

# Syllabus

**M.Sc. Applied Chemistry**

( Semester I to IV )



Department of Chemistry  
Shri G S. Institute of Technology and Science, Indore (MP)

Programme Outcomes (POs) for MSc Applied Chemistry	
PO1	<b>Critical Thinking:</b> Inculcate critical thinking to carry out scientific investigation objectively. Formulate coherent arguments; critically evaluate practices, policies & theories by following scientific approach to knowledge development. Critically evaluate ideas, evidence and experiences from an open-minded & reasoned perspective.
PO2	<b>Knowledge Skill:</b> Equip the student with skills to analyse problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge.
PO3	<b>Scientific Communication Skills:</b> Imbibe effective scientific & / or technical communication in both oral & writing. Ability to show the importance of the subject as precursor to various scientific developments since the beginning of the civilization.
PO4	<b>Ethics:</b> Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned. Ability to identify unethical behaviour such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actions in all aspects.
PO5	<b>Enlightened Citizenship:</b> Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges
PO6	<b>Analytical Reasoning:</b> Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
PO7	<b>Multicultural Competence:</b> Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity within universities. Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is, "welcoming for all students".
PO8	<b>Lifelong Learning:</b> Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning throughout life, through self-paced and self-directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development/ reskilling.
PO9	<b>Leadership Qualities:</b> Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.
PO10	<b>Research Skills:</b> Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C, Python/FORTRAN to various scientific investigations, problem solving and interpretation.

## Programme Specific Outcomes (PSOs)

Programme specific outcomes pertain to exploration of knowledge of chemistry with related disciplines. A student of Applied Chemistry after acquiring Master of Science degree will be able to:

- PSO-1 Accelerate thinking skills with the sound objective of problem solving at the forefront, on the basis of exposure to the curriculum based knowledge of Applied chemistry.
- PSO-2 Explore global level research opportunities for doctoral and post-doctoral studies.
- PSO-3 Avail the benefit of enormous job avenues in different domains such as – academics, pharmaceutical industries, analytical laboratories, scientific organizations, entrepreneurship, administrative positions etc.
- PSO-4 Display their true potential and get appropriate endorsement through qualifying NET/GATE/SET/State Civil Services and other competitive examinations.
- PSO-5 Avail the opportunity to explore the knowledge of Applied Chemistry specially of Drug and Fine Chemicals, in particular knowledge and applications of synthetic methods and analytical techniques with specific orientation towards academia and industries .

# Syllabus

M.Sc. Applied Chemistry

Semester I



Department of Chemistry  
Shri G S. Institute of Technology and Science, Indore (MP)

## CH 91105: PHYSICAL CHEMISTRY

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course covers the basic principles of physical chemistry which are fundamental to the understanding of physical and chemical processes. The students will acquire knowledge of:

- Symmetry elements, various operations, points groups and applications
- Rate equations and theories related to chemical kinetics and the mechanisms for the same
- Different laws of thermodynamics and various concepts of electro-chemistry
- Crystals, their structure, defects and the applications
- Various phenomena occurring at the surface of molecules/substrates

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Apply the symmetry elements and point group for molecule.

**CO2:** Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect.

**CO3:** Interpret the Concept of adsorption, isotherms and laws of thermodynamics.

**CO4:** Enrich various concepts of electrochemistry and solid state chemistry

**CO5:** Solve the problem attribute to thermodynamics and electrochemistry

**Course Contents: Theory-**

### UNIT I

#### Symmetry and Group Theory

Symmetry elements, Symmetry operations, Mathematical group, Classes, Subgroup, Multiplication Table, Symmetry Transformations, point groups, applications.

### UNIT II

#### Chemical Kinetics and mechanisms of chemical reactions

Rate equation, rate constant, order and molecularity of various reactions, factors affecting rate of a reaction, methods of determining order of a reaction, mechanism of various reactions, Theories of reaction rates, Evaluation of thermodynamic parameters, Reactions in solutions and reactions in flow systems, Kinetics of fast reactions. Flow methods, pulse methods. Introduction to molecular reactions, dynamics, applications.

### UNIT III

### **Surface chemistry**

Concept of adsorption, Langmuir and Freundlich theories for adsorption, Gibbs adsorption isotherm, multilinear adsorption- B.E.T theory, surface active agents, classification, micellization and Critical Micell Concentration (CMC), Factors affecting CMC, Solubilization, types of micelles and applications of adsorbent and micelles.

### **UNIT IV**

#### **(a) Electro chemistry**

Introduction, electrode potential, chemical and concentration cell, EMF, its applications and measurements, Ion selective electrodes, sensors.

#### **(b) Solid State Chemistry**

Crystals, Laws of Symmetry: Miller and Wise indices, Crystal lattices, Crystals and X-rays, XRay spectroscopy, Crystal Structure. Defects in stoichiometric & non-stoichiometric crystals, applications.

### **UNIT V**

#### **Thermodynamics**

First and Second laws of thermodynamics, derivations based upon them. Reversible and irreversible processes, Gibbs-Helmholtz equation and its various applications. Molecular dynamics, Statistical thermodynamics- Maxwell-Boltzmann, Fermi-Dirac and Monte-Carlo.

#### **ASSESSMENT:**

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

#### **Books & References Recommended:**

##### **Text Books Recommended:**

1. Gurdeep Raj, Advanced Physical Chemistry (Goel Publishing).
2. Kapoor K.L., A Text book of Physical Chemistry, Vol-I, Vol-II (McGraw Hill publishers).

##### **Reference Books:**

1. Bajpai D.N., Advanced Physical Chemistry (S. Chand Publishing).
2. Rastogi R.P. & Mishra R.R., An Introduction to Chemical Thermodynamics (Vikas Publishing House Pvt. Ltd.).
3. Chandra A.K., Introduction to Quantum Chemistry (McGraw Hill publishers).
4. Glasstone S., Thermodynamics for Chemist (East-West Press Pvt. Ltd.).
5. Glasstone S., Text Book of Physical Chemistry (D. Van-Nostrand Company).
6. Levine A., Text book of Physical Chemistry , (McGraw Hill publishers)

**Journals:**

1. Catalysts and Catalysed Reactions
2. Journal of Physical Chemistry C
3. Journal of Chemical Thermodynamics
4. Progress in Solid State Chemistry
5. Journal of Chemical Thermodynamics

**M.Sc. Applied Chemistry**  
**Semester-I**  
**CH 91106: INORGANIC CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
4			4			CW	End Sem	SW	End Sem	
-	-	-	-	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** The objective of this course is to develop an understanding of structure, bonding and reaction mechanisms in inorganic compounds focusing on coordination chemistry. The course will stimulate interest of students in following areas:

- Classical and wave mechanical approach to chemical bonding
- Concepts of acid-bases
- Coordination chemistry
- Chemistry of trans-uranium elements

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Explain the concept of bond formation, types of bond, structure of complexes etc.

**CO2:** Illustrate the bonding in Hydrides and metal Carbonyls.

**CO3:** Predict working with non-aqueous solvents.

**CO4:** Recall the theories of coordination chemistry and stereochemistry.

**CO5:** Explain the properties and applications of inner transition element and nano chemistry.

**Course Contents: Theory-**

**UNIT I**

**Chemical Bonding:**

(a) Classical approach: Earlier theories and Modern concepts, Fajan's rules. (b) Wave Mechanical concept: Valence bond and Molecular orbital theory, VSEPR theory, Metallic bond, Band gap theory.

**UNIT II**

Types, Bonding, Classification, methods of preparation, chemical properties and applications of the following: **Hydrides and metal Carbonyls, Organometallics in Homogeneous Catalysis**

**UNIT III**

(a) Modern concept of acids and bases.

(b) Reaction in non-aqueous solvents, viz. liquid ammonia, sulphur dioxide and hydrofluoric acid.



#### UNIT IV

##### Coordination chemistry

Coordination compounds and their theories, structure of complexes, Chelation, Stability constants and their determination, Application of complexes. stereo chemistry & reaction mechanism, Introduction to Bioinorganic chemistry.

#### UNIT V

(a) **Inner Transition Elements:** Spectral and Magnetic Properties.

(b) **Nano chemistry:** elementary idea and its applications.

#### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

#### Books & References Recommended:

##### Text Books Recommended:

1. Prakesh S., Tuli G.D., Basu S.K. and Madan R.D., Advanced Inorganic Chemistry Vol.- I & II (S.Chand)
2. Gurdeep Raj, Advanced Inorganic Chemistry (Goel Publishing)

##### Reference Books:

1. Moeller T., Inorganic Chemistry.(John Wiley & Sons)
2. Gilreath ES, Fundamental Concepts of Inorganic Chemistry (Mc-Graw- Hill).
3. Atkin P., Inorganic Chemistry (Oxford press).
4. Huheey JE, Keiter EA, Keiter RL, Medhi OK, Inorganic chemistry (Pearson Publishing)
5. Satya Prakash, Advanced Chemistry of Rare Elements (S. Chand).
6. Bhattacharaya PK, Bioinorganic Chemistry, PHI Learning.

##### Journals:

1. Bio organic & Medicinal Chemistry,Journal - Elsevier
2. Inorganic Chemistry, ACS Publications
3. Journal of Coordination Chemistry,Taylor and Francis
4. Synthesis and Reactivity in Inorganic, Metal-Organic and Nano-Metal Chemistry, Tylor and Francis
5. Rare Metals, Springer

**M.Sc. Applied Chemistry  
Semester-I  
CH 91107: ANALYTICAL CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course covers the fundamental concepts of various analytical techniques used with a view to understand the principles, instrumentation and application. The student will acquire knowledge of:

- Organic reagents used in analysis
- Techniques like colorimetry, polarimetry, conductometry, pH metry and polarography, thermogravimetric analysis, differential thermal analysis and flame photometry
- Chromatographic and membrane separation techniques
- Application of optical rotatory dispersion (ORD) and circular dichroism (CD) for quantitative analysis of organic molecules

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Develop qualitative and quantitative skills needed in application of analytical chemistry.

**CO2:** Recall fundamental principles of colorimetry , polarimetry, and polarography.

**CO3:** Evaluate the spectral properties of instruments such as UV-Visible Spectrometer, Colorimeter etc.

**CO4:** Recall principle and fundamentals of the various chromatographic technique

**CO5:** Estimate ORD, CD, thermogravemetric and flame photometry techniques for analysis of organic molecules.

**Course Contents: Theory-  
UNIT I**

Types of Analytical Techniques, Qualitative and Quantitative Analyses, Data Analyses and Interpretations, Errors and Limits

**UNIT II**

**(a) Fundamental Principles of Spectroscopy :**

Electromagnetic radiation: Definition, wave properties and parameters, electromagnetic spectrum, spectroscopic methods in each region, types of spectra and interaction mechanisms.

**(b) UV & Visible Spectroscopy**

Types of absorption bands, empirical rules for predicting the onward wave-length of absorption peaks. Visible spectrometry and its advantage over colorimetry, instrumentation, sample handling as per industry standard, Applications of UV-Visible spectroscopy.

### UNIT III

Principle, instrumentation and applications of the following:

- (a) Colorimetry
- (b) Polarimetry
- (c) Conductometry
- (d) pH metry
- (e) Polarography

### UNIT IV

Principle, separation techniques, chromatography column, paper, VPC, GC, GLC HPLC, Ion-pair Chromatography, Electrophoresis. Membrane separation techniques bio-separation.

### UNIT V

(a) **ORD and CD:** Fundamental principles, measurements, cotton effect, molecular amplitude, birefringence, refractive indices, application of ORD and CD for quantitative analysis of organic molecules, Octant Rule, Halo Ketone Rule.

(b) Principle, Instrumentation and applications of the following techniques: Thermogravimetric analysis, Differential Thermal Analysis, Flame Photometry

### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

### Books & References Recommended:

#### Text Books Recommended:

1. Sharma, B.K. Instrumental methods of analysis (Krishna Prakashan Media)
2. Willard, Merritt Dean & settle, Instrumental Methods of Chemical Analysis (Van Nostrandor 7th Ed.)

#### Reference Books:

1. Shrivastav A.K., Jain P.C., Instrumental Approach to Chemical Analysis (S. Chand & Company)
2. Ewing G.W., Instrumental Methods of Chemical Analysis (McGraw -Hill)
3. Skoog D.A. and West DM, Fundamental of Analytical Chemistry (Saunders College Publishing)

4. Sivashankar B., Bio separation, (PHI learning publishing)
5. Skoog DA, Holler F J, Crouch RS, Principles of Instrumental Analysis (Brooks Cole; 6 edition)
6. Vogel A.I., Quantitative Chemical analysis (Longman Scientific and Technical Publisher)

**Journals:**

1. Analytical and Bioanalytical Chemistry, Springer
2. Analytical Chemistry, ACS Publications
3. Journal of Solution Chemistry, Springer
4. Inorganic, Physical, Theoretical and Analytical Chemistry, Indian Journal of Chemistry
5. Journal of the Indian Chemical Society

**M.Sc. Applied Chemistry**  
**Semester-I**  
**CH 91108: CHEMISTRY OF ENGINEERING MATERIALS**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course emphasizes the role of chemistry in the field of engineering. The focus is on the characterization and application of various materials in engineering. The course will enable student to

- Understand the implications of hard water in industry and its treatment
- Understand the concept of corrosion and their protection
- Analyze the use of different types of composite, polymers, fuels, lubricants, refractory, cement and mortar in industry.
- Consider the environmental aspects of industrial processes elements

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Apply Specifications, testing and treatment of water for industrial and domestic use.

**CO2:** Recall the different types fuels used in combustion and illustrate the combustion in the internal combustion engines.

**CO3:** Illustrate Concepts, manufacturing and applications of different types of industrially important materials such as lubricants, refractory and corrosion.

**CO4:** Categorize polymerization reactions with respect to mechanisms and distinguishes differences of these reactions.

**CO5:** Enrich the knowledge on themes of biodiversity, natural resources, pollution control & waste management.

**Course Contents: Theory-**

**UNIT I**

**Water treatment**

Source, Types of impurities and their effects, Hardness, its expression and determination, Boiler troubles and their causes, treatment of water industrial and domestic purposes, Alkalinity and its determination, Numerical problems. Effect of impurities in water used in different industries, eg. steam generation, textile industries, leather tanning, paper etc. IS specifications for portable water.

**UNIT II**

**Fuels**

Classification, calorific value & its determination, analysis of solid fuel, pulverized coal, carbonization of coal, criteria of metallurgical coke, manufacture of coke. Petroleum distillation cracking, cracked and synthetic gasoline, knocking, anti knocking compounds, power alcohol, Gaseous fuels- natural gas, LPG, coal, gas, producer gas, water gas, carbureted water gas, introduction to nuclear fuels, numerical problems based on combustion and calorific value.

### UNIT III

#### (a) Lubricants

Principles of lubrication, study of solid, semi solid, liquid and synthetic lubricants, lubricating emulsions, properties and selection of lubricants.

(b) **Corrosion** Introduction, theories of corrosion, Factors affecting rate of corrosion, protection against corrosion, types of corrosion, Ethics for corrosion prevention and industrial practices to prevent corrosion.

### UNIT IV

(a) **Polymers** Classification of polymers, types of polymerisation, mechanisms, structure-property relationships, polymer materials of industrial importance - plastics, rubbers and synthetic fibres.

(b) **Cement & Mortars** Portland cement, composition, specifications, manufacture, setting, lime and mortars, testing of cement, cementing materials and puzzolana cement (c) Chemistry and manufacture of silicates, porcelains and glasses

### UNIT V

(a) **Environment and Pollution:** Environment, pollution of atmosphere, hydrosphere and lithosphere, process of its control. Chemistry for green environment- basic concepts and significance

(b) **Refractories :** Classification, chemical composition, properties of Acidic, Basic and Neutral refractories, testing of refractories, applications in industries.

### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

### Books & References Recommended:

#### Text Books:

1. Palanna O.P., Engineering Chemistry (Mc Graw Hill)
2. Rajaram & Kuriacose, Chemistry in Engineering and Technology Vol.-II ( Mc Graw Hill.)

