



**Yogi Divine Society inspired,  
Sarvodaya Kelavani Samaj managed,  
Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot**

**(Autonomous)**

**Affiliated to Saurashtra University, Rajkot**

Re-Accredited at 'A' Level by NAAC

STAR college Scheme & Status by MST-DBT

UGC- College with Potential for Excellence (CPE)

UGC-DDU KAUSHAL Kendra

GAAA – Highest Grade A-1 by KCG, Government of Gujarat

GPCB-Government of Gujarat approved Environment Audit Center

UGC-Autonomous College

**DEPARTMENT OF CHEMISTRY**

**Integrated B.Sc.-M.Sc. CHEMISTRY**

**Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot**  
**(Autonomous)**  
**Affiliated to Saurashtra University, Rajkot**

**Department of Chemistry**

**Integrated B.Sc.-M.Sc. CHEMISTRY**

**OBJECTIVES OF THE PROGRAM**

Courses offered in this program are geared towards providing students with an overall understanding of general chemistry so that they can enter the workforce with the necessary knowledge and skills. It will enable students to gain familiarity with the current industry practices and technologies.

The objectives are to:

- Train graduates with the requisite knowledge to pursue M.Sc. &/ Ph.D. degrees in Chemistry.
- Turn out graduates who can teach the subject in secondary and tertiary level of education in the county.
- Train graduates who can be employed in Industry and the other sectors of the economy.

**Graduates from the Integrated-degree program will have to demonstrate:**

- An understanding of major concepts, theoretical principles and experimental findings in chemistry.
- An ability to work effectively in diverse teams in both classroom and laboratory.
- An ability to employ critical thinking and efficient problem-solving skills in the four basic areas of chemistry (analytical, inorganic, organic, and physical).
- An ability to conduct experiments, analyze data, and interpret results, while observing responsible and ethical scientific conduct.
- Effective written and oral communication skills, especially the ability to transmit complex technical information in a clear and concise manner.
- The ability to use classical & modern instrumentation for chemical analysis and separation.
- The ability to use computers for chemical simulation and computation.
- The ability to employ modern library search tools/ databases (e.g. Scifinder, Science direct etc.) to locate, retrieve, and evaluate scientific information.
- A familiarity with and application of safety and chemical hygiene regulations and good laboratory practices.
- An ability to gain entry into professional organizations, or other related job.

Semester - III							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>PART – I</b>							
16ILCEN03	Advanced English Language -I	3	3	40	60	100	3
<b>PART- II</b>							
16IUCCC09	<b>Core -5:</b> Inorganic Chemistry	4	3	30	70	100	4
16IUCCC10	<b>Core -6:</b> Analytical Chemistry	4	3	30	70	100	4
16IUCCC11	<b>Core -7:</b> Petroleum and Petrochemicals	2	2	30	70	100	2
16IUCDA05	<b>DSE-Allied-3:</b> Mathematics-I	3	3	30	70	100	3
16IUCCC12	<b>Core Practical -5:</b> Inorganic Chemistry Practical	5	3	20	30	50	2
16IUCCC13	<b>Core Practical-6:</b> Analytical Chemistry Practical	5	3	20	30	50	2
16IUCCC14	<b>Core Practical-7:</b> Petroleum Analysis Practical	2	3	20	30	50	1
16IUCDA06	<b>DSE- Allied Practical-3:</b> Mathematics-I Practical	2	3	20	30	50	1
		<b>30</b>				<b>700</b>	<b>22</b>

