	<b>P.R. GOVERNMENT COLLEGE(A), KAKINADA</b>	<b>Program &amp; Semester</b> III B.Sc. <b>ORGANIC CHEMISTRY</b> (SEMESTER – V)			
Course Code ORCH-XII	TITLE OF THE COURSE Course -OC-12: <b>ENVIRONMENTAL CHEMISTRY</b>				
Teaching	Hours Allocated: 45 ( <b>Theory</b> ) (3 hrs. / Wk.)	L	T	P	C
Pre-requisites:	Basic knowledge about Environment and its scope and importance.	45	10	30	2+1

### Course Objectives:

1. To inculcate basic knowledge on basic concepts of environmental Pollution.
2. To illustrate the classification of segments of environment.
3. To provide knowledge and applications on various types of environmental pollutions.
4. To understand about the concepts of ecosystem and Bio-diversity.

### Course Outcomes:

On Completion of the course, the students will be able to-		Cognitive Domain
CO1	To inculcate basic knowledge on basic concepts of environmental Pollution.	Knowledge
CO2	To understand the classification of segments of environment.	Understand
CO3	To provide knowledge and applications on various types of environmental pollutions.	Knowledge
CO4	To understand about the concepts of ecosystem and Bio-diversity.	Understand

### Syllabus:

#### UNIT-1

##### **Introduction**

**9h**

Concept of Environmental chemistry-Scope and importance of environment in now adays  
 – Nomenclature of environmental chemistry – Segments of environment - Natural resources – Renewable Resources – Solar and biomass energy and Nonrenewable resources  
 – Thermal power and atomic energy – Reactions of atmospheric oxygen and Hydrological cycle.

## **UNIT-II**

### **Air Pollution**

9h

Definition – Sources of air pollution – Classification of air pollution – Acid rain – Photochemical smog – Greenhouse effect – Formation and depletion of ozone – Bhopal gas disaster – Controlling methods of air pollution.

## **UNIT-III**

### **Water pollution**

9h

Unique physical and chemical properties of water – water quality and criteria for finding of water quality – Dissolved oxygen – BOD, COD, Suspended solids, total dissolved solids, alkalinity – Hardness of water – Methods to convert temporary hard water into soft water – Methods to convert permanent hard water into soft water – eutrophication and its effects – principal wastage treatment – Industrial waste water treatment.

## **UNIT-IV**

### **Chemical Toxicology**

9h

Toxic chemicals in the environment – effects of toxic chemicals – cyanide and its toxic effects – pesticides and its biochemical effects – toxicity of lead, mercury, arsenic and cadmium.

## **UNIT-V**

### **Ecosystem and biodiversity**

9h

#### **Ecosystem**

Concepts – structure – Functions and types of ecosystem – Abiotic and biotic components – Energy flow and Energy dynamics of ecosystem – Food chains – Food web – Tropic levels – Biogeochemical cycles (carbon, nitrogen and phosphorus)

#### **Biodiversity**

Definition – level and types of biodiversity – concept - significance – magnitude and distribution of biodiversity – trends - biogeographically classification of India – biodiversity at national, global and regional level.

#### **List of Reference books**

1. Fundamentals of ecology by M.C.Dash
2. A Text book of Environmental chemistry by W. Moore and F.A. Moore
3. Environmental Chemistry by Samir k. Banerji

## **PROGRAMME OUTCOMES (PO's)**

At the completion of the B.Sc. Chemistry program, the students of our department will be able to:

**(PO1) Knowledge:** Attain in depth knowledge about the fundamental principles, essential facts, conclusions and applications of chemical and scientific theories in various domains of chemistry.

**(PO2) Critical Thinking:** Carry out experiments in the area of Environmental analysis, estimation, hardness of water, preparation, Kinetic, experiments and water analysis applying the domain of critical thinking.

**(PO3) Problem Solving:** Define the background of heavy metals like Pb, As, Cd, Hg. Cycles of N, C, P. Determination of carbonate and Bicarbonate in water sample and also analysis of alkalinity and turbidity.

**(PO4): Usage of modern tools:** Create data using modern chemical tools and ICT for modeling and analyze the data obtained from sophisticated instruments (like UV - Vis, FTIR, NMR, GCMS, Fluorescence, SEM, TEM and XRD) for chemical analysis

**(PO5): Communication:** Develop Skills to evaluate, analyze and interpret the chemical information and data and to communicate effectively within the chemical community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**(PO6): Life-long Learning:** Demonstrate scholarly attitude to pursue a career in the field of chemical education and research and have the zeal and vision to engage in independent and life-long learning in the broadest context of technological and social change.

**(PO7) Ethical Practices and Social Responsibility:** Generate ideas and solutions for green and sustainable chemistry and approach towards planning and execution of research in frontier areas of Environmental chemical sciences

## **PROGRAM SPECIFIC OUTCOMES (PSO's)**

At the time of graduation, our under graduates would be able to:

**PSO 1-** Evaluate, analyze, interpret and effectively apply the basic laws, principles, phenomena, processes and mechanisms involved in the domain of organic, inorganic, physical, analytical and Environmental Chemistry

**PSO2** - Demonstrate the knowledge of Chemistry in the domain of research, education and perspective entrepreneurship.

**PSO3** - Evaluate distinct problems in the field of Environmental data analysis, scientific interpretation and analysis of water,Air,Soil with an understanding on basic tools to be employed.

