TLO2.4:** Describe the polymerization process of given polymer. **TLO2.5:** Explain the properties and uses of given	Polymers and Monomer, Classification on the basis of Molecular structure, on the basis of monomer (homo and co-polymers), on the basis of thermal behavior (Thermoplastics and Thermosetting). Type of polymerization Reaction, Addition Polymerization, Condensation Polymerization, degree of polymerization, simple reactions involved in preparation and their application of thermoplastics and thermosetting plastics using Polyethylene, PVC, PS(Polystyrene), PTFE, nylon – 6, nylon-66 and Bakelite), Epoxy Resin rubber and vulcanization of rubber.			
3	**TLO3.1:** Describe the properties of given type of fuel. **TLO3.2:** Describe proximate analysis and ultimate analysis of coal samples. **TLO3.3:** Calculate the calorific value of the given solid fuel using Bomb calorimeter. **TLO3.4:** Explain properties of liquid fuels. **TLO3.5:** Describe composition, properties of given gaseous fuel with their applications. **TLO3.6:** Describe production of green hydrogen by electrolysis.	**UNIT 3: Chemistry of Fuels** Definition of fuel and combustion of fuel, classification of fuels, calorific values (HCV and LCV), and ignition temperature calculation of HCV and LCV using Dulong's formula. Calorific value of solid fuel by bomb calorimeter and simple numerical calculation based on its. Proximate analysis of coal solid fuel. Chemical composition, calorific values and applications of Liquid fuel properties knocking, cracking, Petrol and diesel – fuel rating (octane and cetane numbers), Gaseous fuels: LPG, CNG, water gas, coal gas, producer gas and biogas. Green hydrogen: Producing green hydrogen by electrolysis from electrolysis from renewable sources, advantages and disadvantage of green hydrogen. Electrical conductance in metals and electrolytes, specific conductance, equivalent conductance, cell constant.	Chalk-board demonstrat-ion, Case study and Video demonst-ration	10	CO 3

	TLO3.7: Describe construction and working of given cells and batteries.	Cells and batteries: construction, working and application of dry cell, lead acid storage cell H2-O2 fuel cell, Ni- Cd battery and Lithium-ion battery.			
4	**TLO4.1:** Suggest the lubricant for various types of machines in industry.	**UNIT 4: Lubricants** Lubrication – function and characteristic properties of good lubricant, classification with examples. Lubrication mechanism – Hydrodynamic and boundary lubrication, physical properties (viscosity and viscosity index, oiliness, flash and fire point, cloud and pour point only) and chemical properties (coke number, total acid number and saponification value) of lubricants.	Chalk-board demonstrat-ion, Case study and Video demonst-ration	08	CO 4
5	**TLO5.1:** Describe the phenomenon of given type of corrosion and its prevention. **TLO5.2:** Identify the different factors affecting rate of corrosion for the given type of material. **TLO5.3:** Select the protective measures to prevent the corrosion in the given corrosive medium. **TLO5.4:** Identify the ingredients of given paints. **TLO5.5:** List out the salient properties of given paint and varnish.	**UNIT 5: Corrosion, Methods of Prevention of corrosion, organic coatings** Definition of Corrosion, type of corrosion, Theory of corrosion, Galvanic cell formations theory, differential aeration theory, factor influencing the rate of corrosion. Methods of Prevention of corrosion – control of environment, alloying, surface coating, metal coating, electroplating, galvanization and tinning, Inorganic coating, anodizing, cathodic protection, sacrificial anode method and impresses voltage method. Organic Coating –Paints- Purpose of applying paint, Definition, components of paints and their functions and examples of each ingredient. Varnish definition, Differences between paint and varnish, special paints, luminescent paints, fire retardants paints, Aluminum paints and distemper.	Chalk-board demonstrat-ion, Case study and Video demonst-ration	06	CO6

6	**TLO6.1:** Suggest the relevant catalyst for given application	**UNIT 6: Catalysis** Definition of catalyst – Positive catalyst and Negative catalyst, Type of catalysis- Homogeneous and Heterogeneous. Promoters and Poison catalyst, Characteristics of a catalyst. Industrial applications of catalysts.	Chalk-board demonstration, Case study and Video demonstration	08	CO6