Semester- IV							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>PART – I</b>							
16ILCEN04	Advanced English Language -II	3	3	40	60	100	3
<b>PART- II</b>							
16ICHCC15	<b>Core -8:</b> Organic Chemistry	4	3	30	70	100	4
16ICHCC16	<b>Core -9:</b> Physical Chemistry	4	3	30	70	100	4
16ICHCC17	<b>Core -10:</b> Agrochemicals	2	2	30	70	100	2
16ICHDA07	<b>DSE- Allied-4:</b> Mathematics-II	3	3	30	70	100	3
16ICHCC18	<b>Core Practical-8:</b> Organic Chemistry Practical	6	3	20	30	50	2
16ICHCC19	<b>Core Practical-9:</b> Physical Chemistry Practical	6	3	20	30	50	2
16ICHDA08	<b>DSE- Allied Practical-4:</b> Mathematics-II Practical	2	3	20	30	50	1
		<b>30</b>				<b>650</b>	<b>21</b>

\*Compulsory internship / Training / Project for 4 weeks in summer vacation between IV<sup>th</sup> & V<sup>th</sup> Semester. Report to be submitted in the beginning of V<sup>th</sup> semester. Viva voce conducted in the beginning of V<sup>th</sup> semester.

### Semester – III

16ICHCC09	Core-5 Inorganic Chemistry	4 hrs/week	4 Credits
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#### Objectives:

To enable the students to

- Understand elementary concepts of wave mechanics.
- Develop skill to predict properties of F- block element.
- Describe the phenomena of magnetism, types of magnetism and Gouy's method.
- Predict Magnetic behavior of transition metal complexes, splitting of d-orbital and transition in metal complexes.
- Understand & write the preparation & properties of Organometallic compounds and their applications.

#### Unit-1: Introduction to Quantum Chemistry

(12 hrs.)

##### (1) Wave Mechanics

- Operators, Algebra of operators:
  - (a) Addition and subtraction (b) Multiplication of operators
- Communicative properties
  - Linear operator
  - Communicator of operators
  - Laplacian operator
  - Momentum operator
  - Hamiltonian operator
- Particle in one dimensional box
- Wave function and energy of particle in one dimension box
- Energy levels, normalization of  $\Psi$  and orthogonality of  $\Psi$ .
- Characteristics of wave function
- Utility of the particle in a box model
- Particle in three dimensional box
- Degeneracy
- Wave function and energy for a particle moving in a rectangular box
- Wave equation for a hydrogen atom
- Separation of variables
- Numerical

#### Unit-2: Chemistry of Elements - II

(06 hrs.)

##### (2) Lanthanides and Actinides

- Electronic configuration
- Oxidation states
- Color & Magnetic properties
- Lanthanide contraction
- Separation of lanthanides (ion exchange method only)
- Applications

### Unit-3: Electronic & Magnetic Properties

(12 hrs.)

#### (3) Magneto chemistry

- Introduction (Magnetic field, Magnetic pole, Intensity of magnetization).
- Magnetic induction.
- Permeability, Intensity of Magnetism, Magnetic susceptibility, Molar magnetic susceptibility.
- Magnetic behavior: Diamagnetism, Paramagnetism, Ferro magnetism and Antiferromagnetism.
- Effect of temperature on magnetic behaviour of substances.
- Derivation of equation for total angular magnetic momentum and diamagnetic momentum.
- Determination of magnetic susceptibility by Gouy's method.

#### (4) Multi electron system

- Concept of spectral terms and term symbols.
- S-S coupling, L-L coupling, L-S coupling, J-J coupling and L-S coupling with vector diagram.
- Derivation of spectral term symbol for p<sup>1</sup>, p<sup>2</sup>, p<sup>3</sup>, & d<sup>1</sup> to d<sup>9</sup>.
- Micro states: definition, calculation and derivation of microstates for p<sup>1</sup>, p<sup>2</sup>, d<sup>1</sup> & d<sup>2</sup> (Pegionhole diagram).
- Hund's rules for the determination of ground state spectral term.

### Unit-4: Crystal field Theory

(12 hrs.)

#### (5) CFT – I

- Introduction, Concept of crystal field theory
- Splitting of d-orbital in octahedral and tetrahedral crystal field with CFSE concept.
- Factors affecting splitting energy.
- Weak field and strong field ligand.
- High spin and low spin complexes with pairing energy.
- Magnetic behavior of transition metal complexes.
- Orbital angular momentum contribution to magnetic momentum of complexes.
- Examples based on CFSE, Pairing energy and magnetic momentum.

