GOVERNMENT POLYTECHNIC KANDHAMAL
PHULBANI

DEPARTMENT OF MATHEMATICS & SCIENCE

LESSON PLAN
ENGINEERING CHEMISTRY (THEORY)
FOR
2ND SEMESTER
(BRANCH: COMMON)
(SESSION: 2025 – 26)

PREPARED BY
Gouranga Badhei
Sr. Lecturer in Chemistry

GOVERNMENT POLYTECHNIC KANDHAMAL, PHULBANI

NAME OF THE COURSE: ENGINEERING CHEMISTRY			
COURSE CODE	**Th 5 (b)**	**SEMESTER**	**2nd Sem.**
THEORY PERIODS	**4 Periods/Week**	**EXAMINATION**	**3 Hrs**
TOTAL PERIODS	**60**	**INTERNAL ASSESSMENT TEST**	**30 Marks**
END SEMESTER EXAMINATION	**70 Marks**	**NO. OF CREDITS**	**4**

Topic wise distribution of periods

Unit No.	Topics/ Units	Periods
1	Atomic Structure, Chemical Bonding and Solutions	20
2	Water	12
3	Engineering Materials	12
4	Chemistry of Fuels and Lubricants	8
5	Electrochemistry	8
	TOTAL	**60**

Syllabus Coverage up to1st Internal Examination

Unit-1 & 2

Course Outcome

After the Completion of the Course the Students will be able to:

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After completing this course, students will be able to:

CO-1: Solve various engineering problems by applying the basic knowledge of atomic, molecular, electronic modifications and Chemical bonding by analyzing the technology based on them.

CO-2: Identify the problems associated with raw water used in drinking & boilers and sewage water and solve the problems by using different water treatment methods.

CO-3: Analyze the properties engineering materials and substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.

CO-4: Use relevant fuel and lubricants for domestic and industrial applications

CO-5: To impart knowledge on the essential aspects of electrochemical cells, emf, applications of emf measurements and understand the principles of corrosion and corrosion control.

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 ETDA 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 proper ties (viscosity and viscosity index, oiliness, flash and fire point, could 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), H2 liberation and O2 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.

References/Suggested Learning Resources:

(a) Books:

1) Textbook 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 Del hi, 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 (Atomic structure and chemical bonding)
2 www.visionlearning.com (Atomic structure and chemical bonding)
3 www.chem1.com (Atomic structure and chemical bonding)
4 https://www.wastewaterelearning.com/elearning/ (Water Treatment)
5 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 (Fuel and Combustion)
7 www.chemcollective.org (Metals, Alloys) 8 www.wqa.org(Water Treatment)

LESSON PLAN
Session: 2025 – 26 (Summer)

Course Name : Engineering Chemistry	**Name of the Faculty: Gouranga Badhei,**
Course Code : Th 5	**Sr. Lecturer (Chemistry)**
Semester : 2nd Semester (Even)	**Session : Summer 2025-26**
Periods/Week : 04	**Date : 09-01-2026 to 08-05-2026**
Total Periods : 60	**No. of Credits : 4**