#### Reference Books:

1. D. Braun, Polymer Synthesis: Theory & Practice: Fundamentals, Methods, Experiments (Springer).

2. De A.K., Environmental Chemistry (Pearson Education).
3. Ambasta B.K., Chemistry for Engineers( University Science Press).
4. Dara S.S., Engineering Chemistry (S. Chand publishing).
5. Agrawal C.V., Chemistry of Engineering Materials. (B.S. Publications)
6. Maheswaramma K.S., Engineering chemistry (Pearson Education)

**Journals:**

1. E-Polymers
2. High Energy Chemistry
3. Journal of Fuel Chemistry and Technology
4. Corrosion science
5. Journal of ceramic processing research

**M.Sc. Applied Chemistry**  
**Semester-I**  
**CH 91173: PHYSICAL CHEMISTRY AND MATERIALS LAB**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** This course will illustrate the principles of chemistry relevant to the study of science and engineering. The students will learn to:

- Determine properties of lubricants and oil samples
- Analyze water in terms of hardness, chloride content and alkalinity

**Laboratory Outcomes:** By the end of the course student will be able to:

**LO1:** Analyze experimentally about the partition coefficient, heat of neutralization and Adsorption isotherm.

**LO2:** Evaluate Transition temperature, Velocity constant and Solubility curve of compounds.

**LO3:** Determine flash point and viscosity of oil samples.

**LO4:** Evaluate Total solids in water sample and Percentage of moisture in a coal sample.

**LO5:** Estimate the hardness, chloride and alkalinity of water sample.

**Course Contents: Practical-**

**List of Practical's- Determination of the following:**

1. Partition coefficient for Iodine in  $\text{CCl}_4/\text{H}_2\text{O}$  system.
2. Partition coefficient for Benzoic acid in Benzene/ $\text{H}_2\text{O}$  system.
3. Heat of neutralization.
4. Adsorption isotherm for oxalic acid on activated charcoal
5. Solubility curve of Phenol/ $\text{H}_2\text{O}$  system.
6. Transition temperature of Strontium Chloride.
7. Velocity constant of alkaline hydrolysis of ethyl acetate.
8. Flash point by Abel's apparatus.
9. Flash point by Pensky Martin's apparatus.



10. Redwood viscosity by viscometer no. 1
11. Redwood viscosity by viscometer no. 2
12. Total solids in water sample.
13. Percentage of moisture in a coal sample.
14. Total hardness of water sample by Ethylene di amine tetra acetic acid(EDTA) method.
15. Carbonate, bicarbonate and total alkalinity of water sample.
16. Free chloride in water sample.

**Assessment:** Term end practical exam and Comprehensive viva-voice

**Text Books:**

1. Practical engineering chemistry, S. S. dara , S chand Publishing
2. Advanced practical physical chemistry, J. B. Yadav , Krishna
3. Laboratory manual on engineering chemistry, S. K . Bhasin, Sudha Rani, Dhanpat rai Pub.

**Reference Books:**

1. Practical Aspects of Chemical Engineering, Springer
2. Practical Physical Chemistry, Arthur A. Vernon, Sixth edition (Findlay, Alexander)

**M.Sc. Applied Chemistry**  
**Semester-I**  
**CH 91174: INORGANIC CHEMISTRY LAB.**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** This course will illustrate the principles of chemistry related to inorganic chemistry. Students will learn :

- Quantitative analysis of radicals (anions and cations ) in various inorganic mixture.
- Gravimetric and volumetric analysis of alloys
- Preparation of inorganic double salts.
- Quantitative estimation of engineering material

**Laboratory Outcomes:** By the end of the course student will be able to:

**LO1:** Prepare how to prepare inorganic complexes in the laboratory.

**LO2:** Analyze qualitatively mixture of Inorganic salts containing seven radicals.

**LO3:** Evaluate Gravimetric and volumetric analysis of alloys.

**LO4:** Prepare various inorganic complexes.

**LO5:** Analyze quantitatively limestone and cement.

**Course Contents: List of Practical-**

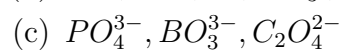
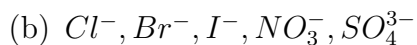
1. 1. Qualitative analysis of mixture of Inorganic salts containing seven radicals out of the following:

**Cations:**

- (a)  $Pb^{2+}, Ag^+, Hg^+$
- (b)  $Cu^{2+}, Bi^{3+}, Hg^{2+}, As^{3+}, Sb^{2+}, Sn^{2+}$
- (c)  $Fe^{3+}, Al^{3+}, Cr^{3+}$
- (d)  $Ni^{2+}, Co^{2+}, Zn^{2+}, Mn^{2+}$
- (e)  $Ca^{2+}, Sr^{2+}, Ba^{2+}$
- (f)  $Mg^{2+}, NH_4^+$

**Anions:**

- (a)  $CO_3^{2-}, SO_3^{2-}, S^{2-}, CH_3COO^-, NO_2^-$



2. Gravimetric and volumetric analysis of alloys for at least two metals
3. Preparation of Chrome Red
4. Preparation of Cuprammonium sulphate
5. Preparation of Mohr's salt
6. Preparation of Potash Alum
7. Preparation of Chrome Alum
8. Quantitative analysis of limestone and cement

**Assessment :** Term end practical exam and comprehensive viva-voice.

**Text Books:**

1. Practical Inorganic Chemistry, Gurdeep raj , Krishna Publishing
2. practical Inorganic chemistry, Shikh Gulati , CBS Publishing
3. Theoretical and Inorganic Chemistry ( Theory) & Volumetric Analysis-II (Practical), Anu Gopianth , Vishal Publishing

**Reference Books:**

1. Practical Inorganic Chemistry: Preparations, Reactions and Instrumental Methods.
2. Geoffrey Pass and Haydn Sutcliffe, Chapman and Hall Publishing Vogel's Qualitative Inorganic Analysis 5th Ed.

# Syllabus

M.Sc. Applied Chemistry

Semester II



Department of Chemistry  
Shri G S. Institute of Technology and Science, Indore (MP)

**M.Sc. Applied Chemistry**  
**Semester-II**  
**CH 91205: ORGANIC CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course covers the fundamental aspects of organic chemistry i.e. factors, effects, models, selectivity, conformation, and stereochemistry of molecules. Emphasis is on gaining ability and understanding of reagents, mechanisms, photochemistry and synthesis through problem-based case-studies and tests. The course will enable student to:

- Identify chiral center in the given organic compounds, define erythro, threo, meso, diastereoisomers with suitable examples and find R/S configuration in compounds.
- Conceptualize the structure and reactivity of organic molecules which will help in understanding of the reaction mechanisms with emphasis on some name reactions.
- Draw the various conformers of cyclic and acyclic molecules and explain their stability
- Apply the disconnection approach to provide the retrosynthetic routes for molecules.
- Rationalize the use of different reagents for target molecule synthesis
- Understand the importance of photochemistry and pericyclic reactions

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Apply the stereochemical implications and conformations analysis of organic compounds

**CO2:** Interpret and analyze reactions having different functionalities and rearrangements.

**CO3:** Use the concept of Disconnection approach and asymmetric synthesis.

**CO4:** Apply the use of modern reagent for various reactions.

**CO5:** Relate the concept of aromaticity and photochemistry.

**Course Contents: Theory-**  
**UNIT I**

**(a) Stereochemistry**

Stereochemistry of carbon compounds, optical and geometrical isomerism, isomerism of Diphenyls, Allenes and Spiranes

**(b) Conformational Analysis**

Theory and stability of cyclic and acyclic compounds: Ethane, Butane, cyclopentane, Cyclohexane, and their substituted derivatives.

## UNIT II

(a) Types and Mechanisms of Substitution, Elimination and Addition Reactions, Methods for determining mechanism of reaction

(b) **Reactive intermediates:** (Carbenes and Nitrenes) and their reactions (c)

**Molecular Rearrangements:** Pinacol-Pinacolone, Beckmann, Lossen, Schmidt, Hofmann, Curtius, Baeyer-Villiger, Fries, Favroskii and Wittig, Walden inversion.

## UNIT III

### Disconnection approach

An introduction to synthesis and synthetic equivalents, Disconnection approach, functional group inter conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, reversal of polarity, protection of groups, Asymmetric synthesis.

## UNIT IV

(a) **Modern reagents in organic synthesis:**

Metal hydrides, organic peroxides, peracids, boron trifluoride, ozone, lead tetra-acetate, selenium dioxide, N-Bromo succinimide, Diazomethane, Diazoacetic ester, Osmium tetroxide, and trifluoroacetic acid, DCC.

(b) Organometallic compounds of Al, Li, Mg and Cu and their applications in organic synthesis.

## UNIT V

(a) **Aromaticity**

Aromaticity of benzenoid and non-benzenoid compounds, Huckel's Rule, Anti-aromaticity, Homoaromaticity.

(b) **Organic photochemistry**

Jablonski's diagram, Norrish type I and II reactions (c)**Pericyclic Reactions :**

Symmetry of Orbitals, Electrocyclic reactions, Cycloaddition reactions and sigmatropic rearrangements.

## ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

## Books & References Recommended :

### Text books:

1. Finar I.L., Organic Chemistry Vol. I & II.(ELBS and Longman Ltd. New Delhi)
2. Morrison and Boyd, Organic Chemistry. (Prentice-hall Publishing)

### Reference books:

1. Eliel E.L., Stereo chemistry of Carbon Compounds (Mc Graw Hill.)

2. March J, Structure Reactions and Mechanism. (John Wiley & Sons, New York)
3. Kalsi P.S., Stereochemistry of Organic Compounds. (New-Age International Pub; New Delhi)
4. Mukherji S. M. & Singh S.P. Reactions and Mechanism in Organic Chemistry. (Macmillan India)
5. Clyden and Greeves, Organic chemistry, Oxford university press.
6. Peter Sykes, Structure and Mechanism in Organic Chemistry (Orient Longman Ltd; New Delhi)

**Journals:**

1. THEOCHEM
2. RSC Advances
3. Molecular Biosynthesis
4. Organic Letters
5. Chemical Reviews
6. European Journal of Organic Chemistry
7. Resonance-Journal of Science Education, Indian Academy of Sciences
8. The Journal of Organic Chemistry - American Chemical Society

**M.Sc. Applied Chemistry**  
**Semester-II**  
**CH 91206: MODERN ANALYTICAL METHODS**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course introduces the students to important spectroscopic techniques used for characterization of molecules. The course will stimulate interest of students in following areas:

- Fundamentals of spectroscopy
- Interpretation of structure of molecules on basis of their UV-vis, IR, NMR, and mass spectra.
- Theory and applications of Raman, laser and atomic absorption spectroscopy

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Apply the knowledge of sampling, data analysis, interpretation and select proper analytical method.

**CO2:** Explain the principles of IR and Raman spectroscopy.

**CO3:** Interpret and analysis the molecular structure by NMR spectroscopy.

**CO4:** Apply the knowledge of Mass spectroscopy for structure elucidation.

**CO5:** Explain the principles of ESR spectroscopy.

**Course Contents: Theory-**  
**Unit-I**

**(a) IR Spectroscopy**

Introduction and theory, types of vibrations, theoretical and observed number of modes, intensity of absorption bands, group frequencies, finger print regions, factors affecting group frequencies and band shapes, Vibrational & Rotational fine structures.

Instrumentation and Applications, Introduction to Fourier transform IR spectroscopy.

**(b) Raman Spectroscopy**

Introduction and theory, Advantages of Raman spectroscopy over IR spectroscopy.

Correlation between IR and Raman Spectra. Factors affecting the choice between IR and Raman spectra. Instrumentation and Applications of Raman Spectroscopy.

**Unit II**

**NMR Spectroscopy**

Introduction, theory of magnetic and nuclear resonance, magnetic shielding and chemical shift, spin-spin interactions, coupling constants, splitting pattern, nature of coupling, rules



for predicting band multiplicities, spin decoupling, shift reagents, instrumentation, sample handling, applications-structure elucidation, qualitative and quantitative analysis, kinetic studies, property studies. NMR spectra of nuclei other than protons,  $^{13}\text{C}$ ,  $^{31}\text{P}$ ,  $^{19}\text{F}$  &  $^{14}\text{N}$ . Applications

### Unit III

#### Mass Spectroscopy

Introduction, principles, instrumentation and applications of mass spectrometry( EI- MAS, FAB, ESI)

### Unit IV

#### (a) ESR Spectroscopy

Introduction, theory, intensity and width, position and multiplet structure of spectral lines, instrumentation and applications.

#### (b) Laser Spectroscopy

Introduction, basic principles, instrumentation and applications.

### Unit V

#### Atomic Spectroscopy

Theory of atomic absorption spectroscopy (AAS) instrumentation, general methodology of AAS, Preparation of samples, applications of AAS in environmental science, engineering, analytical chemistry and industries. Overview of ICPES, Flame photometry.

### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

### Books & References Recommended:

#### Text books:

1. Banwell C.N., Mc Cash E.M., Fundamentals of Molecular Spectroscopy (McGraw Hill Education)
2. Ewing G.W., Instrumental Methods of Chemical Analysis (McGraw Hill Education).

#### Reference books:

1. Silverstein R.M., Spectrometric Identification of Organic Compounds (J. Wiley & Sons, New York).
2. William D., Fleming I., Spectroscopic Methods in Organic Chemistry (McGraw Hill Education).
3. Shrivastav A.K., Jain P.C., Instrumental Approach to Chemical Analysis (S. Chand & Company).

4. Sharma B.K., Instrumental Methods of Chemical Analysis (Krishna Prakashan Media).
5. Sharma Y.R., Elementary Organic Spectroscopy (S. Chand and Company).
6. Kalsi P.S., Spectroscopy of Organic Compounds (New Age International Publisher).

**Journals:**

1. Concepts in Magnetic Resonance Part B: Magnetic Resonance Engineering
2. International Journal of Mass Spectrometry
3. Journal of Electron Spectroscopy and Related Phenomena
4. Journal of Molecular Spectroscopy
5. Journal of Applied Spectroscopy

M.Sc. Applied Chemistry  
Semester-II  
CH 91207: NATURAL PRODUCTS

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course introduces the students to major classes of biomolecules such as vitamins, carbohydrates, lipids, terpenoids, carotenoids and porphyrins. Importance is given on the structural and functional aspects of these molecules. The course will enable student to:

- Know different bio molecules.
- Appreciate the role of biochemistry in the day to day life.
- Write the various projections of carbohydrates and explain their optical activity
- Synthesis of several bio molecules.

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Elucidate the bio synthetic pathways to prepare water and fat soluble vitamins.

**CO2:** Analyze the factors affecting the biosynthesis of secondary metabolites and apply the concept to improve the yield

**CO3:** Design the appropriate strategy to isolate and characterize different class of natural products.

**CO4:** Identify industrially relevant method for quantification of different class of natural products.

**CO5:** Express the concept of secondary metabolites and their bio synthetic pathways.

**Course Contents: Theory-**

Introduction, classification, occurrence, isolation, synthesis, biological significance and constitution of:

**Unit I**

Water soluble vitamins Vitamin B-Complex, thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, folic acid, inositol, B12, biotins, vitamin-C.

**Unit II**

Fat-soluble vitamins : Vitamin - A, D, E & K.

**Unit III**

**(a) Carbohydrates**

Structure determination of glucose, fructose, sucrose, cellulose and starch.

**(b) Glycosides-** Cardiac glycosides.

**(c) Lipids**

Properties, constitution and uses of simple and compound lipids and waxes.

**Unit IV**

**Terpenoids**

Terpenoid compounds, isoprene & special isoprene rule, composition and properties of common essential oils, citral, citronellol, geraniol, linalool, limonene, terpineol, carvone, thymol, menthol, pinene, camphene, camphor, farnesols, zingiberene and bisabolene

**Unit V**

**(a) Carotenoids**

Carotene, alpha -carotene, beta-carotene, lycopene. **(b) Porphyrins**  
Porphin derivatives, their stability and synthesis, constitution of haemin, biological significance of haemin.

**ASSESSMENT:**

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

**Text Books Recommended :**

1. Agrawal O.P. Chemistry of natural products Vol I & II (Goel Publishing House )
2. Chatwal G.R. Chemistry of natural products Vol I & II (Himalaya Publishing House).

**Reference Books:**

1. Finar I. L. Organic Chemistry Vol. I & II.(ELBS and Longman Ltd. New Delhi)
2. Sewald N, Jakubke HD Peptides: Chemistry and Biology. Wiley-VCH publisher.
3. Thisbe K. Lindhorst, Essentials of Carbohydrate Chemistry & Biochemistry (Wiley publisher).
4. Li J.J., Corey E.J., Total Synthesis of Natural Products: At the Frontiers of Organic Chemistry (Wiley publisher).
5. Dewick P.M., Medicinal natural products (Wiley publisher).
6. Robyt, John F., Essentials of Carbohydrate Chemistry (Springer).

**Journals:**

1. Journal of Natural Products - ACS Publications
2. Indian Journal of Natural Products and Resources
3. Journal of Asian Natural Products Research
4. journal of natural medicine
5. Cholesterol — An Open Access Journal

M.Sc. Applied Chemistry  
Semester-II  
CH 91209: CHEMISTRY OF DRUGS - I

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course introduces the students to major classes of drugs and therapeutic agents. The focus is on the preparation, applications and structure-activity relationship of biologically active molecules. The course will stimulate interest of students in following areas:

- Drug intermediates and fine chemicals
- Antiseptic, antifungal, antitubercular, sulphadruugs, anthelmintic, antiprotozoals and sulphadruugs
- Drugs derived from various heterocycles

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Apply the mechanistic pathways of different class of medicinal compounds.

