

**Department of Chemistry, College of Basic Science and Humanities**  
**2nd Year Honours**

**Course Code: CHC2305**

**Course Title: Physical Chemistry – III**  
**Lesson Plan**

Unit No	Name of the Chapter	Topic Title	No. of Lectures	Name of the Faculty
1.	Electrochemistry – I	General Introduction	2	Dr. (Mrs.) N. Swain
		Conductance	2	
		Kohlarusch's law	3	
		Applications of conductance measurement	7	
2.	Electrochemistry – II	Electrolytes and electrolytic dissociation	2	Dr. (Mrs.) N. Swain
		Debye- Huckel theory	8	
		Transport number	5	
3.	Electrochemistry – III	Cells	5	Mr. S. Muni
		Polarization and over voltage	2	
		Electrodes and electrochemical series	3	
		Concentration cells	2	
		Application of emf measurement	8	
4.	Ionic equilibrium	Acid and bases	2	Mr. S. Muni
		Dissociation constant and hydrolysis	3	
		Acid and base indicators	5	

**Course Break Up**

**Unit – 1**

**Chapter Name: Electrochemistry – I**

**Name of the Faculty: Dr. (Mrs.) N. Swain**

Lecture No.	Details of the topic to be covered
1.	General Introduction: Metallic conductors, electrolytes and interconversion of electrical and chemical energy
2.	Electrolytic cell and electrochemical cell.
3.	Specific, equivalent and molar conductance.
4.	Variation of specific and equivalent conductance with dilution
5.	Kohlarusch's law of independent migration of ions
6.	Ionic mobility
7.	Application of Kohlarusch's law
8.	Applications of conductance measurement: determination of degree of dissociation, dissociation constant of weak monobasic acid
9.	Applications of conductance measurement- Solubility and solubility product of sparingly soluble salts
10.	Applications of conductance measurement- degree of hydrolysis of salts
11.	Applications of conductance measurement- ionic product of water
12.	Conductometric titration.
13.	Conductometric titration-Contd.

**Unit – 2****Chapter Name: Electrochemistry – II****Name of the Faculty: Dr. (Mrs.) N. Swain**

Lecture No.	Details of the topic to be covered
1.	Arrhenius theory of electrolytic dissociation
2.	Ostwald's dilution law; Strong and weak electrolytes
3.	Debye- Huckel theory of strong electrolyte
4.	Interionic attraction theory
5.	Ionic doublet
6.	Asymmetry effect and electrophoretic effect.
7.	Debye- Huckel limiting law(derivation not required)
8.	Debye- Huckel limiting law Contd.
9.	Onsager's conductance equation and its validity (derivation no-t required)
10.	Activity coefficient
11.	Transport number.
12.	Transport number-Continued
13.	Transport number determination by Hittorf method.

**Unit – 3****Chapter Name: Electrochemistry – III****Name of the Faculty: Dr. S. Muni**

Lecture No.	Details of the topic to be covered
1.	Galvanic cell and cell reaction
2.	Types of reversible electrodes and electrode reaction
3.	E.M.F of reversible cells and its experimental determination
4.	Relation between cell emf, $\Delta H$ , $\Delta G$ , $\Delta S$
5.	Expression for single electrode potential
6.	Polarization and over voltage
7.	Reference electrodes; Standard oxidation potential
8.	Electrochemical series and its application
9.	Concentration cells with transference
10.	Concentration cells without transference
11.	Application of e.m.f. measurement- determination of transport number, valence of ions
12.	Activity coefficient, solubility of sparingly soluble salts, heat of reaction
13.	pH and its determination by Hydrogen and Quinhydrone electrode
14.	pH by glass electrode; Dissociation constant of weak monobasic acids
15.	Ionic product of water, degree of hydrolysis, Potentiometric titration

**Unit – 4****Chapter Name: Ionic Equilibria****Name of the Faculty: Dr. S. Muni**

Lecture No.	Details of the topic to be covered
1.	Acid and bases, theory of acids and bases
2.	Relative strengths, solvent and substituent effect on strengths
3.	Dissociation constant of acids and bases. pH
4.	Salt hydrolysis, degree of hydrolysis
5.	Buffer solutions, action, range, capacity; Henderson's equation
6.	Buffers in the body- buffer of tissue fluids and carbonate-bicarbonate buffer.
7.	Theory of acid and base indicators, range, choice of indicators
8.	Neutralisation curves
9.	Elementary knowledge about other types of indicators.