Week	Class/Day	Topics to be Covered
1	1	Rutherford model of atom, Bohr's theory
	2	Hydrogen spectrum explanation based on Bohr's model of atom,
	3	Heisenberg Uncertainty Principle, Quantum numbers (Principal and Azimuthal)
	4	Quantum numbers (Magnetic and Spin)– orbital concept.
2	1	Shapes of s, p and d- orbitals, Aufbau rule, electronic configurations.
	2	Hund's rule of maximum multiplicity, Pauli's exclusion principle,
	3	Cause of chemical bonding, types of bonds: ionic bonding (NaCl example),
	4	Covalent bond (H_2, F_2, HF)
3	1	Concept of Hybridization, Hybridization in $BeCl_2$, BF_3 ,
	2	Hybridization in CH_4 , NH_3 , H_2O, coordination bond in NH^{4+}.
	3	Concept of Hydrogen Bonding, Anomalous properties of NH_3, H_2O due to hydrogen bonding.
	4	Metallic Bonding.
4	1	Idea of solute, solvent and solution, methods to express the concentration of solution- molarity (M = mole per liter)
	2	ppm, mass percentage, volume percentage and mole fraction.
	3	**UNIT DISCUSSION**
	4	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.
5	1	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.)
	2	Quantitative measurement of water hardness by ETDA method,
	3	Total dissolved solids (TDS) alkalinity estimation.
	4	Water softening techniques – soda lime process
6	1	Zeolite process and ion exchange process.
	2	Municipal water treatment (in brief only) – sedimentation, coagulation, filtration, sterilization.
	3	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).
	4	**UNIT DISCUSSION**
7	1	Natural occurrence of metals – minerals, ores of iron, aluminium and copper, gangue (matrix),
	2	Flux, slag, metallurgy – brief account of general principles of metallurgy.
	3	Extraction of - iron from haematite ore using blast furnace, aluminium from bauxite along with reactions.
	4	Alloys – definition, purposes of alloying, ferrous alloys and non-ferrous with suitable examples, properties and applications.

8	1	General chemical composition, composition-based applications (elementary idea only details omitted): Port land cement and hardening,
	2	Glasses Refractory and Composite materials.
	3	Polymers – monomer, homo and co polymers, degree of polymerization, simple reactions involved in preparation and their application of PVC, PS,
	4	Simple reactions involved in preparation and their application of PTFE, nylon – 6, nylon-6,6 and Bakelite)
9	1	Rubber and vulcanization of rubber.
	2	**UNIT DISCUSSION**
	3	Definition of fuel and combustion of fuel, classification of fuels, calorific values (HCV and LCV), calculation of HCV and LCV using Dulong's formula.
	4	Proximate analysis of coal, liquid fuel petrol and diesel - fuel rating (octane and cetane numbers),
10	1	Chemical composition, calorific values and applications of LPG, CNG, water gas, coal gas, producer gas and biogas.
	2	Lubrication – function and characteristic properties of good lubricant, classification with examples.
	3	Lubrication mechanism – hydrodynamic and boundary lubrication
	4	Physical properties of lubricants (viscosity and viscosity index, oiliness, flash and fire point, could and pour point only)
11	1	Chemical properties (coke number, total acid number saponification value) of lubricants.
	2	**UNIT DISCUSSION**
	3	Electronic concept of oxidation, reduction and redox reactions. Definition of terms: electrolytes, non-electrolytes with suitable examples
	4	Faradays laws of electrolysis and simple numerical problems.
12	1	Industrial Application of Electrolysis – Electrometallurgy, Electroplating and Electrolytic refining.
	2	Application of redox reactions in electrochemical cells – Primary cells (dry cell), Secondary cell (commercially used lead storage battery), fuel and Solar cells.
	3	Introduction to Corrosion of metals – Definition, types of corrosion (chemical and electrochemical)
	4	H_2 liberation and O_2 absorption mechanism of electrochemical corrosion,
13	1	Factors affecting rate of corrosion. Internal corrosion preventive measures – Purification, alloying and heat treatment
	2	External corrosion preventive measures: a) metal (anodic, cathodic) coatings, b) organic inhibitors.
	3	DOUBT CLEARANCE
	4	DOUBT CLEARANCE
14	1	DOUBT CLEARANCE
	2	DOUBT CLEARANCE
	3	DOUBT CLEARANCE
	4	DOUBT CLEARANCE
15	1	DOUBT CLEARANCE
	2	DOUBT CLEARANCE
	3	DOUBT CLEARANCE
	4	DOUBT CLEARANCE

Course Beyond Syllabus:

Unit	Topics beyond Syllabus
1	Brief discussion on discovery of fundamental particles
	Dalton's atomic theory
	Summerfield atomic model
	Concept of VBT and MOT
	Normality and molality
2	Sources of water
	Hardness of water
3	Definition with examples of minerals, ores, gangue
	Methods of refining of crude metals
4	Solid fuels
	Advantages and disadvantages of coal, coke, charcoal
5	Electrochemical series
	Galvanization

Signature of the Faculty

Signature of HOD