#### (6) CFT – II

- Jahn-Teller effect: Statement and explanation.
- Tetragonal distortion with example.
- Splitting of d-orbital in square planar complexes with examples.
- Hole formalism.
- Splitting of d and f ground terms (using Hole formalism).
- Orgel Diagram of d and f states.
- Selection rules for d-d transition.
- Types of electronic transition in metal complexes.

**(7) Organometallic Compounds**

- Introduction, Classification based on nature of M-C Bond.
- Trans effect for Isomerism in OMC, EAN rules & Numerical
- Preparation, Properties and uses of Organolithium (Ph-Li & Bu-Li), Organomagnesium (Grignard), Organocopper (Gilman, Phthalocyanine Green & Blue), Organoaluminium (AlP, Ziegler-Natta) and Organoplatinum (Cisplatin)

**Text Books:**

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2010-11) *Principles of Inorganic Chemistry*. New Delhi : Milestone

**Reference Books:**

**Inorganic Chemistry**

1. Madan, R. L. (2011) *Chemistry for degree student First year*. New Delhi: S. Chand (ISBN: 81-219-3230-0).
2. Lee, J. D. (2002, Fifth edition) *Concise Inorganic Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 0-632-05293-7).
3. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller & Fraser Armstrong (2010, Fifth edition) *Inorganic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-959960-8).

### Semester – III

16ICHCC10	Core – 6: Analytical Chemistry	4 hrs/week	4 Credits
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#### Objectives:

To enable the students to

- Illustrate & Perform solvent extraction methods.
- Understand concept of EMF, types of cell and EMF series.
- Understand & perform the conductometric titration and its applications.
- Analyzed and describe optical activity & optical isomerism
- Understand the principles and applications of electro analytical methods.

#### Unit-1: Analytical Separation Techniques

(12 hrs.)

##### (1) Separation involving Solvent Extraction

- Introduction, Nature of the separation process
- Separation by precipitation
- Separation based on control of acidity
- Sulphide separations
- Other inorganic precipitant
- Organic precipitant
- Separation of constituents present in trace amounts
- Separation by electrolytic precipitation
- Extraction methods
- Sequence of the extraction process
- Extraction technique
- Applications of extraction procedures
- Ion exchange separation

#### Unit-2: Electro analytical methods - I

(12 hrs.)

##### (2) EMF

- Introduction: Electrochemistry, electrochemical cell, electrolytes, oxidation, reduction, anode, cathode, half cell, cell potential, concentration cell
- Reversible and irreversible cell
- Nernst Equation and its applications
- Calculation of equilibrium constant
- EMF series
- Relation among G, H and K

##### (3) Conductometry

- Electric transport, conductance in metals and in electrolyte solution
- Specific conductance, equivalent conductance
- Importance of conductivity electrodes. and platinization of electrodes
- Variation of specific conductance with dilution as well as area of cross section of dip type electrode and distance between two plates of electrodes etc.



- Kohlrausch law and its importance, cell constant and its importance.
- Conductometric Titration :
  - (1) Strong acid - strong base
  - (2) Strong acid - weak base
  - (3) Weak acid – strong base
  - (4) Weak acid – weak base
  - (5) Mixture of strong acid + weak acid - strong base
- Precipitation Titration :
  - (1)  $\text{AgNO}_3 - \text{NaCl}$
  - (2)  $\text{BaCl}_2 - \text{K}_2\text{SO}_4$
  - (3)  $\text{Ba}(\text{OH})_2 - \text{MgSO}_4$
- Replacement Titration :
  - (1) Salt of weak acid – strong acid
  - (2) Salt of weak base – strong base
- Degree or hydrolysis and Hydrolysis constant
- Determination of solubility and solubility product of sparingly soluble salt, for the measurement of conductivity

**Unit-3: Electro analytical methods - II**

**(06 hrs.)**

**(4) Polarography**

- Introduction, principle, instrumentation, working & calibration, factors affecting the limiting currents, cells, forms of waves and half wave potentials, applications, voltammetry, chronopotentiometry, tensametry.