**CO2:** Predict the chemistry of drugs with respect to their pharmacological activity.

**CO3:** Develop the capability to analyze the dose & route of administration of antiseptics , anti fungal & anti protozoal drugs.

**CO4:** Identify dose, route of administration, precautions, & contraindications of diuretics & sulpha drugs.

**CO5:** Illustrate the importance of heterocycles, learn the properties and synthetic routes of various transformations involving heterocycles.

**Course Contents: Theory-  
Unit I**

(a) Introduction to drugs, classification and theories of action of drugs, structure and activity, drug metabolism, mechanism of drug action, bio availability, drug distribution and elimination, toxicity, drug interactions.

(b) Organometallic Therapeutic Agents : Preparation, properties and uses of organometallic compounds of As, Sb, Bi, Au and Hg.

**Unit II**

**(a) Drug Intermediates**

Preparation, properties and synthetic applications of barbituric acid, carbazoles, ethyl acetoacetate, succinic anhydride, phenyl acetic acid, hydroxyl amine hydrochloride,

acetoxime, acetanilide, benzanilide, 2-amino-pyridine, o & p amino-phenols, p amino benzoic acid.

**(b) Fine Chemicals**

Preparation, Properties and Synthetic applications of Salicylates (methyl, ethyl, phenyl, mercury and lithium) citrates, tartrates, diethyl malonate, aluminium hydroxide gel, glycerophosphates, menthol crystals, benzocaine.

**Unit III**

Pharmaceuticals Preparation (if possible manufacture) properties, mode of action, structure-activity relationship and uses.

**(a) Antiseptics**

Alcohols, phenols and their derivatives, Povidone Iodine, nitrofurazone, halazone, chloroazodin, medicinal dyes : Gentian violet, basic fuschin, acridine derivatives, methylene blue.

**(b) Antifungal Drugs**

Propionic acid, salicylic acid and their derivatives, tolnaftate, chlordantoin, clotrimazole, miconazole.

**(c) Antitubercular Drugs**

Aminosalicylic acid and its derivatives. Isoniazid, Pyrazinamide, ethambutol, ethionamide.

**Unit IV**

Pharmaceuticals Preparation (if possible manufacture) properties, mode of action, structure-activity relationship and uses.

**(a) Sulphadruugs**

Sulphanilamide, sulphadiazine, sulphamerazine, sulphamethazine, sulphapyrazine, sulphapyridine, sulphaguanidine, sulphathiazoles, sulphapyrimidine, sulphacetamide.

**(b) Anthelmintics**

Piperazines, pyrantel pamoate, mebendazole, thiabendazole.

**(c) Antiprotozoals**

Metronidazole, diethyl carbamazine citrate, quinoline derivatives, Chloroquine and Pamaquine phosphate, furazolidone.

**Unit V**

**Heterocyclics**

Preparation, properties and uses of two drugs derived by each of the following : thiazoles, pyrazoles, pyrimidines, pyrans, indoles, carbazoles, isoquinolines.

**ASSESSMENT:**

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weight-age is 70%.

**Books & References Recommended :**

**Text Books:**

1. Wilson & Gisvold, Organic Medicinal and Pharmaceutical Chemistry.

2. Ashutosh Kar Medicinal Chemistry.(Wiley Eastern Ltd, New Delhi)

**Reference Books:**

1. John A. Joule, Keith Mills , heterocyclic chemistry, Wiley publisher.
2. Berger, Medicinal Chemistry.(Wiley Interscience Pub. New york)
3. Lednicer D. & Lester A. Mitscher, Organic Chemistry of Drug Synthesis. (Wiley)
4. William Foye, Principles of Medicinal Chemistry. (Lea & Febiger Pub. House, Bombay)
5. Raj K Bansal, Heterocyclic chemistry, (News Age publisher).
6. Dewick P.M., Medicinal natural products (Wiley publisher).

**Journals:**

1. The Journal of Antibiotics - Nature
2. The Journal of Infectious Diseases
3. Eco-Friendly Synthesis of Fine Chemicals
4. Antiseptics
5. Journal of Hetero-cyclic Chemistry



**M.Sc. Applied Chemistry**  
**Semester-II**  
**CH 91273: ORGANIC CHEMISTRY AND DRUGS LAB-I**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** This course will illustrate the principles of chemistry related to organic and drugs chemistry. Students will learn to:

- Determine the percentage of organic compounds in respective organic formulations.
- Quantitative analysis of various organic functional groups in organic compounds.
- Preparation of organic compounds using single and three step process.
- Extract various natural products using chemical processes.

**Laboratory Outcomes:** By the end of the course student will be able to:

**LO1:** Illustrate Theoretical aspects of separation for multi components analysis.

**LO2:** Apply practical skills for the analysis of drugs and excipients using various instrumentation techniques.

**LO3:** Report accurate analysis and report the results in defined formats.

**LO4:** Learn documentation and express the observations with clarity.

**LO5:** Apply the professional and safety responsibilities for working in the analysis laboratory.

**Course Contents: List of Practicals-**

1. Determination of percentage of Acetyl salicylic acid in Aspirin.
2. Determination of percentage of formaldehyde w/w in formalin.
3. Estimation of glucose using Fehling's solution.
4. Estimation of glycine by formal titration.
5. Oil analysis : (a) determination of acid value (b) Saponification No. (c) Iodine value
6. Quantitative analysis of binary organic mixture, separation, isolation and identification of following classes of organic compounds: (a) Acids (b) Alcohols (c) Hydrocarbons (d) Aldehyde and Ketones (e) Esters (g) Amines (I) Nitro compounds (j) Carbohydrates

7. Organic preparation :

(a) ) Single step preparations:

- i. Phenyl Azo Beta Naphthol
- ii. Naphthol
- iii. Aspirin
- iv. Phthalimide

(b) Three- step preparations:

- i. Ortho- Chloro benzoic acid
- ii. Para amino aniline
- iii. Orange red dye

8. Extraction of alkaloids from natural sources.

9. separation and identification of amino acids, carbohydrates and phenyl hydrazones by TLC.

**Assessment** : Term end practical exam and comprehensive viva-voice.

**Text Books:**

1. Practical Organic Chemistry, O P Agrawal, Krishna Publishing
2. Advanced Practical Organic Chemistry, 3rd Edition, John Leonard, Barry Lygo, Garry Procter
3. Advanced Practical Organic Chemistry, R K Bansal, Tata McGraw Hill Publications

**Reference Books:**

1. Advanced Practical Organic Chemistry, Third Edition John Leonard, CRC Press
2. Vogels Practical Organic Chemistry, Ethyl Sulfate. Uploaded by. Joan Mas Torrent. Mann.

**M.Sc. Applied Chemistry**  
**Semester-II**  
**CH 91274: MODERN ANALYTICAL METHOD LAB.**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** This course will illustrate the principles of chemistry relevant to study of physical chemistry and spectroscopy. Students will learn:

- Determination and verification of  $\lambda$  max of organic compound using spectroscopic techniques.
- Determination equivalence conductance and dissociation constant
- Determination of mutational and optical properties of organic chemistry
- Determination of physical properties of various organic and inorganic compounds.

**Laboratory Outcomes:** By the end of the course student will be able to:

**LO:1** Apply basic theoretical knowledge of the instrumentation techniques available.

**LO:2** Apply practical skills for the analysis of drugs & excipients using various instrumentation techniques.

**LO:3** Learn documentation and express the observations with clarity.

**LO:4** Apply the professional and safety responsibilities for working in the analysis laboratory.

**LO:5** Know how to handle different instruments data for interpretation.

**Course Contents: List of Practical's-**

1. Verification of Beer– Lambert's Law by Colorimeter.
2. Determination of  $\lambda_{max}$ .
3. Quantitative determination of the compounds by spectrometric method.
4. Determination of composition of binary mixture containing  $K_2Cr_2O_7$  and  $KMnO_4$  using spectrophotometer.
5. Determination of equivalent conductivity and dissociation constant of a weak electrolyte.
6. Determination of equivalent conductance of a strong electrolyte at different dilutions and verification of Onsagar's equation.

7. Determination of hydrolysis constant of aniline hydrochloride.
8. Determination of inversion and energy of activation of the reaction for the cane sugar in presence of an acid.
9. Determination of relative strength of acids by studying the inversion of activation of the cane sugar in HCl and  $H_2SO_4$  acids.
10. Determination of mutarotation of glucose catalysed by acid or base.
11. Determination of order of reaction for alkaline hydrolysis of ethyl acetate.
12. Determination of pH of the given solution using glass electrode including calibration of pH meter.