## Lesson Plan

Unit No	Name of the Chapter	Topic Title	No. of Lectures	Name of the Faculty
1.	Chemistry of s and p Block Elements	Chemistry of s & p Block Elements: General properties	2	Mr. S.R Panda
		Hydrides and their classifications:	2	
		Study of compounds: Boric acids, borates, boron nitrides, borohydrides (diborane).	3	
		Study of compounds carboranes, graphitic compounds, silanes,	2	
		Study of compounds Oxides and oxoacids of nitrogen, phosphorous and chlorine, Peroxo acids of sulphur, Interhalogen compounds, pseudohalogens	8	
2.	Non-aqueous Solvents	Introduction & classification of solvents	2	Mr. S.R Panda
		Reaction in liquid NH <sub>3</sub>	3	
		Liquid SO <sub>2</sub> :	3	
	General Principles of Metallurgy	General principles of metallurgy, various methods of concentration	2	Dr (Mrs). S. Jena
		purification and refining, metallurgy of important metals	2	
3.	Principles in qualitative analysis	Concept of precipitation	2	Dr. H.S.Sahoo
		Analysis of acidic radicals	4	
		Analysis of interfering radicals	2	
		Analysis of basic radicals	4	
4.	Nuclear Chemistry	Nature of radiation, Composition of Nuclei, binding energy	3	Dr (Mrs). S. Jena
		Radioactive disintegration, kinetics of radioactive disintegration, Nuclear reactions	3	
		Thermonuclear reactions, radiation detection and measurement, artificial transmutation	4	
		carbon dating, activation analysis, isotopic dilution, radioactive titration	4	

## Course Break Up

## Unit – 1

## Chapter Name: Chemistry of s and p Block Elements

Name of the Faculty: Mr. S. R. Panda

Lecture No.	Details of the topic to be covered
1.	Inert pair effect, relative stability of different oxidation states, diagonal relationship and behaviour of first member of each group
2.	Allotropy and catenation, Complex formation tendency of s and p block elements.
3.	ionic, covalent and interstitial hydrides, its preparation
4.	Properties of hydrides and Basic beryllium acetate and nitrate.
5.	Preparation, properties, uses, structure and bonding of Boric acids
6.	Preparation, properties, uses, structure and bonding of borates, boron nitrides
7.	Preparation, properties, uses, structure and bonding of borohydrides (diborane).
8.	Preparation, properties, uses, structure and bonding of carboranes, graphitic compounds.
9.	Preparation, properties, uses, structure and bonding of silanes,
10.	Preparation, properties, uses, structure and bonding of Oxides and oxoacids of nitrogen,
11.	Preparation, properties, uses, structure and bonding of oxoacids of phosphorous and chlorine
12.	Preparation, properties, uses, structure and bonding of Oxides of Chlorine
13.	Preparation, properties, uses, structure and bonding of oxoacids of chlorine
14.	Preparation, properties, uses, structure and bonding of Peroxo acids of sulphur
15.	Preparation, properties, uses, structure and bonding of Interhalogen compounds
16.	Preparation, properties, uses, structure and bonding of polyhalide ions,
17.	Preparation, properties, uses, structure and bonding of pseudohalogens and basic properties of halogens.