**WEIGHTAGE TO CONTENT**

S No	Course Content	Essay (10M)	Short (5M)	Total marks	Question Relates as per Bloom's Taxonomy
1.	UNIT-I	1	1	15	Remembering, understanding
2.	UNIT-II	1	2	20	Analyzing, Remembering
3.	UNIT-III	2	1	20	Analyzing, Remembering
4.	UNIT-IV	1	1	25	Analyzing, Evaluating
5.	UNIT-V	1	1	15	Evaluating
	Total	6	7	95	

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE(A)**  
**III B.Sc. ORGANIC CHEMISTRY , SEMESTER-V**  
**COURSE-OC-12: ENVIRONMENTAL CHEMISTRY**

**MODEL QUESTION PAPER**

**TIME: 2 hrs.**

**MAX. MARKS: 50**

**SECTION-A**

**Answer any THREE questions choosing at least ONE question from each section Each carries 10 Marks**

*3x10=30M*

1. One question is to be set from unit-I
2. One question is to be set from unit-II
3. One question is to be set from unit-III

**SECTION-B**

4. One question is to be set from unit-III
5. One question is to be set from unit-IV
6. One question is to be set from unit-V

**Answer any FOUR questions Each carries FIVE marks.**

**4x5=20M**

7. One question is to be set from unit-I
8. One question is to be set from unit-II
9. One question is to be set from unit-II
10. One question is to be set from unit-III
11. One question is to be set from unit-IV
12. One question is to be set from unit-V
13. One question is to be set from unit-V

## **QUESTION BANK**

### **ESSAY QUESTIONS**

1. Explain the Segments of Environment.
2. Discuss about Renewable and Non-Renewable energy resources with examples.
3. Explain the reactions of atmospheric Oxygen.
4. Discuss about Hydrological cycle.
5. What is Air pollution. Explain classification and control measures of Air pollution.
6. Explain        a) Acid rains    b) Global Warming    c) Formation and depletion of Ozone layer  
                    d) Bhopal Gas disaster    e) Photo chemical smog
7. Give the methods to convert Permanent hard water into soft water.
8. Give the methods to convert Temporary hard water into soft water.
9. What is the quality parameters of water.
10. What is Eutrophication. How industrial waste water is purified.
11. Explain the Toxicity of a) Lead    b) Arsenic    c) Mercury    d) Cadmium.
12. Define Ecosystem. Explain the types of Ecosystems.
13. Give detailed account on Biodiversity.

### **SHORT ANSWER QUESTIONS**

1. Explain the importance of environment in now a day.
2. Give about the hardness of water.
3. Discuss briefly about Food chain and Food web.
4. What are the toxic effects of cyanide on the environment.
5. Explain the biochemical effects of Pesticides.
6. Define biotic and abiotic components.
7. What are the functions of Ecosystem.
8. Define the terms i) COD        II) BOD
9. Write about biogeochemical cycles of C, N, P
10. Explain biogeographical classification of India.

Practical Paper –OC - 12 (at the end of semester V)

30 hrs (2 h / W)

1. Determination of carbonate and bicarbonate in water samples
2. Determination of hardness of water using EDTA
  - a) Permanent hardness
  - b) Temporary hardness
3. Determination of Acidity of water samples
4. Determination of Alkalinity of water samples
5. Determination of chlorides present in water samples

**CLO-PLO Mapping:****1: Slight [Low]; 2: Moderate [Medium]; 3: Substantial [High], 4: (No Correlation)**

	CL O/P LO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	CLO\ PLO	PLO1
CLO1	3	3	3	2	3	2	2	2	3	2	2	3	3
CLO2	3	3	3	2	3	2	2	3	2	3	3	3	3
CLO3	3	2	3	2	3	1	2	2	2	2	2	3	2
CLO4	3	3	2	1	3	2	2	1	2	3	3	3	3
CLO5	3	2.75	2.75	2	3	2	2	2	2.25	2.5	2.5	3	2.75

## SCHEME OF VALUATION

1. Procedure – 10M
2. Tabular form and values -15M

### % of error

3. Below 1% 15
4. 1-2% Error – 10
5. >2%-5M
6. Record-05M
7. Viva-5M

	<b>PITHAPUR RAJAH'S GOVERNMENT COLLEGE KAKINADA</b>	<b>Program &amp; Semester</b>			
Course Code <b>CHE-13</b>	<b>TITLE OF THE COURSE</b> <b>COURSE 13 : CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF ANALYSIS</b>	III B.Sc.HONOR Organic Chemistry (V Semester)			
Teaching	Hours Allocated: 45 ( <b>Theory</b> )	L	T	P	C
Pre - requisites	Fundamental Knowledge in functional Groups of organic compounds and their general formulas	45	10	30	3+1

### Course Outcomes:

**At the end of the course , the students will be able to**

- 1) Identify the importance of chromatography in the separation and identification of compounds in a mixture
- 2) Acquire a critical knowledge on various chromatographic techniques.
- 3) Demonstrate skills related to analysis of water using different techniques.
- 4) Understand the principles of Spectrophotometry in the determination of metal ions.
- 5) Comprehend the applications of atomic spectroscopy.