**Unit-4: Opto-analytical Methods - I**

**(12 hrs.)**

**(5) Refractometry**

- Introduction
- Abbe refractometer- Instrumentation, Working & Calibration
- Optical exaltation

**(6) Polarimetry**

- Introduction
- Plane polarized light
- Optical activity
- Types of molecules analysed by polarimeter
- Theory of optical activity
- Polarimeter- Instrumentation, Working, Calibration & Application

**(7) Visible Spectrophotometry and Colourimetry**

- Introduction, Instrumentation, Working & Calibration
- Growth Draper law, Lambert's Law, Beer's Law, Lambert's-Beer's Law and derivation, application and deviation from Lambert's Law
- Spectrophotometric titration with graph and proper explanation
  - (1) Deficit of absorbance by product and titrant
  - (2) Deficit of absorbance by product and reagent
  - (3) Deficit of absorbance by reagent and titrant
  - (4) Deficit of absorbance by product only

## Unit-5: Opto-analytical Methods - II

(06 hrs.)

### (8) Flame Photometry

Introduction, General principles of flame photometry, Instrumentation, Working & Calibration, Effect of solvent in flame photometry, Interferences in flame photometry, Limitations of flame photometry

#### Text Books:

1. Sharma, B. K. (2014) *Instrumental Method of Chemical Analysis*. Meerut: GOEL publishing House (ISBN: 978-81-8283-099-8).

#### Reference Books:

##### Analytical Chemistry

1. Douglas A. Skoog, West, Holler, Crouch (2004, Eighth edition) *Fundamental of Analytical Chemistry*. Mexico: Thomson-Brooks/Cole (ISBN: 81-315-0051-9).
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4)
3. Christian, Gary D.; Dasgupta, Purnendu K.; Schug, Kevin A. (2007, Sixth edition) *Analytical Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 978-81-265-1113-6).

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### Semester – III

16ICHCC11	Core – 7: Petroleum and Petrochemicals	2 hrs/week	2 Credits
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#### Objectives:

To enable the students to

- To understand petroleum and its products.
- To classify petroleum products
- To study process flow diagram for manufacturing of C1 to C4 compounds.

#### Unit.1 Introduction of Petroleum (4 hrs.)

- Introduction to petroleum, Origin of Petroleum, Petroleum Production, Composition of Petroleum,
- Classification of Petroleum, Nature of Indian Crude,
- Important petroleum products including gasoline, kerosene, ATF, diesel, fuel oils, lubricants

#### Unit.2 Definition of Petrochemicals (5 hrs.)

- Petrochemical, Industries in India, Principal raw materials,
- Manufacture of the following compounds: Methane, Ethylene, Acetylene

#### Unit.3 Chemicals from C1 Compounds and C2 Compounds (5 hrs.)

- Manufacture of the following compounds from Methane: Methanol, Hydrogen Cyanide, Carbon disulphide.
- Manufacture of the following compounds from Ethylene: Ethyl chloride, Ethanol, Ethylene oxide, Ethylene glycol, Acetic acid, Styrene, Vinyl Acetate

#### Unit.4 Chemicals from C3 Compounds and C4 Compounds (5 hrs.)

- Manufacture of the following compounds From Propylene: Isopropanol, Cumene, polypropylene, Glycerin, Acrylonitrile, Propylene oxide, Acrylic Acid and Bis-Phenol.
- Manufacture of the following compounds From C<sub>4</sub> hydrocarbons: Butadiene, Isobutane, Butanol, Methacrylic acid and Maleic anhydride.