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/ TUTORIAL EXPERIENCE:

Sr. No.	Practical / Tutorial /Laboratory Learning Outcome (LLO)	Laboratory Experiment/ Practical Titles/ Tutorial Titles	No. of Hrs.	Relevant Cos
1	**LLO 1.1** Use of oven for appropriate temperature settings. **LLO 1.2** Calculate moisture and ash content in coal samples.	Determination of the moisture and ash content in a given coal sample using proximate analysis.	2	CO2, CO3
2	**LLO 2.1** Set up a Bomb Calorimeter. **LLO 2.2** Calculate the calorific value	Determination the calorific value of given solid fuel using Bomb calorimeter.	2	CO2, CO3
3	**LLO 3.1** Use gravimetric analysis method. **LLO 3.2** Calculate the percentage of Sulphur.	Determine the percentage of Sulphur in a given coal samples by ultimate analysis. (Gravimetric analysis)	2	CO2
4	**LLO 4.1** Prepare Cu ore sample. **LLO 4.2** Calculate the percentage of Cu.	Determination of percentage of copper in given copper ore.	2	CO2
5	**LLO 5.1** Determine the effect of temperature on viscosity for given lubricating oil using Redwood viscometer.	Determination of the effect of temperature on viscosity for given lubricating oil using Redwood viscometer.	2	CO5
6	**LLO 6.1** Determine the steam emulsification number of given lubricating oil. **LLO 6.2** Measure the steam flow duration.	Determination the steam emulsification number of given lubricating oil.	2	CO5
7	**LLO 7.1** Calculate the flash and fire point of given lubricating oils using Cleveland open cup apparatus.	Determine the flash and fire point of given lubricating oils using Cleveland open cup apparatus.	2	CO5

8	**LLO 8.1** Determine the flash point of given lubricating oils using Abel's closed cup apparatus.	Determination the flash point of given lubricating oils using Abel's closed cup apparatus.	2	CO5
9	**LLO 9.1** Determine thinner content in oil paint using electric oven	Determination of thinner content in oil paint.	2	CO2
10	**LLO 10.1** Prepare corrosive solution. **LLO 10.2** Determine the extent of corrosion.	Preparation of corrosive medium for Aluminum at different Temperature.	2	CO4
11	**LLO 11.1** Prepare corrosive solutions. **LLO 11.2** Determine the extent of corrosion. **LLO 11.3** Compare the corrosion behavior of Aluminum at different Temperature.	Determination of effect of corrosion at different temperature for Aluminum.	2	CO4
12	**LLO 12.1** Prepare KmnO4 solution. **LLO 12.2** Prepare standard oxalic acid solution. **LLO 12.3** Standardize KMnO4 solution.	*Standardization of KMnO4 solution using standard oxalic acid solution.	2	CO2
13	**LLO 13.1** Set up titration assembly. **LLO 13.2** Record the observation. **LLO 13.3** Calculate percentage of iron in haematite ore by titration method.	*Determination of percentage of iron present in given Haematite ore by KMnO4 solution.	4	CO2
14	**LLO 14.1** Prepare the cement sample for titration. **LLO 14.2** principle of redox titration for determining iron content. **LLO 14.3** Explain the procedure for converting iron (III) to iron (II) and titrating it with potassium permanganate. **LLO 14.4** Calculate percentage of the iron content of the sample based on titration results. **LLO 14.5** Understand the concept of molarity and its application in titration calculations.	Determination of the Iron content in given cement sample by KMnO4 solution.	4	CO2

Note: Out of above suggestive LLOs
'*' Marked Practicals (LLOs) are mandatory.
Minimum 80% of the above listed lab experiments are to be performed.
Judicious mix of LLOs is to be performed to achieve desired outcomes.