<b>On Completion of the course, the students will be able to</b>	
<b>CO1</b>	Handle in depth of various various Chromatographic and instrumental methods for analysis
<b>CO2</b>	Understand the basic concepts of Chromatography and allied techniques
<b>CO3</b>	Learn and identify applications of Beer-Lamberts Law
<b>CO4</b>	Understand the reactivity and structure of different functional groups of compounds

### Course with focus on employability/entrepreneurship/SkillDevelopment modules

Skill Development		Employability		Entrepreneurship	
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## **COURSE 13 : CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF ANALYSIS**

### **I**

#### **Syllabus:**

#### **Unit-1:**

#### **Chromatography-Introduction and classification**

Principle, Classification of chromatographic methods, Nature of adsorbents, eluents, Rf-values, factors affecting Rf-values.

#### **UNIT-2:**

#### **TLC and paper chromatography**

**Thin layer chromatography:** Principle, Experimental procedure, preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, applications and advantages.

**Paper Chromatography:** Principle, Experimental procedure, choice of paper and solvents, various modes of development- ascending, descending, radial and two dimensional, applications.

#### **UNIT-3:**

#### **Column chromatography**

**Column chromatography:** Principle, classification, Experimental procedure, stationary and mobile phases, development of the Chromatogram, applications.

**HPLC:** Basic principles, instrumentation–block diagram and applications.

#### **UNIT-4: Spectrophotometry**

Principle, Instrumentation : Single beam and double beam spectrometer, Beer-Lambert's law

Derivation and deviations from Beer-Lambert's law,

applications of Beer-Lambert's law

Quantitative determination of  $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$  and  $\text{Pb}^{+2}$  .

#### **UNIT-5: Polarimetry and Refractometry**

#### **Polarimetry and Refractometry:**

**Polarimetry :** Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity.

**Refractometry;** The refractive index, Refractometer.

## List of Reference books:

- 1) Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
- 2) Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Seventh edition, Wiley.
- 3) Quantitative analysis by R. A. Day Jr. and A. L. Underwood, Sixth edition, Pearson.
- 4) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition/Pearson.
- 5) Instrumental methods of Chemical Analysis by Dr. B. K. Sharma 1981

## SEMESTER-V

### COURSE 13 : CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF ANALYSIS

Practical Credits: 1

2 hrs/week

## II.

### Learning Outcomes:

On successful completion of this practical course, student shall be able to:

- 1) Perform the separation of a given dye mixture using TLC
- 2) Learn the preparation of TLC plates
- 3) Demonstrate the separation of mixture of amino acids using paper chromatography
- 4) Acquire skills in using column chromatography for the separation of dye mixture.

## III.

### Laboratory course Syllabus:

- 1) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
- 2) Separation of mixture of methyl orange and methylene blue by column chromatography.
- 3) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
- 4) Separation of food dyes using Column Chromatography
- 5) Separation of triglycerides using TLC
- 6) Verification of Beer Lambert's law. (Using potassium permanganate solution) using colorimeter / spectrophotometer.

## IV. List of Reference books:

- 1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
- 2) Vogel A. I. Practical Organic Chemistry, Longman Group Ltd.

- 3) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 4) Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.
- 5) Mann F. and Saunders B.C, Practical Organic Chemistry, Pearson Education.

### Course outcome & Program outcome mapping

On Completion of the course, the students will be able to	
CO1	In depth understanding of theory in Chromatography and Instrumental methods
CO2	Understand and explain properties in various chromatographic methods, types of solvent systems, principles etc.
CO3	Understand the importance of structure, preparation and chemical applications in respect of Chromatographic and Instrumental Methods
CO4	Comprehend the concepts and applications of Chromatography & Instrumental methods

### CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	2	1	3	2	2
CO2	3	1	2	2	1	1	1	3	1	2
CO3	3	2	2	3	2	2	2	3	2	2
CO4	3	1	1	1	1	1	1	2	1	1

### PROGRAMME OUTCOMES (PO's)

At the completion of the B.Sc. Chemistry program, the students of our Department will be able to:

**(PO1) Knowledge:** Attain in depth knowledge about the fundamental principles, essential facts, conclusions and applications of chemical and scientific theories in various domains of chemistry.

**(PO2) Critical Thinking:** Carry out experiments in the area of organic analysis, estimation, derivative process, inorganic semi micro analysis, preparation, Kinetic, experiments and spectral analysis applying the domain of critical thinking.