#### Unit.5 Aromatic compounds, Syngas and SNG Production (5 hrs.)

- Manufacture of the following compounds: Benzene, Toluene, Xylene, Naphthalene, Linear alkyl benzenes and their sulphonates, Caprolactum and adipic acid.
- Manufacture of the following compounds:  
Steam refining: from natural gas and from naphtha.  
Scheme for CO & H<sub>2</sub> production, SNG production: from naphtha and from via partial oxidation.

#### Text Books:

1. B.K. Bhaskar Rao (1990), Petrochemicals, CRC Press
2. A.L. Waddams (1970), Chemicals from Petroleum, 2<sup>nd</sup> Edition, ELBS, London

#### Reference Books:

1. G.N. Pandey (1977), Chemical Technology, 3<sup>rd</sup> Edition, Vikas Publishing House Pvt. Ltd.
2. Gopal Rao M and Marshall Sittig (1997), Dryden's Outlines of Chemical Technology, 3<sup>rd</sup> Edition, East-West Press.

### Semester – III

16ICHCC12	Core Practical –5: Inorganic Chemistry	5 hrs/week	2 Credits
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#### Objectives:

To enable the students to

- Identify unknown inorganic mixture
- Develop skill to prepare and purify inorganic complexes.
- Develop skill to determine concentration of metal ion in the given solution.

#### Practical

- Inorganic Qualitative Analysis – Four radicals (08)
- Complexometric Analysis
- Inorganic Preparations & Purification (04)

### Semester – III

16ICHCC13	Core Practical –6: Analytical Chemistry	5 hrs/week	2 Credits
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#### Objectives:

To enable the students to

- Develop skill to determine concentration of unknown concentration of given solution by different instrumental methods.

#### Practical

- **Instrumental Methods of Analysis**
  - Conductometry,
  - Colourimetry,
  - Visible Spectrophotometry,
  - Refractometry

#### Reference Books:

1. Brian S. Furniss (1989, Fifth edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012, Third edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
4. Jerry R. Mohrig (2010, Third edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).
5. Svehla, G. (1979, Fifth edition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).

Semester – III

16ICHCC14	Core Practical –7: Petroleum Analysis	2 hrs/week	1Credits
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**Objectives:**

To enable the students to

- Determine analysis of smoke point, viscosity and fire point for petroleum products
  
- To determine the penetration number of given Bituminous sample.
- To determine the softening point of Bituminous material (Grease or Wax).
- To determine the smoke point of light petroleum products.
- To determine the kinematic viscosity of an oil sample using Redwood viscometer.
- To determine the kinematic viscosity of an oil sample using Saybolt viscometer.
- To determine flash and fire point of the given sample by using cleaveland open-cup apparatus.
- To determine the % moisture present in a given sample of liquid petroleum by Dean and Stark's method.
- Determination of Cloud and Pour point of heavy petroleum product.

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## Semester-IV

16ICHCC15	Core –8: Organic Chemistry	4 hrs/week	4 Credits
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### Objectives:

To enable the students to

- Describe preparations and chemical properties of various functional groups.
- Predict & describe mechanism of different name reactions.
- Give the applications of various reagents.
- Write the synthesis and uses of different dyes, perfumes and explosives.

### Unit-1: Chemistry of carbonyl compounds

(12 hrs.)

#### (1) Aldehyde and Ketone

Nomenclature, preparation of aldehyde by

- a) Reduction methods (Rosenmund, Stephen)
  - b) Oxidation method (Etard, Sarett using PCC and PDC)
- Preparation of ketone: a) Friedel-Craft Acylation, b) Organometallic compounds of Li and Cd
  - Physical properties of aldehyde and ketone
  - Chemical properties of aldehyde and ketone
- Nucleophilic addition reaction
- a) Reaction with NaHSO<sub>3</sub>
  - b) Acetal and ketal formation
  - c) Cyanohydrin formation
  - d) Oxime formation
  - e) Hydrazone formation
  - f) Reaction with Grignard reagent
- Some important reactions
    - a) Aldol condensation
    - b) Crossed aldol condensation
    - c) Cannizzaro reaction
    - d) Clemmensen reduction
    - e) Wolff-Kishner reduction