**Assessment :** Term end practical exam and comprehensive viva-voice.

**Text Books:**

1. Advanced practical physical chemistry, J. B. Yadav , Krishna
2. Practical Physical Chemistry, Arthur A. Vernon, Sixth edition (Findlay, Alexander)

**Reference Books:**

1. Advanced Practical Organic Chemistry, Third Edition John Leonard, CRC Press.
2. Vogels Practical Organic Chemistry, Ethyl Sulfate. Uploaded by. Joan Mas Torrent. Mann.

# Syllabus

M.Sc. Applied Chemistry

Semester III



Department of Chemistry  
Shri G S. Institute of Technology and Science, Indore (MP)

**M.Sc. Applied Chemistry**  
**Semester-III**  
**CH 91305: CHEMISTRY OF DRUGS (NATURAL)**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** The basic focus of this course is consideration of structural and physiological functions of various naturally occurring molecules. Emphasis would be given on significant active compounds from natural sources such as antibiotics, steroids, hormones, etc. The course will stimulate interest of students in following areas:

- General methods of determination of structure of various alkaloids.
- Study of various antibiotics, their commercial production and biological significance.
- Role of steroids and hormones and their structural elucidation.

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Recognize the different types of alkaloids, antibiotics, hormones & proteins & their chemistry & medicinal importance.

**CO2:** Explain vitamins Chemistry and Physiological significance of Vitamin.

**CO3:** Elaborate general methods of structural elucidation of compounds of natural origin.

**CO4:** Illustrate isolation, purification and characterization of simple chemical constituents from the natural source.

**CO5:** Explain protein, enzyme and nucleic acids and their Physiological significance in human physiology.

**Course Contents: Theory-**

Introduction, Sources, isolation, synthesis, structure determination, physiological activity and structure Activity relationship (if any) of:

**Unit-I**

**Alkaloids**

General methods of determination of structure, nicotine, atropine, cocaine, conine, morphine, papaverine, quinine, reserpine, strychnine, ephedrine.

**Unit-II**

**Antibiotics**

(a) Definition, classification and importance, general study of penicillins, cephalosporins, aminoglycosides, tetracyclines, macrolides, lincomycins, polypeptides, polyenes, griseofulvin, and vancomycin.

(b) Commercial production, constitution, properties, biological significance of penicillin, streptomycin, tetracyclines and chloramphenicol.

### Unit-III

#### Steroids

(a) **Sterols** : Classification, role in biochemistry, structure elucidation with emphasis to following compounds: cholesterol, bile acids and their relation to cholesterol.

(b) **Adreno: Hormones:** Cortisone, Cortisol, Adrenaline.

### Unit-IV

(a) **Sex Hormones:** Oestrogens, Androgens, Progesterone

(b) General Study of Anterior and Posterior Pituitary Hormones.

### Unit-V

#### (a) Proteins and Enzymes

The peptide linkage, primary structure of peptides, synthesis of peptides, secondary and tertiary structure of proteins, oxytocin, insulin, biosynthesis of proteins, Nomenclature of enzymes, cofactors, mechanisms of enzyme actions, Enzyme inhibitors.

#### (b) Purines and Nucleic acids

Uric acid, purine derivatives and xanthine bases, nucleosides, nucleotides, RNA and DNA, chemical and enzymatic synthesis of polynucleotides.

### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

### Books & References Recommended :

#### Text Books:

1. Chatwal G.R. Chemistry of natural products Vol I & II (Himalaya Publishing House )
2. Agrawal O.P. Chemistry of natural products Vol I & II (Goel Publishing House )

#### Reference Books:

1. L. F. Fieser and sM. Fieser. Steroids. (Reinhold Publishing Corporation, New York)
2. Sewald N, Hans-Dieter Jakubke Peptides: Chemistry and Biology. (Wiley-VCH publisher).
3. Li JJ, Corey EJ, Total Synthesis of Natural Products: At the Frontiers of Organic Chemistry, (Wiley-VCH publisher).
4. Finar I.L., Organic Chemistry Vol.I and II (ELBs and Longman Ltd. New Delhi)
5. Lednicer D, Steroid chemistry at a glance (Wiley publisher).
6. Dewick P.M., Medicinal natural products (Wiley publisher).

**Journals:**

1. The Journal of Antibiotics
2. Pharmaceutical Chemistry Journal
3. Drug and Chemical Toxicology
4. Medicinal chemistry Journals
5. Chemistry - A European Journal



M.Sc. Applied Chemistry  
Semester-III  
CH 91306: CHEMISTRY OF DRUGS - II

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course is an extension of the previous course on synthetic drugs. Different classes of drugs will be the focus of this course which has been not covered earlier. The course will stimulate interest of students in following areas:

- Analgesics, antipyretic, antiinflammatory drugs, sedatives and hypnotics
- Antidepressant, antianxiety agents and tranquilizers
- Drugs targeting the nervous system such as cholinergic agents and antihistamines
- Diuretics, antimalarial and cardiovascular drugs

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Describe structure, mechanism of action and uses of analgesics, sedatives and hypnotics Drugs.

**CO2:** Describe structure, mechanism of action & uses of antidepressants & antianxiety agents, Tranquilizers, & anti emetics

**CO3:** Recall structure, mechanism of action and uses of autonomic drugs.

**CO4:** Describe the drugs acting on Diuretics, antimalarial and cardiovascular system

**CO5:** Explain the new updates on the Antineoplastic and respiratory drugs and describe the chemistry and use of hypoglycemic agents.

**Course Contents: Theory-  
Unit I**

(a) Analgesics, antipyretics and anti inflammatory drugs, acetaminophen, amidopyrine, antipyrine, oxyphenabutazone, phenyl butazone, pethidine, ibuprofen, ketoprofen, mefenamic acid, fulfenamic acid, diclofenac sodium. (Alclafenac). piroxicam and nimesulide.

(b) **Sedatives and hypnotics** : Barbiturates, acyclic ureides, carbonal, barbital, cyclic imides and amides, benzodiazepines, glycol and its derivatives, oxazole derivatives.

**Unit II**

(a) **Antidepressants and antianxiety agents** phenyl ethylamine analogues, monoamine oxidase inhibitors, tricyclic antidepressants.

(b) **Tranquilizers**

Phenothiazines; benzoquinolizines.

**(c) Anticonvulsants**

Hydantoins, oxazolidine-diones, succinimides, primidone, phenacemide.

**(d) Antiemetics**

Trimethobenzamide, diphenidol.

**Unit III**

**Autonomic drugs**

**(a) Cholinergic agents**

Methacholine chloride, carbachol, Edrophonium chloride, physostigmine, neostigmine, pyridostigmine.

**(b) Anticholinergic agents**

Dicyclomine, oxyphenonium bromide, isopropamide iodide, diphenhydramine.

**(c) Adrenergic agents**

Epinephrine and related compounds, ephedrine and related compounds, imidazoline derivatives.

**(d) Antihistamines**

Ethanolamine derivatives, ethylene diamines, alkylamines, phenothiazines and piperazines.

**Unit IV**

**(a) Diuretics**

Sulphonamides, thiazides, sulphamyl benzoic acid derivatives.

**(b) Antimalarials**

4-amino quinolines, 8-amino-quinolines, 9-amino-acridines, biguanides, pyrimidines and sulphones.

**(c) Cardiovascular drugs**

Antianginals and vasodilators. Antiarrhythmic drugs. Antihypertensive drugs, antihyperlipidemic agents, anticoagulants and antiplatelet drugs, sclerosing agents.

**Unit V**

**(a) Hypoglycaemic agents**

Sulphonyl ureas and biguanides.

**(b) Antineoplastic drugs**

Alkylating agents, antimetabolites, antineoplastic antibiotics.

**(c) Respiratory drugs**

Respiratory stimulants, antitussives, expectorants, mucolytics and decongestants antiasthmatics.

**ASSESSMENT:**

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

**Books & References Recommended :**

**Text Books:**

1. Ashutosh Kar Medicinal Chemistry (New Age International Ltd. New Delhi )

2. Wilson & Gisvold, Organic Medicinal and Pharmaceutical Chem & stry. (Lippincott International Edition)

**Reference Books:**

1. May's, Chemistry of Synthetic Drugs. (UNODC Publications)
2. William Foye, Principles of Medicinal Chemistry. (Varghese & Co.)
3. Berger J, Medicinal Chemistry.(John Willy & sons).
4. Chatwal G.R., Chemistry of natural products Vol I & II Chemistry of Synthetic Drugs. (Himalaya Publishing House).
5. Lednicer D. & Lester A. Mitscher Organic Chemistry of Drug Synthesis., (John Willy & sons).
6. Satoskar R.S. Medicinal Chemistry(India Popular Prakashan).