**Unit – 2 Chapter Name: Non – Aqueous Solvents****Name of the Faculty: Mr. S. R. Panda**

Lecture No.	Details of the topic to be covered
1.	The properties of non- aqueous solvent,
2.	classification of solvents
3.	solution of metal in liquid NH <sub>3</sub> , metathetical reaction
4.	ammonation reaction, acid base reactions and ammonolysis.
5.	Advantages and disadvantages of liquid ammonia as solvent
6.	autoionisation, solvolytic reaction, Precipitation reaction and acid base reaction.
7.	Liquid SO <sub>2</sub> : auto ionisation, solvolytic reaction,
8.	Use of redox potential data - analysis of redox cycle

**Unit – 2 Chapter Name: General Principles of Metallurgy****Name of the Faculty: Dr (Mrs). S. Jena**

Lecture No.	Details of the topic to be covered
1.	Principles involved in the extraction of elements. General principles of metallurgy, occurrence of metals with special emphasis on mineral wealth of India
2.	Calcination, roasting, smelting, bessemerization, various methods of concentration,
3.	purification and refining (such as parting process, zone refining, oxidation refining, electrolytic refining and solvent extraction)
4.	Metallurgy of important metals like Ag, Au, Zn, Cu, Ni

**Unit – 3 Chapter Name: Principles in qualitative analysis****Name of the Faculty: Dr. H. S. Sahoo**

Lecture No.	Details of the topic to be covered
1.	Theory of precipitation: ionic product, solubility product.
2.	Co-precipitation, post-precipitation, Purification of precipitates
3.	Identification of acid radicals
4.	Analysis of CO <sub>3</sub> <sup>2-</sup> , NO <sub>2</sub> <sup>-</sup> , S <sup>2-</sup> , S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> , CH <sub>3</sub> COO <sup>-</sup>
5.	Analysis of F <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup> , NO <sub>3</sub> <sup>-</sup>
6.	Analysis of BO <sub>3</sub> <sup>3-</sup> , C <sub>2</sub> O <sub>4</sub> <sup>2-</sup> , PO <sub>4</sub> <sup>3-</sup>
7.	Interfering radicals
8.	Separation of interfering radicals
9.	Analysis of group-I basic radicals
10.	Analysis of group –II basic radicals
11.	Analysis of group –III A and group-IIIB basic radicals
12.	Analysis of group –IV and group V basic radicals

**Unit – 4 Chapter Name: Nuclear Chemistry****Name of the Faculty: Dr (Mrs). S. Jena**

Lecture No.	Details of the topic to be covered
1.	Nature of radiation from radioactive substances
2.	Composition of Nuclei, structure of nucleus, forces operative within nucleus
3.	nuclear stability and mass energy equivalence (binding energy)
4.	Radioactive disintegration series,
5.	kinetics of radioactive disintegration,
6.	half-life period, average life period
7.	Nuclear reactions: Types of nuclear reactions,
8.	thermonuclear reactions including fusion and fission reactions
9.	radiation detection and measurement, semi-conductors detectors
10.	Artificial transmutation of elements,
11.	Radio-carbon dating
12.	synthetic elements
13.	Activation analysis
14.	isotopic dilution and radioactive titration

## Lesson Plan

Unit No	Name of the Chapter	Topic Title	No. of Lectures	Name of the Faculty
1.	Halogen compounds	Aliphatic halide preparation and general mechanism	4	Dr. P. K. Jena
		Aryl halides	5	
		Organometallic compounds	2	
2.	Alcohols, phenols, ethers and epoxides	Alcohols	4	Dr. B. P. Acharya
		Phenols	6	
		Ethers and Epoxides	2	
3.	Carbonyl compounds	Structure and reactivity	3	Dr. H. Nayak
		Name reactions and rearrangements	8	
		Active methylene compounds and applications	3	
4.	Carboxylic acids and their derivatives.	Properties and reactivities	2	Dr. H. Nayak,
		Hydroxy and unsaturated acids	2	
		Acid derivatives	2	
		Ester hydrolysis	2	
		Name reactions	4	
	Sulphur containing compounds	Synthesis and Properties	3	Dr. P. K. Jena