#### (2) Active Methylene Compounds

- Introduction
- Keto-enol tautomerism in acidic & basic medium
- Preparation of Ethyl acetoacetate by Claisen condensation
- Physical & chemical properties
- Various Synthesis from EAA
  - a) Monocarboxylic acid
  - b) Dicarboxylic acid
  - c)  $\alpha,\beta$ -Unsaturated acid
  - d) Diketone
  - e) Ketone
  - f) Heterocyclic compounds

**Unit-2: Carboxylic acid****(08 hrs.)****(3) Carboxylic acid and its derivatives**

- Nomenclature
- Synthesis of monocarboxylic acid,
  - a) Oxidation of primary alcohol
  - b) Hydrolysis of acid derivatives
- Physical properties
- Acidity of carboxylic acid
- Effect of substituent on acidity of carboxylic acid
- Chemical properties
  - a) Hell-Volhard-Zelinsky reaction, b) formation of acid derivatives like acid chloride, acid anhydride, ester and amide
- Reactions of acid derivatives
- Hydrolysis of ester
  - a) Acidic, b) Basic
- Trans Esterification

**Unit-3: Nitrogen containing Compounds****(08 hrs.)****(4) Amines**

- Nomenclature, Classification
- Preparation of primary amines: a) Reduction of nitro compounds, b) Reaction of ammonia with alkyl halide, c) Hoffmann bromamide reaction
- Physical properties
- Chemical properties: a) reaction with aryl sulfonyl chloride, b) reaction with acid chloride, c) reaction with alkyl halide
- Hinsberg test for identification / isolation of amines
- Diazotization and reaction of diazonium salt

**Unit-4: Reaction, Rearrangement and Reagent****(12 hrs.)****(5) Organic Name Reactions**

- Principle, mechanism, and application of
  - Reformatsky reaction
  - Baeyer-Villiger oxidation
  - Vilsmeier-Haack reaction
  - Wittig reaction
  - Appel reaction
  - Michael addition

**(6) Rearrangement and Reagents**

Principle, mechanism and applications of

- Fries
- Beckmann
- Benzil-Benzilic acid

Preparation, properties, and applications of

- $\text{LiAlH}_4$
- $\text{NaNH}_2$
- NBS

## Unit-5: Chemistry of synthetic molecules

(08 hrs.)

### (7) Dyes

- Introduction, Classification
- Synthesis and uses of following dyes
  - a) Alizarin
  - b) Indigo
  - c) Malachite green
  - d) Congo red
  - e) Methyl orange
  - f) Crystal violet
  - g) Diamond black –F

### (8) Explosives

Synthesis and uses of following

- a) RDX
- b) PETN
- c) TNT

### (9) Perfumes:

- a) Musk Xylene
- b) Musk Ketone
- c) Musk Ambrette

### (10) Polynuclear aromatic Hydrocarbons

Introduction, Synthesis and chemical properties: a) Biphenyl, b) Diphenyl methane, c) Naphthalene, d) Anthracene.

#### Text Books:

1. Bansal, Raj K. (2009, Fifth) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).

#### Reference Books:

1. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. T.W. Graham Solomons (2011, 10th edition) *Organic Chemistry*. Hoboken: John Wiley & Sons (ISBN: 978-0-470-55659-7).
3. Clayden, Greeves, Warren & Wothers (2012) *Organic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-850346-0).
4. Agrawal, O. P. (2009, 46th edition) *Organic Chemistry: Reaction and Reagents*. Meerut: Krishna Prakashan Media (p) Ltd. (ISBN: 81-87224-65-7).
5. Morrison & Boyd (2009, Sixth edition) *Organic Chemistry*. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).