**(PO3) Problem Solving:** Define the background of reaction mechanisms, complex chemical structures, instrumental method of chemical analysis, and

separation techniques and apply appropriate techniques for analyzing specific problems both qualitatively and quantitatively in laboratories and in industries.

**(PO4): Usage of modern tools:** Create data using modern chemical tools and ICT for modeling and analyze the data obtained from sophisticated instruments (like UV - Vis, FTIR, NMR, GCMS, Fluorescence, SEM, TEM and XRD) for chemical analysis

**(PO5): Communication:** Develop Skills to evaluate, analyze and interpret the chemical information and data and to communicate effectively within the chemical community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**(PO6): Life-long Learning:** Demonstrate scholarly attitude to pursue a career in the field of chemical education and research and have the zeal and vision to engage in independent and life-long learning in the broadest context of technological and social change.

**(PO7) Ethical Practices and Social Responsibility:** Generate ideas and solutions for green and sustainable chemistry and approach towards planning and execution of research in frontier areas of chemical sciences

### **PROGRAM SPECIFIC OUTCOMES (PSO's)**

At the time of graduation, our under graduates would be able to:

**PSO 1-** Evaluate, analyze, interpret and effectively apply the basic laws, principles, phenomena, processes and mechanisms involved in the domain of organic, inorganic, physical and analytical Chemistry

**PSO2 -** Demonstrate the knowledge of Chemistry in the domain of research, education and perspective entrepreneurship.

**PSO3 -** Evaluate distinct problems in the field of chemical data analysis, scientific interpretation and reaction mechanisms with an understanding on basic tools to be employed.

### **Weightage to the content**

<b>S.No.</b>	<b>Course Content</b>	<b>Long Answer Questions</b>	<b>Short Answer Questions</b>	<b>Total Marks</b>	<b>As per Blooms Taxonomy</b>
1	Chromatography- Introduction and classification	1	1	15	Understanding, Application
2	TLC and paper chromatography	1	2	20	Remembering, Understanding
3	Column chromatography	2	1	25	Analyzing & Creation
4	Spectrophotometry	1	2	20	Evaluation, Understanding
5.	Polarimetry and Refractometry	1	1	15	Understanding, Application
	<b>TOTAL</b>	<b>6</b>	<b>7</b>	<b>95</b>	

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A) :: KAKINADA**

**III YEAR B.Sc (Examination at the end of V semester)  
COURS-13 :: CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF  
ANALYSIS**

**MODEL PAPER**

**Duration: 2hr**

**Max.Marks: 50M**

**Section – 1**

Answer any THREE questions choosing at least one from each part.

Each question carries TEN marks.

3 X 10 = 30 Marks

**PART-A**

1. Explain the classification of various chromatographic methods on the basis of Stationery Phase and Mobile Phase [BT1, CO1]
2. Support the advantages of Thin Layer Chromatography with its applications [BT1, CO2]
3. How column chromatography is used to separate a mixture of organic compounds [BT2, CO2]

**PART-B**

4. Give the block diagram and explain the working, principle of HPLC.[BT3, CO3]
5. Discuss various types of spectro photometers with their block diagrams. [BT2 CO3]
6. Elaborate the working principle of polarimeter with block diagram. [BT3, CO4]

**Section-II**

Answer any four of the following questions.

Each question carries FIVE marks.

4x5=20 Marks

7. Brief about the factors affecting R<sub>f</sub>-values [BT3, CO1]
8. Brief about the development of chromatogram in TLC [BT3, CO1]
9. Write about two dimensional paper chromatography with example [BT1, CO2]
10. Write a note on mobile phase for Column chromatography [BT3, CO3]
11. Brief deviations from Beer-Lamberts Law.[BT3, CO1]
12. Give the procedure for the determination of Mn by colorimetry. [BT2, CO3]
13. Write about refractometry[BT1, CO1]

**PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A) : KAKINADA**

**BOARD OF STUDIES 2025-26**

**DEPARTMENT OF CHEMISTRY**

**III B.Sc., Honors in Organic Chemistry**

**SEMESTER – V**

**Paper: III - CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF ANALYSIS**

**(Course 13 )**

**Question Bank**

**UNIT- I**

**Chromatography-Introduction and classification**

**Essay Questions**

1. Explain the general theory of Chromatographic processes
2. Briefly explain the classification of chromatography methods
3. What is meant by R<sub>f</sub>-values? Explain. Mention some of the factors which influence the R<sub>f</sub>-value

**Short Answer Questions**

1. Give the principle of chromatography
2. Write about adsorbents and their nature

**UNIT – II**

**TLC and paper chromatography**

**Essay Questions**

1. Explain the general procedure of thin layer chromatography
2. Explain the following
  - A) Ascending Paper Chromatography
  - B) Descending Paper chromatography
3. Explain the following
  - A) Radial Paper Chromatography and
  - B) Two Dimensional Paper Chromatography

**Short Answer Questions**

1. Write about the applications of thin layer chromatography
2. Explain various ways in which spots due to component compounds of a mixture are detected after development of the plate in TLC
3. What are the commonly used adsorbents in thin layer chromatography
4. Mention some of the advantages of thin layer chromatography