VI. SUGGEST MICRO PROJECT /ASSIGNMENT / ACTIVITIES FOR SPECIFIC LEARNING/ SKILLS DEVELOPMENTS (SELF LEARNING):

ASSIGNMENTS: Preparation of table showing different ores of iron, copper and aluminium metals along with their chemical compositions and classify into oxide, sulphide and halide ores.

SEMINAR: Discuss the chemical reactions taking place in blast furnace in extraction of Fe, Cu and Al metals.

PROJECTS: Make table showing place of availability of different ores in India and show places on India map.

ASSIGNMENTS: Calculation of HCV and LCV of fuel using fuel composition in Dulong's formula.

SEMINAR: Chemical structure of fuel components influences on fuel rating.

PROJECTS: Mapping of energy resources in India.

PROJECTS: Collection of data of various lubricants available in the market.

ASSIGNMENTS: Distinguish between paint and varnishes.

SEMINAR: 1. Corrosion rate and units.

2. Corrosion prevention.

PROJECTS: Mapping of area in India prone to corrosion.

PROJECTS: Collection of data of various electrochemical cells batteries used in equipment and devices and available in market. Visit to sites such as Railway station to watch corrosion area in railways and research establishment in and around the institution.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOL/SOFTWARE REQUIRED:

Sr. No.	Equipment Name with Broad Specification	Relevance LLO Number
1	Nephelometer; Auto ranging from 20-200NTU, +/-2% of reading plus 0.1 NTU, power 220 volts+/-10%AC50Hz	LLO9.2
2	pH meter reading up to pH14; ambient temperature -40 to 700C.; pH/mV resolution:13 bit	LLO9.1, LLO10.1
3	Electric oven inner size 18 *18*18; temperature range 100 to 2500C with capacity of 40 Lt.	LLO1.1, LLO2.1, LLO4.1, LLO6.1
4	Bomb calorimeter as per IRDTE	LLO2.2, LLO3.2
5	Conductivity meter; conductivity range -0.01uS/cm to 200mS/cm, Cell constant- digital 0.1 to 2.00; Temperature range -00Cto 1000C	LLO5.2, LLO11.1

6	Electronic balance, with scale range of 0.001gm to 500.0gm, pan size 100mm; response time 3-5 sec; power requirement 90-250 V, 10watt	All
7	Redwood Viscometer, Power: single phase, 220-240v, 50/60hz, 6.0a or 115v, 12.0a Max Working Temperature: 990C Capacity: 1 sample at a time Net weight: 12 lbs (5.5kg) Input power supply: 230 V ac, 50 hz, 1 phase with 6-amp current rating	LLO4.1
8	Cleveland open cup apparatus Automatic Flash point detection Automatic cutoff at 30°C beyond expected flash point or at max. temperature limit set by the user. 16 x 4 Line Back Lit Alpha numeric display In-built Key pad for settings & data entry Audio visual indication of end of test and Alarms Over temperature safety cutoff and alarm. Last reading stored until report is printed or next test is initiated. Serial Printer interface for Automatic printing of test report at a press of a button. Ensures minimum power consumption by design thereby reducing operation cost. Electrical ignition instead of gas (Optional) Resolution: 0 .1°C * Controller Accuracy: 0.5°C Flash Detection Accuracy: ±1°C Load: 1Kw Operation on 230V 50Hz, single phase. Temperature range 00C to 4000C	LLO6.1
9	Abel's close cup apparatus Flash point temperature Air-cooled 10 °C to 130 °C Liquid-cooled -30 °C to +130 °C Ignition type Electric (encapsulated hot wire) Optional gas ignition Barometric pressure correction Flash point is automatically corrected to barometric pressure Sample temperature Automatic by Pt100 Safety Integrated automatic fire-extinguishing system in combination with a unique optical fire detection system Overheat protection, automatic shut-off | Detects a "flash" outside the cup User management with different access levels Calibration of sample and block temperature, stirrer speed, and internal barometer. Memory 1 GB space Interfaces 4 × USB, 1 × LAN Power supply 100 V to 240 V, 50/60 Hz, 300 W Gas supply Integrated fire extinguisher: CO2 or N2 inert gas; inlet pressure 400 kPa to 500 kPa Optional gas ignition: 50 mbar of propane or butane	LLO7.1

