



**DIPLOMA WING**  
**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

*SEMESTER I – GROUP 'A'*

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|-------------------|---|-------------------|
| COURSE TITLE      | : | APPLIED CHEMISTRY |
| PAPER CODE        | : | 7352              |
| SUBJECT CODE      | : | 103               |
| THEORY CREDITS    | : | 04                |
| PRACTICAL CREDITS | : | 02                |

**Course Objectives:**

There are numerous number materials are used in fabricating and manufacturing devices for the comfort of life. The selection, characterization and suitability assessment of natural raw materials essentially requires principles and concepts of Applied Chemistry for technicians. On successful completion of this course content will enable technicians to understand, ascertain and analyse and properties of natural raw materials require for producing economical and eco-friendly finished products.

- Solve various engineering problems applying the basic knowledge of atomic structure and chemical bonding.
- Use relevant water treatment method to solve domestic and industrial problems.
- Solve the engineering problems using knowledge of engineering materials and properties.
- Use relevant fuel and lubricants for domestic and industrial applications
- Solve the engineering problems using concept of Electrochemistry and corrosion.

**Course Content:**

• **Unit 1: Atomic Structure, Chemical Bonding and Solutions**

Rutherford model of atom, Bohr's theory (expression of energy and radius to be omitted), and hydrogen spectrum explanation based on Bohr's model of atom, Heisenberg uncertainty principle, Quantum numbers – orbital concept. Shapes of s, p and d orbitals, Pauli's exclusion principle, Hund's rule of maximum multiplicity Aufbau rule, electronic configuration.

Concept of chemical bonding – cause of chemical bonding, types of bonds: ionic bonding (NaCl example), covalent bond ( $H_2$ ,  $F_2$ , HF hybridization in  $BeCl_2$ ,  $BF_3$ ,  $CH_4$ ,  $NH_3$ ,  $H_2O$ ), coordination bond in  $NH_4^+$ , and anomalous properties of  $NH_3$ ,  $H_2O$  due to hydrogen bonding, and metallic bonding.

Solution – idea of solute, solvent and solution, methods to express the concentration of solution- molarity ( $M$  = mole per liter), ppm, mass percentage, volume percentage and mole fraction.

• **Unit 2: Water**

Graphical presentation of water distribution on Earth (pie or bar diagram). Classification of soft and hard water based on soap test, salts causing water hardness, unit of hardness and simple numerical on water hardness.

Cause of poor lathering of soap in hard water, problems caused by the use of hard water in boiler (scale and sludge, foaming and priming, corrosion etc), and quantitative measurement of water hardness by EDTA method, total dissolved solids (TDS) alkalinity estimation.

i). Water softening techniques – soda lime process, zeolite process and ion exchange process.

ii). Municipal water treatment (in brief only) – sedimentation, coagulation, filtration, sterilization.

Water for human consumption for drinking and cooking purposes from any water sources and enlist Indian standard specification of drinking water (collect data and understand standards).

- **Unit 3: Engineering Materials**

Natural occurrence of metals – minerals, ores of iron, aluminium and copper, gangue (matrix), flux, slag, metallurgy – brief account of general principles of metallurgy.

Extraction of - iron from haematite ore using blast furnace, aluminium from bauxite along with reactions. Alloys – definition, purposes of alloying, ferrous alloys and non-ferrous with suitable examples, properties and applications.

General chemical composition, composition based applications (elementary idea only details omitted):

Port land cement and hardening, Glasses Refractory and Composite materials.

Polymers – monomer, homo and co polymers, degree of polymerization, simple reactions involved in preparation and their application of thermoplastics and thermosetting plastics (using PVC, PS, PTFE, nylon – 6, nylon-6,6 and Bakelite), rubber and vulcanization of rubber.

- **Unit 4: Chemistry of Fuels and Lubricants**

Definition of fuel and combustion of fuel, classification of fuels, calorific values (HCV and LCV), calculation of HCV and LCV using Dulong's formula.

Proximate analysis of coal solid fuel

petrol and diesel - fuel rating (octane and cetane numbers),

Chemical composition, calorific values and applications of LPG, CNG, water gas, coal gas, producer gas and biogas.