## **UNIT-III**

### **Column chromatography**

#### **Essay Questions**

1. Explain the theory and principle of Column Chromatography
2. What is HPLC? Explain the theory and principle involved in HPLC
3. Explain the preparation of Dry and Wet Columns

#### **Short Answer Questions**

1. Write about important applications of HPLC
2. Write the important applications of column chromatography

## **UNIT-IV**

### **Spectrophotometry**

#### **Essay Questions**

1. State and explain Lambert's Law and Beer-Lamberts Law
2. What are single beam and double beam spectrophotometers? Briefly explain.
3. Derive an expression for Beer-Lamberts Law

#### **Short Answer Questions**

1. Write about the applications of Beer-Lamberts law
2. Write about the application of Beer-Lamberts Law for quantitative analysis of Fe(II)
3. Write about the application of Beer-Lamberts Law for quantitative analysis of Mn(II)
4. Write about the application of Beer-Lamberts Law for quantitative analysis of Pb(II)
5. What is molar absorptivity
6. What is absorbance and transmittance explain

## **UNIT- V**

### **Polarimetry and Refractometry**

#### **Essay Questions**

1. Explain the Nature of polarized light,
2. Elaborate the working of polarimeter,
3. Explain the operation of the polarimeter
4. Explain the Principle and working of Refractometer.

#### **Short Answer Questions**

1. Write about sample cells in Polarimeter

2. Explain the term optical Purity

3. What is the significance the refractive index,

### SEMESTER-V

## COURSE 13 : CHROMATOGRAPHY AND INSTRUMENTAL METHODS OF ANALYSIS

Practical

Credits: 1

2 hrs/week

### (At the end of V Semester)

- 1) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
- 2) Separation of mixture of methyl orange and methylene blue by column chromatography.
- 3) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
- 4) Separation of food dyes using Column Chromatography
- 5) Separation of triglycerides using TLC
- 6) Verification of Beer Lambert's law. (Using potassium permanganate solution) using colorimeter / spectrophotometer.

### Scheme of Valuation for Practical

#### Chromatographic Experiment

Procedure - 10 M

Principle - 5 M

Mobile Phase and Stationery Phase Composition - 5 M

Detection of Spots - 5 M

Rf-values Calculation - 2x5=10 M

Error - 5 M

Viva-voce - 5 M

Record - 5 M

#### Colorimetric Experiment

Procedure ( Calibration of Instrument ) - 5 M

Principle and Formulae - 5 M

Preparation of Stock Solution and Working Solutions - 5 M

Detection of Absorbance Values and Neat Tabular Form - 5 M

Construction of Calibration Graph - 5 M


Calculation for Two Unknowns - 2x5=10 M

Error - 5 M

Viva-voce - 5 M

Record - 5 M

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	<b>P R Govt College(A) Kakinada</b>		<b>Program &amp; Semester</b> III B.Sc. ORGANIC CHEMISTRY (V Semester)			
Course Code CHEM-OC14A	TITLE OF THE COURSE <b>GREEN CHEMISTRY AND NANOTECHNOLOGY</b>					
Teaching	HoursAllocated:60 ( <b>Theory</b> )		L	T	P	C
Pre-requisites	Basic principles of organic chemistry, catalysis and green chemistry, atom economy, rearrangements, Nano particles, green synthesis.		45	10	30	4+2

### CourseObjectives:

1. Green Chemistry- I
2. Green Chemistry- II
3. Green catalysis and green synthesis
4. Microwave and Ultrasound assisted green synthesis
5. Nanotechnology in Green chemistry

### Learning Objectives:

1. Understand the importance of green chemistry and green synthesis.
2. Engage in Microwave assisted organic synthesis.
3. Demonstrate skills using the alternative green solvents in synthesis.
4. Demonstrate and explain enzymatic catalysis.
5. Analyze alternative sources of energy and carry out green synthesis.
6. Carry out the chemical method of nanomaterial synthesis.

### CourseOutcomes:

<b>On Completion of the course, the students will be able to</b>	
CO1	Student will acquire knowledge on basic concepts in different types of green chemical reactions
CO2	Student will get the knowledge in understanding the fundamental concepts involved in the green chemistry and gets acquainted with new kind of reactions
CO3	Student shall have opportunity to understand the importance of green chemistry in Nanotechnology in which is a key analysis in recent research trends.
CO4	Students shall Comprehend the applications of different novel reagents and reactions in synthetic green chemistry.

### Course with focus on Skill Development/Employability/Entrepreneurship modules

Skill Development		Employability		Entrepreneurship	
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## **Syllabus:**

### **Unit-I Green chemistry-I**

Introduction-Definition of green Chemistry, Need for green chemistry, Goals of Green chemistry Basic principles of green chemistry. Green synthesis- Evaluation of the type of the reaction i) Rearrangements (100% atom economic),ii)Addition reaction (100% atom economic). Organic reactions by Sonication method: apparatus required and examples of sono chemical reactions (Heck, Hundsdiecker and Wittig reactions).