## Course Break Up

## Unit – 1

## Chapter Name: Halogen compounds

Name of the Faculty: Dr. P. K. Jena

Lecture No.	Details of the topic to be covered
1.	Methods of preparation of aliphatic halides via SN1 mechanisms
2.	Methods of preparation of aliphatic halides via SN2 and SNi mechanisms
3.	nucleophilic substitution reactions –with stereochemical aspects and effect of solvent etc.;
4.	nucleophilic substitution vs. elimination.
5.	Preparation of aryl halides, including preparation from diazonium salts.
6.	nucleophilic aromatic substitution;
7.	SNAr, Benzyne mechanism.
8.	Relative reactivity of alkyl, allyl halides towards nucleophilic substitution reactions.
9.	Relative reactivity of benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
10.	Organometallic compounds of Mg – Use in synthesis of organic compounds.
11.	Organometallic compounds of Li – Use in synthesis of organic compounds.

## Unit – 2

## Chapter Name: Alcohols, Phenols, Ethers and Epoxides

Name of the Faculty: Dr. B. P. Acharya

Lecture No.	Details of the topic to be covered
1.	Alcohols: preparation and relative reactivity of 1°, 2°, 3° alcohols.
2.	Properties of alcohols, Bouvaelt-Blanc Reduction.
3.	Preparation and properties of glycols: Oxidation by periodic acid and lead tetra acetate.
4.	Pinacol-Pinacolone rearrangement.
5.	Phenols: Preparation and properties; Acidity and factors effecting it.
6.	Ring substitution reactions.
7.	Reimer-Tiemann Reaction with mechanism.
8.	Kolbe's-Schmidt Reactions with mechanism.
9.	Fries rearrangements with mechanism.
10.	Claisen rearrangements with mechanism.
11.	Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives.
12.	Reactions with LiAlH <sub>4</sub> , Grignard and Organolithium reagents.

**Unit – 3****Chapter Name: Carbonyl compounds****Name of the Faculty: Dr. H. Nayak**

Lecture No.	Details of the topic to be covered
1.	Structure, reactivity
2.	Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism
3.	Mechanisms of Aldol and Benzoin condensation
4.	Knoevenagel condensation, Claisen-Schmidt,
5.	Perkin, Cannizzaro deaction
6.	Wittig reaction, Beckmann rearrangement
7.	Benzil-Benzilic acid rearrangements, haloform reaction
8.	Baeyer Villiger oxidation, $\alpha$ -substitution reactions,
9.	reductions: Clemmensen, Wolff-10Kishner,
10.	reductions:LiAlH <sub>4</sub> , NaBH <sub>4</sub> , MPV
11.	reductions:PDC and PGC; Addition reactions of unsaturated carbonyl compounds: Michael addition
12.	Active methylene compounds: Keto-enol tautomerism.
13.	Preparation and synthetic applications of diethyl malonate
14.	Preparation and synthetic applications of ethyl acetoacetate

**Unit – 4****Chapter Name: Carboxylic acids and their derivatives****Name of the Faculty: Dr. H. Nayak**

Lecture No.	Details of the topic to be covered
1.	Preparation and physical properties
2.	Reactions of monocarboxylic acids, Typical reactions of dicarboxylic acids; succinic/phthalic
3.	Hydroxy acids ; lactic, malic, tartaric, citric,
4.	Unsaturated acids; maleic and fumaric acids
5.	Preparation and reactions of acid chlorides
6.	Preparation and reactions of anhydrides, esters and amides
7.	Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters
8.	Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters
9.	Claisen condensation, Dieckmann reaction
10.	Reformatsky reactions
11.	Hofmann bromamide degradation
12.	Curtius rearrangement.

**Unit – 4****Chapter Name: Sulphur containing compounds****Name of the Faculty: Dr. P. K. Jena**

Lecture No.	Details of the topic to be covered
1.	Preparation and reactions of thiols, thioethers and sulphonic acids.
2.	Mustard gas:Preparation from ethylene,Oxidation
3.	Chlorination of mustard gas