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 saponification value) of lubricants.

- **Unit 5: Electro Chemistry**

Electronic concept of oxidation, reduction and redox reactions.

Definition of terms: electrolytes, non-electrolytes with suitable examples, Faradays laws of electrolysis and simple numerical problems.

Industrial Application of Electrolysis –

- Electrometallurgy
- Electroplating
- Electrolytic refining.

Application of redox reactions in electrochemical cells –

- Primary cells – dry cell,
- Secondary cell - commercially used lead storage battery, fuel and Solar

cells. Introduction to Corrosion of metals –

- definition, types of corrosion (chemical and electrochemical),  $H_2$  liberation and  $O_2$  absorption mechanism of electrochemical corrosion, factors affecting rate of corrosion.

Internal corrosion preventive measures –

- Purification, alloying and heat treatment and

External corrosion preventive measures: a) metal (anodic, cathodic) coatings, b) organic inhibitors.

### **Suggested Sessional work:**

- **Unit 1: Atomic Structure, Chemical Bonding and Solutions**

Assignments: Writing electronic configuration of elements up to atomic number 30 ( $Z=30$ ). Numerical on molarity, ppm, mass percentage, volume percentage and mole fraction of given solution.

Seminar: 1. Quantum numbers,

2. Discuss the metallic properties such as malleability, ductility, hardness, high melting point, conductance of heat and electricity, magnetic properties of metals.

Projects: Model of molecules  $\text{BeCl}_2$ ,  $\text{BF}_3$ ,  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ .

- **Unit 2: Water**

Assignments: Simple problems on hardness calculation.

Seminar: 1. Quality and quantity requirement of water in house and industry.

2. Quality of control measures of effluents (BOD & COD).

Projects: Collect water samples from different water sources and measure of hardness of water.

- **Unit 3: Engineering Materials**

Assignments: Preparation of table showing different ores of iron, copper and aluminium metals along with their chemical compositions and classify in to oxide sulphide 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.

- **Unit 4: Chemistry of Fuels and Lubricants**

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

Seminar: Chemical structure of fuel components influence on fuel rating.

Projects: Mapping of energy resources in India. Collection of data of various lubricants available in the market.

- **Unit 5: Electro Chemistry**

Assignments: Simple problems on Faraday's laws of electrolysis. Seminar: 1. Corrosion rate and units.

2. Corrosion preventions.

Projects: Mapping of area in India prone to corrosion. 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.



## Learning Outcomes

At the end of the course student will be able to

1. Understand the classification and general properties of engineering materials such as metal, alloys, glasses, cement, refractory and composite materials using knowledge of chemical bonding.
2. Understand and assess the suitability of water source for domestic and industrial application, effluents and minimize water pollution.
3. Qualitatively analyze the engineering materials and understand their properties and applications.
4. Choose fuel and lubricants suitable for economical industrial processing to obtain eco-friendly finished products.
5. a) Ascertain construction, mechanism efficiency of electrochemical cells, solar cell fuel cells  
b) Understand corrosion and develop economical prevention techniques.

## References/Suggested Learning Resources:

### (a) Books :

- 1) Text Book of Chemistry for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi, 2017-18.
- 2) Agarwal, & Shikha, Engineering Chemistry, Cambridge University Press; New Delhi, 2015.
- 3) C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
- 4) Dara, S. S. & Dr.S.S.Umare, Engineering Chemistry, S.Chand. Publication, New Delhi, New Delhi, 2015.
- 5) Jain & Jain, Engineering Chemistry, Dhanpat Rai and Sons; New Delhi, 2015.
- 6) Dr. Vairam, S., Engineering Chemistry, Wiley India Pvt.Ltd., New Delhi, 2013.
- 7) Dr. G. H. Hugar & Prof A. N. Pathak, Applied Chemistry Laboratory Practices, Vol. I and Vol. II, NITTTR, Chandigarh, Publications, 2013-14.
- 8) Agnihotri, Rajesh, Chemistry for Engineers, Wiley India Pvt.Ltd., 2014.