**Journals:**

1. Journal of Cardiovascular Disease Research
2. Journal of Malaria Research
3. Pharmacology of Antihistamines
4. International Journal of Impotence Research
5. Antidepressants: MedlinePlus

**M.Sc. Applied Chemistry**  
**Semester-III**  
**CH 91307: COMPUTER APPLICATIONS IN CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** In this course students will be introduced basic computer skills and programming languages. At the end of this course students should be well versed in following topics:

- Introduction to computers, networking and database management.
- Basic computer language C, python and FORTRAN
- Use of soft-wares and programming techniques in chemistry

**Course Outcomes:** By the end of the course student will be able to:

- CO1:** Recall & infer the fundamentals of Computer, its components, structure, types & Peripheral devices.
- CO2:** Identify and apply the knowledge of networking and database management system.
- CO3:** Identify and apply the knowledge of languages like C, Python/FORTRAN useful for innovation, awareness, empowering entrepreneurs to create, manage and scale tech driven businesses effectively.
- CO4:** Apply and write the computer code in chemistry
- CO5:** Identify and apply the software packages in chemistry.

**Course Contents: Theory-**  
**UNIT I**

Computers and peripheral devices

- (a) Review of basic concepts of computers and peripheral devices.
- (b) Basic organization of digital computers.
- (c) Introduction of Operating systems.
- (d) Computer languages
- (e) Introduction to Internet.

**UNIT II**

**Computer programming using C, Python/FORTRAN**

- (a) Principle of programming, algorithms and flow-charts.
- (b) Basic concepts of FORTRAN/C/Python, Subroutines, loops, control statements, transfer statements.

### UNIT III

Networking and Data Base System (a) Networking :Historical background, Need & Advantage of computer network, Type of computer network, LAN, MAN, WAN, Basic HW & SW requirement for networking  
(b) Introduction to Database, Database application in chemistry, Characteristics of DBMS, Protein data bank, PubChem database.

### UNIT IV

Programming in chemistry:

Development of small computer codes involving simple formulae in chemistry, such as vander Walls equation pH titration, Kinetics, radioactive decay, evaluation of lattice energy and ionic radii from experimental data.

### UNIT V

Software package in Chemistry

(a)Linear and Non-linear Regressions.

(b)Introduction to Structure drawing and chemical calculation software packages

### ASSESSMENT:

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weight-age is 70%.

### Books & References Recommended :

#### Text Books:

1. R Kumari Computers & their Applications to Chemistry (Prentice- hall, New Delhi)
2. K.V Raman Computers in Chemistry (Tata Mcgraw Hills)

#### Reference Books:

1. V Rajaraman , Fundamentals of Computers.(Prentice- hall, New Delhi)
2. FORTRAN Mannuals

#### Journals:

1. Journal of Computer-Aided Molecular Design
2. Journal of Cheminformatics
3. Chemical Biology & Drug Design
4. Current Computer-Aided Drug Design
5. Computer-Aided Design

**M.Sc. Applied Chemistry**  
**Semester-III**  
**CH-91308:ADVANCED ORGANIC AND MEDICINAL CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
4	-	-	4	-	-	30	70	-	-	100

Pre-requisite: Nil

**Course Objectives:** This course covers some advanced aspects of organic chemistry such as conformation and stereo chemistry of molecules and their applications in medicine. On successful completion of the course, students will be able to:

- Demonstrate the importance of chemistry in the development and application of therapeutic drugs.
- Obtain knowledge of various name reactions and green synthesis of drugs.
- Understand the processes employed in pharmaceutical industries.

**Course Outcomes:** By the end of the course student will be able to:

**CO1:** Learn the structural activity relationship of the important class of drugs.

**CO2:** Design new techniques of organic synthesis using green chemistry.

**CO3:** Apply various processes involved in pharmaceutical manufacturing process.

**CO4:** Identify stereogenic centres in organic molecules and appreciate the role of chirality in nature and in drug design.

**CO5:** Learn various structure based drug design methods.

**Course Contents: Theory-**  
**UNIT I**

**Advanced Stereochemistry and its applications**

Role of stereochemistry in Pharmacokinetics and Pharmacodynamics. Selective organic transformations –chemoselectivity, regioselectivity, stereoselectivity, racemic switches, dynamic stereochemistry, stereoselective synthesis, uses of chiral homogenous and heterogeneous catalysts.

**UNIT II**

**Drug design and Chiral techniques in synthesis of drugs**

Concepts of pro drugs and soft drugs, Principles of drug parameters. Designing of new drugs using green chemicals.

Concept of chiral drugs, asymmetric synthesis of following drugs:-Vitamin C, Atenolol, Nifedipine, Ethambutol, Omeprazole, Aspartame, Ampicillin and Thalidomide.

**UNIT III**

Mechanisms, stereochemistry and applications of following reactions of synthetic importance: Birch reduction, Mannich reaction, Diel's alder reaction, Meerwein Ponndorf verley reduction, Oppeneaur oxidation, Catalytic hydrogenation reactions, Ozonolysis, Reformatsky reaction, Michael reaction.

#### **UNIT IV**

##### **Eco-friendly Techniques in organic synthesis**

Water as solvent, ionic liquids, supercritical liquids, supported reagents and catalysts, solvent free reactions, microwave & ultrasound assisted synthesis, biocatalytic synthesis.

#### **UNIT V**

##### **Unit processes**

Introduction, types of reagents, methods, mechanism, controlling factors and applications of following: Nitration, sulphonation, halogenation, oxidation and reduction. Introduction to Drug and Pharmaceutical Industries: varoius divisions and their working.

##### **ASSESSMENT:**

- Continuous evaluation through two/three mid-term test with a weight-age of 30 % of the total marks. It includes class attendance as well as assignments on the course topics.
- The end-term theory examination weightage is 70%.

##### **Books & References Recommended:**

###### **Text books:**

1. Finar I.L., Organic Chemistry Vol.I and II. (ELBs and Longman Ltd. New Delhi).
2. Jerry March, Structure Reactions and Mechanism (John Willy & sons).

###### **Reference books:**

1. Organic Chemistry of Drug Synthesis Lednicer D. & Lester A. Mitscher, (John Willy & sons).
2. Groggins, P. H., Unit processes in organic synthesis (McGraw Hill publication).
3. Eliel E.L., Stereochemistry of Carbon Compounds (John Willy & sons).
4. Kalsi P.S., Stereochemistry of Organic Compounds (New age International).
5. Srivastava M.M., Green Chemistry (Narosa publication).
6. May's, Chemistry of Synthetic Drugs (UNODC Publications).

###### **Journals:**

1. Chirality
2. Tetrahedron: Asymmetry - Journal - Elsevier
3. Journal of Chemical Education –ACS
4. Journal of Environmentally Friendly Processes
5. Journal of Green Science and Technology

M.Sc. Applied Chemistry  
Semester-III  
CH 91389: COMPUTER LAB

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** Through these practicals, students will be introduced to basic computer skills and programming languages. At the end of this course, students would have learned

- Networking and database management
- Basic computer languages- C, Python and FORTRAN
- Use of software's and programming techniques in chemistry

**Laboratory Outcomes:** By the end of the course student will be able to:

**LO1:** Apply diversified solutions using FORTRAN/C++/PYTHON language

**LO2:** Construct the program in FORTRAN/C++/PYTHON language

**LO3:** Apply software packages for various operations in industrial chemistry.

**LO4:** Use the online and offline tools for solving industrial chemistry related problems .

**LO5:** Interpret chemical structure databases of a chemical compound

**Course Contents: List of Practical's-**

1. Programming in FORTRAN/C++/PYTHON

Write codes for:

- First Order Kinetics Equation
- Second Order Kinetics Equation
- van der Waals Equation
- Linear Regression equation
  - Equation for Slope
  - Equation for intercept
  - Equation for R and R<sup>2</sup>
- Solving two dimensional arrays
- Half life period

2. Use of Chemistry software packages such as ChemSketch, ChemDraw etc for:



- (a) Structure drawing
  - (b) Geometry Optimization
  - (c) Estimation of various physic-chemical properties.
3. Use of Online Chemical structure databases for extraction of information for a chemical compound
  4. Use of Online Chemistry Software for their applications in solving chemistry problems faced in industries.
  5. Use of Office tools for writing reports, performing mathematical manipulations, plotting of graphs, preparing presentations, preparing industrial projects.
  6. Use of Office tools for skill development and getting job.