### **Unit- II Green chemistry-II**

**A) Selection of Solvent:**

i) Aqueous phase reactions ii) Reactions in ionic liquids, Heck reaction, Suzuki reactions, epoxidation.  
iii)Solid supported synthesis

**B) Supercritical CO<sub>2</sub>:** Preparation, properties and applications, (decaffeination, drycleaning)

**C) Green energy and sustainability.**

### **Unit-III Microwave and Ultrasound assisted green synthesis:**

Apparatus required, examples of MAOS (synthesis of fused anthraquinones, Leukart reductive amination of ketones)-Advantages and disadvantages of MAOS. Aldol condensation –Cannizzaro reaction - Diels-Alder reactions- Strecker's synthesis

### **Unit-IV Green catalysis and green synthesis:**

Heterogeneous catalysis, use of zeolites, silica, alumina, supported catalysis-biocatalysis: Enzymes, microbes  
Phase transfer catalysis (micellar/surfactant)

Green synthesis of the following compounds: adipic acid, catechol, disodium imino diacetate (alternative Strecker's synthesis)

Microwave assisted reaction in water –Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols–microwave assisted reactions in organic solvents. Diels- Alder reactions and decarboxylation reaction.

### **Unit - V Nanotechnology in Green chemistry:**

Basic concepts of Nanoscience and Nanotechnology – Bottom-up approach and Top-down approaches with examples – Synthesis of Nano materials – Classification of Nanomaterials – Properties and Application of Nanomaterials. Chemical and Physical properties of Nanoparticles. Chemical Synthesis of nanoparticles – precipitation and co-precipitation method, sol-gel method.

### List of Reference books:

1. Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
2. Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
3. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
4. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry(London)
5. Principles and practice of heterogeneous catalysis, Thomas J.M.,Thomas M.J., JohnWiley
6. Green Chemistry: Environmental friendly alternatives R S Sanghli and M.MSrivastava, Narosa Publications

### WebLinks:

1. <https://youtu.be/B45LMANkcKI><https://youtu.be/NDHQ7W2TKIY>
2. <https://youtu.be/pCafvltuo0M>

### CO-PO Mapping:

1: Low = 1 ; 2: Moderate = 2 ; 3: High = 3 ; 4: No Correlation = 0

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	2	3	2	2	2	3	3	2
CO2	3	3	2	3	2	2	1	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	3	2	3
Avg.	3	2.8	2.8	2.5	2.8	2	2	2	2	2	3	2.8	2.3

**PO1 : Knowledge in Chemistry** : Apply the knowledge of green chemistry to the solution of simple to complex synthesis of organic molecules.

**PO2: Problem analysis:** Identify, formulate, review research literature, and analyze simple to complex problems reaching substantiated conclusions using fundamental principles of green synthesis

**PO3: Design/development of solutions:** Design solutions for simple to complex problems and designing novel routes for the synthesis of bioactive / active pharmaceutical ingredients.

**PO4: Conduct investigations of complex problems:** Use fundamental research-based knowledge and available research methods including design of experiments, analysis and interpretation of data, and

synthesis of the organic molecules

**PO5 : Modern tool usage:** Create, select, and apply appropriate techniques, resources, and IT tools for modeling and interpretation of simple to complex organic molecules.

**PO6 : Society:** Applying the contextual knowledge to assess societal, health, safety, legal and cultural issues.

**PO7: Environment and sustainability:** Understand the importance of synthetic organic chemistry for various solutions in societal and environmental context and demonstrate the knowledge and need for sustainable development.

**PO8 : Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the science-based practice.

**PO9 : Communication:** Communicate effectively on issues related to synthetic organic chemistry with the chemistry community, being able to write the effective reports and documentation, presentations.

**PO10: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

**PSO-1:** To have a firm foundation in the fundamentals/concepts/theories and its applications in synthetic organic chemistry.

**PSO-2:** To understand the structure and properties of reagents, Characteristics mechanisms of chemical reactions and their green synthetic utility.

**PSO-3:** To acquaint with safety measures in laboratory and develop skills in proper handling of chemicals and apparatus/instruments and carry out experiments, record the observations and present the inference/results

**Weightage to content**  
**Semester -V**  
**III B.Sc , Organic Chemistry**  
**Course code-14A**

S.No	Course Content	Long Answer	Short Answer	Total marks	As per Blooms Taxonomy
1	Green Chemistry-I	2	1	25	Understanding , Application
2	Green Chemistry-II	1	1	15	Remembering, Understanding
3	Green catalysis and green synthesis	1	2	20	Analyzing & Creation
4	Microwave and Ultrasound assisted green synthesis	1	1	15	Evaluation, Understanding
5	Nanotechnology in Green chemistry	1	2	20	Application & Creation
	<b>TOTAL</b>	<b>6</b>	<b>7</b>	<b>95</b>	

**P.R. GOVERNMENT COLLEGE (A), KAKINADA**

**III B.Sc. Organic Chemistry  
(Examination at the end of V semester)  
(COURSE CODE- 14A, GREEN CHEMISTRY AND NANOTECHNOLOGY)  
MODEL PAPER**

**Duration: 2hr**

**Max. Marks: 50M**

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**SECTION-I**

Answer any **three** of the following questions. Must attempt at least **one** question from each part. Each question carries 10 Marks.