### (b) Open source software and website address:

- 1 [www.chemguide.co.uk/atommenu.html](http://www.chemguide.co.uk/atommenu.html) (Atomic structure and chemical bonding)
- 2 [www.visionlearning.com](http://www.visionlearning.com) (Atomic structure and chemical bonding)
- 3 [www.chem1.com](http://www.chem1.com) (Atomic structure and chemical bonding)
- 4 <https://www.wastewaterlearning.com/elearning/> (Water Treatment)
- 5 [www.capital-refractories.com](http://www.capital-refractories.com) (Metals, Alloys, Cement, and Refractory Materials)
- 6 [www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf](http://www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf) (Fuel and Combustion)
- 7 [www.chemcollective.org](http://www.chemcollective.org) (Metals, Alloys)
- 8 [www.wqa.org](http://www.wqa.org) (Water Treatment)

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# **APPLIED CHEMISTRY LAB**

## **Course Objectives:**

There are numerous number of materials used in fabricating and manufacturing devices for the comfort of life. The selection, characterization and suitability assessment of natural raw materials essentially requires principles and concepts of Applied Chemistry for technicians. The course aims to supplement the factual knowledge gained in the lectures by first hand manipulation of processes and apparatus. This will develop scientific temper and help to apply the basic concepts and principles insolving engineering problems.

## **LIST OF PRACTICALS:**

Perform any 12 (twelve) Laboratory Practicals.

### **Volumetric and Gravimetric analysis:**

- 1 Preparation of standard solution of oxalic acid or potassium permanganate.
- 2 To determine strength of given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.
- 3 Standardization of  $\text{KMnO}_4$  solution using standard oxalic acid and Determine the percentage of iron present in given Hematite ore by  $\text{KMnO}_4$  solution.
- 4 Iodometric estimation of copper in the copper pyrite ore.
- 5 Volumetric estimation of total acid number (TAN) of given oil.
- 6 Volumetric estimation of
  - a) Total hardness of given water sample using standard EDTA solution.
  - b) Alkalinity of given water sample using 0.01M sulphuric acid
- 7 Proximate analysis of coal
  - a) Gravimetric estimation moisture in given coal sample
  - b) Gravimetric estimation ash in given coal sample

### **Instrumental analysis**

8. Determine the conductivity of given water sample.
9. Determination of the Iron content in given cement sample using colorimeter.
10. Determination of calorific value of solid or liquid fuel using bomb calorimeter.
11. Determination of viscosity of lubricating oil using Redwood viscometer.
12. Determination of flash and fire point of lubricating oil using Able's flash point apparatus.
13. To verify the first law of electrolysis of copper sulfate using copper electrode.
14. Construction and measurement of emf of elector chemical cell (Daniel cell).
15. To study the effect of dissimilar metal combination.

## **Teachers should use the following strategies to achieve the various outcomes of the course.**

- Different methods of teaching and media to be used to attain classroom attention.
- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations.
- Micro-projects may be given to group of students for hand-on experiences
- Encouraging students to visit to sites such as Railway station and research establishment around the institution.

**Learning Outcomes:**

At the end of the course student will be able to

- To express quantitative measurements accurately.
- To practice and adapt good measuring techniques.
- To use various apparatus for precise measurements.
- To understand and differentiate different methods of quantitative analysis.
- To know and understand principles of quantitative analysis using instruments.
- To construct different electrochemical cells used in developing batteries.
- To understand and appreciate methods of corrosion abetments.

**Reference Books:**

1. Text Book of Chemistry for Class XI & XII (Part-I, Part-II); N.C.E.R.T., Delhi, 2017-18.
  2. Dr. G. H. Hugar and Prof A. N. Pathak, Applied Chemistry Laboratory Practices, Vol. I and Vol. II, NITTTR, Chandigarh, Publications, 2013-14.
  3. Agnihotri, Rajesh, Chemistry for Engineers, Wiley India Pvt.Ltd., 2014.
  4. Jain & Jain, Engineering Chemistry, Dhanpat Rai and Sons; New Delhi, 2015.
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