**Assessment :** Term end practical exam and comprehensive viva-voice.

**Text Books Recommended:**

1. R Kumari Computers and their Applications to Chemistry (Prentice- Hall, New Delhi)
2. K.V Raman Computers in Chemistry (Tata McGraw Hills)

**Reference Books:**

1. V Rajaraman, Fundamentals of Computers.(Prentice- hall, New Delhi)
2. FORTRAN Manuals
3. Harsh Bhasin,Python for Beginners(New age international, New Delhi).

**M.Sc. Applied Chemistry**  
**Semester-III**  
**CH 91390: ADVANCED ORGANIC AND MEDICINAL CHEMISTRY**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	8	-	-	4	-	-	-	40	60	100

Pre-requisite: Nil

**Course Objectives:** This course will illustrate the principles of advanced chemistry related to organic and medicinal chemistry. Students will learn to:

- Explain techniques of organic synthesis using eco-friendly methods.
- Understanding advanced concepts and principles of organic chemistry, including reaction mechanisms, stereo chemistry, and molecular structure.
- Preparation of organic compounds by using advanced synthesis methods.
- Identify and understand the role of chirality of organic compounds in medicinal chemistry.

**Laboratory Outcomes:** By the end of the course student will be able to:

- LO1:** Illustrate Theoretical aspect of synthesis of advanced organic and medicinal chemistry.
- LO3:** Apply practical skills to analyze drugs using synthesis and instrumentation methods.
- LO3:** Evaluate accurate analysis and report the results in defined format.
- LO4:** Illustrate Eco-friendly method of synthesis for an organic compounds.
- LO5:** Apply the professional and safety responsibilities in the laboratory practices.

**Course Contents: List of Practical's-**

1. To Synthesize Acetanilide by halogenation (Bromination ) reaction.
2. To Synthesize Benzil from Benzoin by oxidation reaction
3. To Synthesize Benzanilide from Aniline by acylation reaction.
4. Assymmetric synthesis of chiral drugs like
  - Vitamin – C
  - Aspartame
  - Ampicillin
  - Thalidomide

5. Organic synthesis by Eco-friendly methods of following compounds like
  - Preparation of 2-cyano, 3-phenyl, acrylic acid ethyl ester
  - Nitration of phenol
  - Bromination of acetanilide
  - Preparation of benzilic acid

**Assessment :** Term end practical exam and comprehensive viva-voice.

**Text Books Recommended:**

1. Practical Organic Chemistry, O P Agrawal, Krishna Publishing
2. Bretherick L, ed. Hazards in the Chemical Laboratory, 6th edition. Royal Society of Chemistry, Cambridge, UK, 1994.
3. Anastas PT, Williamson TC (Eds). Green Chemistry: Designing Chemistry for the Environment. ACS Symposium Series 626. American Chemical Society Washington DC, 1996.

**Reference Books Recommended:**

1. Anne E. Marteel-Parish and Martin A. Abraham, Green Chemistry and Engineering: A Pathway to Sustainability, Wiley Publishing
2. Concepción Jiménez-González and David J.C. Constable, Green Chemistry & Engineering: A Practical Design Approach, Wiley Publishing
3. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, publisher Merck
4. John Leonard, Advanced Practical Organic Chemistry, CRC Press

# Dissertation

M.Sc. Applied Chemistry

Semester IV



Department of Chemistry  
Shri G S. Institute of Technology and Science, Indore (MP)

M.Sc. Applied Chemistry  
Semester-IV

**CH 91499: DISSERTATION**

Period/week			Credits			Maximum marks				
T	P	Tu	T	P	Tu	Theory		Practical		Total Marks
						CW	End Sem	SW	End Sem	
-	-	52	-	26	-	-	-	120	180	300

**CO-PO mapping**  
**Semester-I**  
**CH91105: Physical Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	-	2	1	2
CO2	2	2	1	-	-	2	-	1	-	2
CO3	2	2	1	1	1	2	-	1	-	2
CO4	2	1	1	1	1	2	1	1	1	2
CO5	2	1	1	1	1	1	-	1	1	2

Table 1: CO-PO Attainment Sheet for Physical Chemistry(CH91105)

**CH91106: Inorganic Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	-	-	2	-	2	1	2
CO2	2	2	2	1	1	2	1	2	1	2
CO3	1	2	1	1	1	2	1	2	1	2
CO4	2	2	1	1	1	2	1	2	1	2
CO5	1	1	1	1	-	2	1	1	1	2

Table 2: CO-PO Attainment Sheet for Inorganic Chemistry(CH91106)

**CH91107: Analytical Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	1	2	1	2
CO2	2	2	2	2	1	2	1	2	1	2
CO3	2	2	2	1	1	2	1	1	1	2
CO4	2	2	2	1	-	2	2	2	2	2
CO5	2	2	2	1	1	2	1	2	1	2

Table 3: CO-PO Attainment Sheet for Analytical Chemistry(CH91107)

**CH91108: Engineering Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	1	2	1	2	1	2
CO2	1	1	2	1	1	2	1	1	1	1
CO3	1	1	2	2	1	1	1	1	2	2
CO4	1	1	1	2	1	1	1	2	2	1
CO5	1	1	1	2	2	2	2	2	2	2

Table 4: CO-PO Attainment Sheet for Engineering Chemistry(CH91108)

**CO-PO mapping**  
**Semester-II**  
**CH91205: Organic Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	-	-	1		1	1	2
CO2	2	1	1	-	-	1	-	1	1	2
CO3	2	2	1	1	1	1	1	1	1	2
CO4	2	1	1	-	-	1	1	1	1	2
CO5	2	1	1	-	-	1	-	1	1	1

Table 5: CO-PO Attainment Sheet for Organic Chemistry(CH91205)

**CH91206:Modern Analytical Methods**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	-	-	2	-	1	1	2
CO2	2	2	2	-	-	2	-	1	1	2
CO3	2	2	2	-	-	2	-	1	1	2
CO4	2	2	2	-	-	2	-	1	1	2
CO5	1	1	1	2	1	-	1	-	-	1

Table 6: CO-PO Attainment Sheet for Modern Analytical Methods(CH91206)

**CH91207:Natural Products**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	-	1	1	1	1	-	2
CO2	1	1	1	-	1	1	1	1	-	2
CO3	1	1	1	1	1	1	1	1	1	2
CO4	1	1	1	1	1	1	1	1	1	2
CO5	1	1	1	1	1	1	1	1	1	2

Table 7: CO-PO Attainment Sheet for Natural Products (CH91207)

**CH91209:CHEMISTRY OF DRUGS-I(Synthetic)**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	2	1	2
CO2	1	1	1	1	1	1	1	2	1	2
CO3	1	1	1	1	1	1	1	2	1	2
CO4	1	1	1	1	1	1	1	2	1	2
CO5	2	1	2	-	-	2	-	2	-	2

Table 8: CO-PO Attainment Sheet for Chemistry of drugs-I(CH91209)

**CO-PO mapping**  
**Semester-III**  
**CH91305: Chemistry of Drugs(Natural)**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	0	1	-	1	-	2
CO2	1	1	1	-	-	1	-	1	-	2
CO3	1	1	1	1	1	1	1	1	1	1
CO4	1	1	-	1	1	1	1	1	-	1
CO5	1	1	1	1	1	1	-	1	1	1

Table 9: CO-PO Attainment Sheet for Chemistry of drugs(Natural)(CH91305)

**CH91306: Chemistry of Drugs-II(Synthetic)**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	2	1	2
CO2	1	1	1	1	1	1	1	2	1	2
CO3	1	1	1	1	1	1	1	2	1	2
CO4	1	1	1	1	1	1	1	2	1	2
CO5	1	1	1	1	1	1	1	2	1	2

Table 10: CO-PO Attainment Sheet for Chemistry of Drugs-II (CH91306)

**CH91307:Computer Applications in Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1	-	1	1	1	2	1	2
CO2	2	1	2	-	-	1	1	2	1	2
CO3	2	1	1	1	1	1	1	2	1	2
CO4	2	1	2	-	-	1	1	2	1	2
CO5	2	1	2	-	-	1	1	2	1	2

Table 11: CO-PO Attainment Sheet for Computer applications in chemistry(CH91307)

**CH91309: Advanced Organic & Medicinal Chemistry**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	-	-	1	-	1	1	2
CO2	2	1	2	-	1	1	1	1	1	2
CO3	2	2	1	-	1	1	1	1	1	1
CO4	2	2	1	2	1	1	1	1	-	2
CO5	1	1	1	1	-	2	-	1	1	2

Table 12: CO-PO Attainment Sheet for Ad. organic & medicinal Chemistry(CH91309)