Semester – IV

16ICHCC16	Core –9: Physical Chemistry	4 hrs/week	4 Credits
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**Objectives:**

To enable the students to

- Compare heat change between system and surrounding.
- Illustrate entropy change and its measurement.
- Predict effect of temperature and pressure on chemical potential.
- Understand potential change in different type of titrations using different electrode.
- Write the photochemical reaction and its application.

**Unit-1: Thermodynamic equilibrium**

**(12 hrs.)**

**(1) Thermodynamics – 2**

- Introduction
- Reversible reactions, Spontaneous reactions
- Statements of second law
- Cyclic process
- Concept of entropy
- Determination of entropy of solid, liquid, gas
- Effect of temperature and pressure on entropy
- Entropy of mixing of gases
- Nernst heat theorem
- Statement of third law
- Tests of third law
- Residual entropy
- Numerical

**(2) Free energy and chemical equilibrium**

- Introduction
- Free energy and work function
- Gibbs-Helmholtz equation
- Clausius-Clapeyron equation & its Application
- Van't Hoff isotherm & Van't Hoff isochore
- Applications & Numerical

**Unit-2: Ionic Properties of Solution**

**(10 hrs.)**

**(3) Partial Molar Properties**

- Introduction, Definition of partial molar property
- Concept of chemical potential
- Gibbs-Duhem equation
- Effect of temperature on chemical potential
- Effect of pressure on chemical potential
- Determination of partial molar properties by intercept method
- Application of chemical potential
  - Henry's law, Raoult's law, Nernst distribution law

### Unit-3: Electrochemistry

(12 hrs.)

#### (4) Fundamentals of Electrochemistry

- Introduction
- Types of concentration cell:
  - electrode concentration cell
  - electrolyte concentration cell
- Determination of potential of both types of cell
- Types of electrolyte concentration cell
  - With transference
  - Without transference
- Determination of potential of electrolyte concentration cell with transference
- Determination of potential of electrolyte concentration cell without transference
- Liquid junction potential:
  - Definition, Example, Elimination
- Application of EMF
  - Determination of solubility and solubility product of sparingly soluble salt with EMF
  - Determination of valency of metal ion
  - Determination of transport number of ion
  - Determination of dissociation constant of weak acid
  - Determination of degree of hydrolysis and hydrolysis constant
  - Determination of pH by EMF method with the help of H<sub>2</sub> electrode
  - Numerical

#### (5) pH metry and Potentiometry

- Introduction and interpretation of pH metry and Potentiometry.
- Importance of indicator and reference electrode in the measurement of EMF and pH

#### **E.M.F. method:**

(I) Study of acid – base titration

(II) Redox titration

(III) Argentometric titration including mixture of Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup> with graph and proper explanation.

#### **pH metry:**

- Definition, instrumentation & calibration
- Interpretation of various methods of determining pH value like pH paper method (Demonstration only), potentiometric method using only hydrogen electrode as indicator electrode and calomel electrode as reference electrode to determine pH value.
- Weak acid-strong base titration with curve and determination of dissociation constant (K<sub>a</sub>) of weak acid.

### Unit-4: Photochemistry

(08 hrs.)

- Photochemical reaction, Photo sensitization, Fluorescence, Phosphorescence, Chemiluminescence
- Difference between photochemical and thermochemical reaction

- Laws of Photochemistry: Grotthuss-Draper law; Stark Einstein's law (i.e. law of photochemical equivalence)
- Quantum efficiency and Factors affecting quantum efficiency
- Reasons for low and high quantum yield (photochemical process)

**Unit-5: Phase rule**

**(06 hrs.)**

- Introduction
- Definitions of phase, components, degree of freedom
- General phase diagram
- One component system : Water system, Sulphur system
- Two component system : Zn-Mg system, Pb-Ag system
- Zeotropic & Azeotropic mixtures & separation by distillation

**Text Books:**

1. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4)