3 X 10M = 30M

**Part -A**

1. UNIT- 1
2. UNIT -2
3. UNIT- 3

**Part -B**

4. UNIT-4
5. UNIT-5
6. UNIT- I

**SECTION-II**

Answer any **four** of the following questions. Each carry 5 marks.

4 X 5M= 20M

7. UNIT-1
8. UNIT-2
9. UNIT-3
- 10.UNIT-3
11. UNIT-4
12. UNIT-5
13. UNIT-5

**SEMESTET-V**  
**III B.Sc. Organic Chemistry**

**LABORATORY COURSE**

**COURSE CODE 14A: GREEN CHEMISTRY AND NANOTECHNOLOGY**

(at the end of semester V) 30hrs (2h/W)

50Marks

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**Laboratory course Syllabus:**

1. Identification of various equipment in the laboratory.
2. Acetylation of 1<sup>o</sup> amine by green method: Preparation of acetanilide
3. Rearrangement reaction in green conditions: Benzil - Benzilic acid rearrangement
4. Radical coupling reaction: Preparation of 1,1-bis -2-naphthol
5. Green oxidation reaction: Synthesis of adipic acid
6. Preparation and characterization of Nanoparticles of gold using tea leaves.
8. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
9. Photoreduction of Benzophenone to Benzopinacol in the presence of sunlight.

**List of Reference books:**

- 1) Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
  - 2) Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
  - 3) Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
  - 4) Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
- Web related references suggested by teacher

**SCHEME OF VALUTION**

**Practical Paper -14A :: GREEN CHEMISTRY AND NANOTECHNOLOGY**

a. Equation with Mechanism	10 marks
b. Procedure	10 marks
c. Recrystallization	10 marks
d. Yield	10 marks
e. Record	05 marks
f. Viva-Voice	05 marks
<b>TOTAL</b>	<b>50 marks</b>



**III B.Sc. Organic Chemistry**  
**(Examination at the end of V semester)**  
**(COURSE CODE-14A, GREEN CHEMISTRY AND NANOTECHNOLOGY**  
**QUESTION BANK**