## Lesson Plan

Unit No	Name of the Chapter	Topic Title	No. of Lectures	Name of the Faculty
1.	Basic Concept	Introduction and basic idea	4	Miss S. Sahoo
2.	Synthesis and Uses – I	Synthesis, manufacture and usages of Organochlorines	2	Miss S. Sahoo
		Synthesis, manufacture and usages of Organophosphates	2	
3.	Synthesis and Uses – II	Synthesis, manufacture and usages of Carbamates	2	Miss S. Sahoo
		Synthesis, manufacture and usages of Quinones	1	
		Synthesis, manufacture and usages of Anilides	2	

## Course Break Up

## Unit – 1

## Chapter Name: Basic Concept

Name of the Faculty: Miss S. Sahoo

Lecture No.	Details of the topic to be covered
1.	General introduction to pesticides (natural and synthetic)
2.	Benefits and adverse effects; Changing concepts of pesticides
3.	Structure activity relationship of pesticides
4.	Structure activity relationship of pesticides contd.

## Unit – 2

## Chapter Name: Synthesis and uses – I

Name of the Faculty: Miss S. Sahoo

Lecture No.	Details of the topic to be covered
1.	Synthesis and technical manufacture and uses of DDT
2.	Synthesis and technical manufacture and uses of Gammexene
3.	Synthesis and technical manufacture and uses of Malathion
4.	Synthesis and technical manufacture and uses of Parathion.

## Unit – 3

## Chapter Name: Synthesis and uses – II

Name of the Faculty: Miss S. Sahoo

Lecture No.	Details of the topic to be covered
1.	Synthesis, technical manufacture and usages of Carbamates: Carbofuran.
2.	Synthesis, technical manufacture and usages of Carbamates: Carbaryl.
3.	Synthesis, technical manufacture and usages of Quinones: Chloranil.
4.	Synthesis, technical manufacture and usages of Anilides: Alachlor.
5.	Synthesis, technical manufacture and usages of Anilides: Alachlor.

**Class: B. Sc.                      2<sup>nd</sup> Year generic                      3<sup>rd</sup> semester**

**Course Code: CHG2303                      Course Title: Transition Metal and  
Co-ordination Chemistry, States of Matter  
and Chemical Kinetics**

**Lesson Plan**

Unit No	Name of the Chapter	Topic Title	No. of Lectures	Name of the Faculty
1	Transition Elements (3d Series)	Properties of transitions elements	8	Dr. Himansu Sekhar Sahoo
		Lanthanoids and actinoids	4	
2	Co-ordination Chemistry	Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu	2	Mr .Sirish Ranjan Panda
		Structural and stereoisomerism in complexes. Drawbacks of VBT.	2	
		IUPAC system of nomenclature	2	
2	Crystal Field Theory	Crystal field effect, octahedral symmetry, Crystal field stabilization energy(CFSE), Crystal field effects for weak and strong fields, tetrahedral symmetry.	3	
		Factors affecting the magnitude of D. Spectrochemical series, Comparison of CFSE for $O_h$ and $T_d$ complexes,	3	
		Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination	2	
3	Liquids	General Introduction	1	Dr. Sachidananda Muni
		Surface Tension and Viscosity	4	
		Effect of temperature	1	
	Solids	General Introduction	1	
		Types and symmetry elements	2	
		Laws of crystallography	2	
		X – ray diffraction	1	
		Structures of various solids	1	
		Defects in crystals	1	
Glass and liquid crystal	1			
4	Kinetic Theory of Gases	General Introduction	1	Ms. Subhasmita Sahoo
		Derivation of gas equation and critical phenomena	3	
		Maxwell Boltzmann distribution laws and viscosity of gases	4	
	Chemical Kinetics	General Introduction	1	
		Derivation of rate equation	3	
		Theories of reaction rate	3	



## Course Breakup

### Unit – 1

### Chapter Name: Transition Elements

Name of the Faculty: Dr. H. S. Sahoo

Lecture No.	Details of the topic to be covered
1.	Transition elements: Introduction and electronic configuration and variable valency
2.	Colour, magnetic behaviour of transition elements
3.	Transition elements: catalytic properties and different complexes
4.	Ability of transition metals to form complexes
5.	Stability of various oxidation states vs emf
6.	Oxidation states of Mn: Latimer diagram of Mn
7.	Oxidation states of Fe: Latimer diagram of Fe
8.	Oxidation states of Cu: Latimer diagram of Cu
9.	Lanthanoids- Electronic configuration, oxidation states
10.	Lanthanoids: Colour and magnetic properties
11.	Lanthanoid contraction and its consequences, separation of lanthanides
12.	Actinoids- Electronic configuration, oxidation states and comparison with lanthanoids