**Reference Books:**

1. Negi, A. S.; Anand, S. C. (2007, Second edition) *A Textbook of Physical Chemistry*. New Delhi: New age International Publisher (ISBN: 81-224-2005-0).
2. Peter Atkins (2006) *Atkin's Physical Chemistry*. Oxford: Oxford University Press (ISBN: 9780198700722).
3. Arun Bahl; B.S. Bahl (2009, First edition) *Numerical Problems in Physical Chemistry*. New Delhi: S. Chand (ISBN: 81-219-3084-7).
4. Madan, R. L. (2011) *Chemistry for degree student Second year*. New Delhi: S. Chand (ISBN: 81-219-3538-5).

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**Semester – IV**

<b>16ICHCC17</b>	<b>Core –10: Agrochemicals</b>	<b>2 hrs/week</b>	<b>2 Credits</b>
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**Objectives:**

To enable the students to

- Understand Properties, manufacturing & applications of fertilizers, pesticides, fungicides, insecticides, weedicide & herbicide.
- Describe about Plant growth regulators.

**Unit.1 Fertilizer: Classification, Properties, manufacturing & applications (6 hrs.)**

**Synthetic:**

- Nitrogenous Fertilizer: Ammonium nitrate, ammonium sulphate, Urea, Calcium cyanamide, DAP.
- Phosphate fertilizer: Normal super phosphate, triple super phosphate, ammonium phosphate.
- NPK fertilizer

**Natural:**

- Concept of organic fertilizer & vermicompost

**Unit.2 Pesticide & Fungicide (4 hrs.)**

Definition, classification, chemistry, synthesis and application of the following:

- Fungicides - Sulphur and Copper fungicides
- Pyrethroid: Tetramethrin

**Unit.3 Insecticides: Definition, Classification, applications. (4 hrs.)**

Synthesis of the following:

- Organophosphate: Chlorpyrifos, Parathion.
- Organochlorines: DDT, BHC

**Unit.4 Weedicide & Herbicide: Definition, Classification, applications (5 hrs.)**

Synthesis of the following:

- Trifluralin, Butachlor
- Dimethoate, Isoproturon

**Unit.5 Plant growth regulators: Definition, Classification, application (5 hrs.)**

Synthesis of the following:

- Auxin, Gibberellic acid, Cytokinin, ethylene

**Reference Books:**

1. J. Benton Jones, Jr. "Inorganic Chemical Fertilizers and Their Properties" in *Plant Nutrition and Soil Fertility Manual*, Second Edition. CRC Press, 2012. ISBN 978-1-4398-1609-7. eBook ISBN 978-1-4398-1610-3.
2. H.A. Mills; J.B. Jones Jr. (1996). *Plant Analysis Handbook II: A practical Sampling, Preparation, Analysis, and Interpretation Guide*. ISBN 1-878148-05-2.
3. "Infographic:Pesticide Planet". *Science*. 341 (6147): 730–731. 2013.doi:10.1126/science.341.6147.730. PMID 23950524.

### Semester – IV

16ICHCC18	Core Practical –8: Organic Chemistry	6 hrs/week	2 Credits
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#### Objectives:

To enable the students to

- Understand how to identify unknown organic compound
  - To develop skill to prepare and purify different organic compound.
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- Organic Qualitative Analysis (08)
  - Organic Preparations & Purification (04)

### Semester – IV

16ICHCC19	Core Practical –9: Physical Chemistry	6 hrs/week	2 Credits
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#### Objectives:

To enable the students to

- Understand concept of EMF, types of cell and EMF series.
  - Understand the potentiometric and pH metric titration.
  - Develop skill to standardize instruments.
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- Electro chemistry: pH metry, Potentiometry
  - Partition coefficient
  - Fraction distillation
  - Thermodynamics

#### Reference Books:

1. Brian S. Furniss (1989, Fifth edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012, Third edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
4. Jerry R. Mohrig (2010, Third edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).
5. Svehla, G. (1979, Fifth edition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).

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