VIII. SUGGEST WEIGHTAGE TO LEARNING EFFORTS AND ASSESSMENT PURPOSE (SPECIFICATION TABLE):

Sr. No.	Unit	Unit Title	Aligned COs	Learning Hours (L+T)	Weightage %
1	I	Metal and Alloy	CO1	10	20
2	II	Engineering Material	CO2	6	14
3	III	Chemistry of fuel	CO3	10	20
4	IV	Lubricant	CO4	8	16
5	V	Corrosion, Methods of Prevention of corrosion, Organic Coating	CO5	6	14
6	VI	Catalyst	CO6	8	16
Grand Total				**48**	**100**

IX. SUGGESTED COs- POS MATRIX FORM:

Course Outcomes (COs)	Programme Outcomes (POs)						
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life long Learning
CO1	3	3	2	2	2	1	2
CO2	3	3	3	2	2	1	2
CO3	3	3	2	3	2	1	2
CO4	2	3	2	2	3	1	2
CO5	2	3	2	3	3	1	2
CO6	3	3	2	3	2	1	2

X. SUGGESTED-LEARNING MATERIALS / BOOKS:

Sr. No.	Author	Title	Publisher with ISBN Number
1		Text Book of Chemistry for Class XI & XII (Part-I, Part-II);	N.C.E.R.T., Delhi, 2017-18 ISBN 81-7450-494-X ISBN 81-7450-535-O
2	Shikha Agarwal	Engineering Chemistry	Cambridge University Press; New Delhi, 2015 ISBN978-1-107-47641-7

3	C.N. R. Rao	Understanding Chemistry	Universities Press (India) Pvt. Ltd., 2011. ISBN8173712506
4	Dara, S. S. & Dr. S. S. Umare	Engineering Chemistry	S. Chand. Publication, New Delhi, 2015 ISBN 8174505660
5	Dr. Vairam S.	Engineering Chemistry	Wiley India Pvt. Ltd., New Delhi, 2013. ISBN 978-8126543342
6	Dr. G. H. Hugar & Prof A. N. Pathak	Applied Chemistry Laboratory Practices, Vol. I and Vol. II	NITTTR, Chandigarh, Publications, 2013-14
7	Agnihotri, Rajesh	Chemistry for Engineers	Wiley India Pvt. Ltd., 2014 ISBN 9788126550784
8	Anuj Rawlly, Devdatta V. Saraf	Applied Chemistry with Lab Manual	Khana Book Publication Co. (P) Ltd. New Delhi, 2021, ISBN 978-93-91505-44-8
9	Bagotsky V. S.	Fundamental of Electrochemistry	John Wiley & Sons, Inc., Hoboken, New Jersey ISBN 8174506314
10	A I Vogel	Text book of Quantitative Inorganic Analysis	Longman Group Ltd Longman House, Burnt Mill, Harlow Esses CM202JE, England ISBN 0582407303
11	G. F. Liptrot	Modern Inorganic Chemistry	Unwin Hyman, London ISBN 9780713521832
12	Peter Atkin	Physical Chemistry	Oxford University Press ISBN 9780198814740
13	J D Lee	Concise Inorganic Chemistry	Wiley India Edition ISBN 8126515546

XI. LEARNING WEBSITES & PORTALS:

Sr. No.	Link / Portal	Description
1	www.em-ea.org/guide%20books/book /2.1%20fuels%20and%20combustion.pdf	Fuel and Combustion
2	www.chemcollective.org	Metals, Alloys
3	www.rsc.org	Catalysis
4	www.onlinelibrary.wiley.com	Material and corrosion
5	http://phet.colorado.edu/en/simulations/ph-scale	pH and pOH
6	www.rsc.org	Analytical Chemistry
7	www.science2learn.com	Online chemistry experiment
8	www.labster.com	Virtual lab
9	www.coursera.org	Electrochemistry, water chemistry
10	www.khanacademy.org	General Chemistry

*****