### Unit – 2

### Chapter Name: Co-ordination Chemistry

Name of the Faculty: Mr. S. R. Panda

Lecture No.	Details of the topic to be covered
1.	Valence Bond Theory (VBT): postulates, definition of inner outer orbital complexes explanation with hybridization and structure of complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4)
2.	hybridization and structure of complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 6).
3.	Isomerism in complexes and its classification, types of Structural isomerism and its examples, stereoisomerism in complexes its types, geometrical isomerism with coordination number 4 with examples
4.	geometrical isomerism with coordination number 6 with examples. Drawbacks of VBT
5.	IUPAC system of nomenclature rules with explanation
6.	Examples for naming and practicing the rule for some complexes

### Unit – 2

### Chapter Name: Crystal Field Theory

Name of the Faculty: Mr. S. R. Panda

Lecture No.	Details of the topic to be covered
1.	Introduction to crystal field theory, important features of CFT, crystal field splitting of d orbitals in octahedral symmetry & tetrahedral symmetry
2.	Splitting of d orbitals in tetragonal complexes
3.	Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields, tetrahedral symmetry
4.	Factors affecting the magnitude of D.
5.	Spectrochemical series and its use and applications
6.	Comparison of CFSE for Oh and Td complexes
7.	Tetragonal distortion of octahedral geometry.
8.	Jahn-Teller distortion, Square planar coordination

### Unit – 3

### Chapter Name: Liquids

Name of the Faculty: Dr. S. Muni

Lecture No.	Details of the topic to be covered
1.	General introduction
2.	Surface tension – its explanation
3.	Determination of surface tension using stalagmometer
4.	Viscosity – its explanation
5.	Determination of co-efficient of viscosity using Ostwald viscometer
6.	Effect of temperature on surface tension and co-efficient of viscosity

**Unit – 3 Chapter Name: Solids****Name of the Faculty: Dr. S. Muni**

Lecture No.	Details of the topic to be covered
1.	General introduction
2.	Types of solids, different symmetry elements
3.	Crystal system and Bravais lattices
4.	Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices.
5.	Miller indices.
6.	X-Ray diffraction by crystals and Bragg's law.
7.	Structures of NaCl, KCl and CsCl (qualitative treatment only).
8.	Defects in crystals – Schottky and Frenkel defects
9.	Glasses and liquid crystals.

**Unit – 4 Chapter Name: Kinetic Theory of Gases****Name of the Faculty: Ms. S. Sahoo**

Lecture No.	Details of the topic to be covered
1.	States of matter, state variables, Postulates of kinetic theory of gases and molecular velocity
2.	Derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation.
3.	Van der Waals equation of state for real gases. Boyle temperature.
4.	Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews's isotherms of CO <sub>2</sub> .
5.	Maxwell Boltzmann distribution laws of molecular velocities and molecular energies and their importance.
6.	Temperature dependence of these distributions. Most probable, average and root mean square velocities
7.	Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules.
8.	Viscosity of gases and effect of temperature and pressure on coefficient of viscosity

**Unit – 4 Chapter Name: Chemical Kinetics****Name of the Faculty: Ms. S. Sahoo**

Lecture No.	Details of the topic to be covered
1.	The concept of reaction rates. Factors affecting reaction rates.
2.	Order and molecularity of a reaction. Derivation of rate equations for zero and first order reactions
3.	Derivation of second order reactions, both for equal and unequal concentrations of reactants
4.	Half-life of a reaction. General methods for determination of order of a reaction.
5.	Concept of activation energy and its calculation from Arrhenius equation.
6.	Collision theory and Activated Complex theory of bimolecular reactions
7.	Comparison of two theories