**Unit-V**

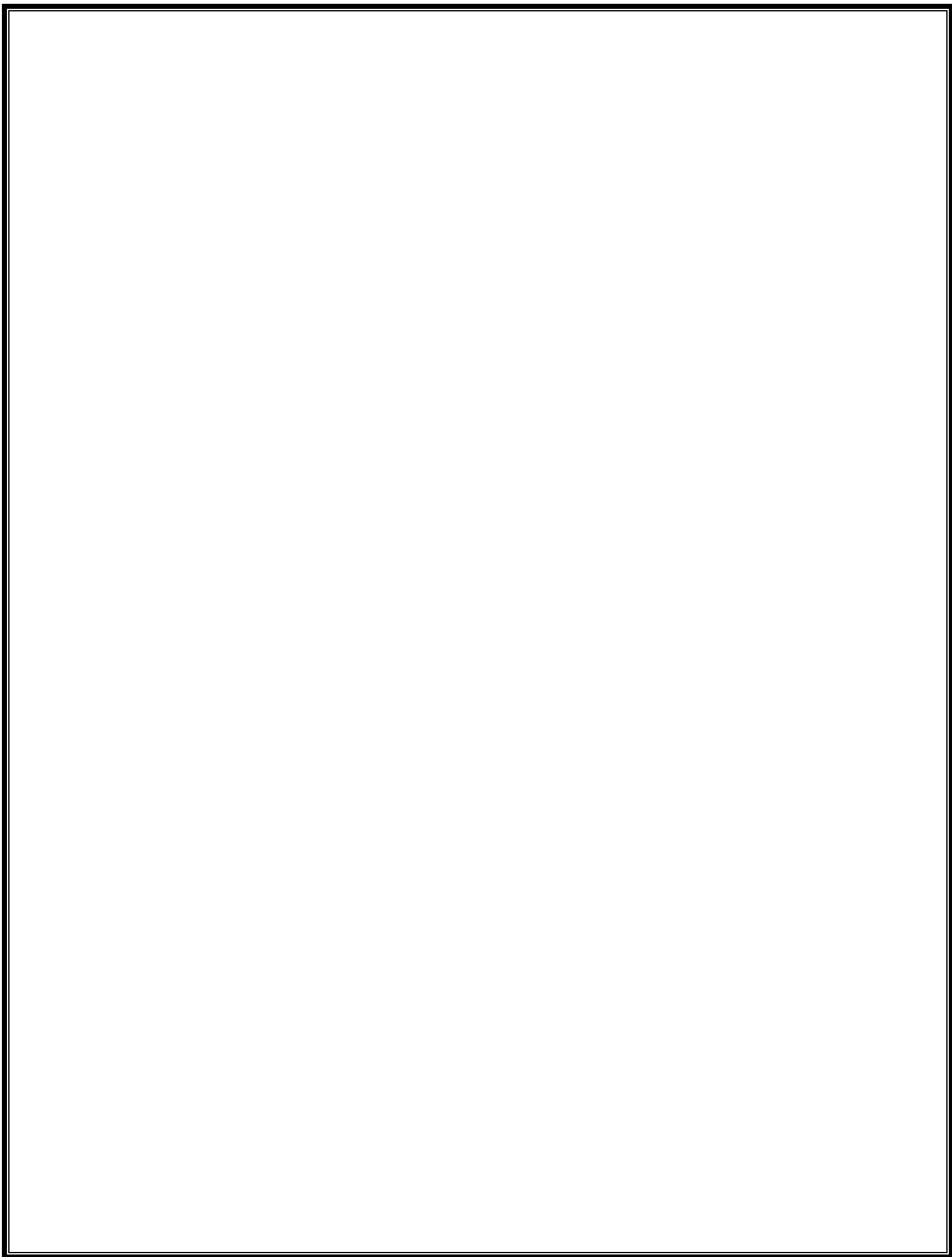
**Essay questions**

1. Explain the synthesis of Nano materials by Bottom-up approach and Top-down approaches with examples
2. Explain precipitation and co-precipitation methods of synthesis of nanoparticles.

**Short questions**

1. Write about basic concepts of Nanoscience and Nanotechnology
2. Write the classification of Nanomaterials?
3. Explain sol-gel method of nanoparticles?

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# PITHAPUR RAJH'S GOVERNMENT COLLEGE(A) KAKINADA

Course Code ORCH-XV A	<b>TITLE OF THE COURSE</b>  <b>ANALYSIS OF ORGANIC COMPOUNDS</b>	Program & Semester III B.Sc. <b>ORGANIC CHEMISTRY</b> (V Semester)			
Teaching	Hours Allocated: 45 ( <b>Theory</b> )	L	T	P	Cr
Pre-requisites	1. Basic structure of the atom: Understanding nuclei, protons, neutrons, and magnetic properties. 2. Basic organic functional groups and structure recognition. 3. Fundamental concepts of electromagnetic radiation and energy levels. 4. Concept of molecular weight and molecular formula calculation. 5. Introduction to ionization and charged species. 6. Basic knowledge of isotopes and their natural abundances. 7. Understanding of IR, NMR, and Mass Spectrometry individually. 8. Ability to identify functional groups from IR spectra. 9. Basic understanding of chromatography principles (stationary vs. mobile phases). 10. Concept of Rf value and factors influencing it.	45	10	30	3+2

### Course Objectives:

By the end of this course, students will be able to

1. Gains knowledge in NMR spectroscopy, Mass spectrometry
2. Structural elucidation by IR, NMR and Mass spectroscopic techniques
3. Applications of Paper and Thin layer chromatographic techniques
4. Problem-solving approach to elucidation of the structure and separation of organic compounds.

### Course Outcomes:

On successful completion of this course, students will be able to

On Completion of the course, the students will be able to	
CO1	Identify the importance of NM spectroscopy, mass spectrometry in the structural elucidation of organic compounds
CO2	Acquire the knowledge on the structural elucidation of organic compounds
CO3	Understand various chromatography methods in the separation and identification of organic compounds.
CO4	Demonstrate the knowledge gained in solvent extraction for the separation of organic compounds

## PROGRAMME OUTCOMES

At the completion of the B.Sc. Chemistry program, the students of our Department will be able to:

**(P01) Knowledge :** Attain in depth knowledge about the fundamental principles, essential facts, conclusions and applications of chemical and scientific theories in various domains of chemistry.

**(P02) Critical Thinking:** Carry out experiments in the area of organic analysis, estimation, derivative process, inorganic semi micro analysis, preparation, Kinetic, conductometric and potentiometric experiments and spectral analysis applying the domain of critical thinking.

**(P03) Problem Solving :** Define the background of reaction mechanisms, complex chemical structures, instrumental method of chemical analysis, and separation techniques and apply appropriate techniques for analysing specific problems both qualitatively and quantitatively in laboratories and in industries.

**(P04): Usage of modern tools:** Create data using modern chemical tools and ICT for modeling and analyze the data obtained from sophisticated instruments (like UV-Vis, FTIR, NMR, GCMS, Fluorescence, SEM, TEM and XRD) for chemical analysis

**(P05) :Communication:** Develop Skills to evaluate, analyze and interpret the chemical information and data and to communicate effectively within the chemical community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**(P06): Life-long Learning :** Demonstrate scholarly attitude to pursue a career in the field of chemical education and research and have the zeal and vision to engage in independent and life-long learning in the broadest context of technological and social change.

**(P07) Ethical Practices and Social Responsibility:** Generate ideas and solutions for green and sustainable chemistry and approach towards planning and execution of research in frontier areas of chemical sciences.

## PROGRAM SPECIFIC OUTCOMES (PSO's)

At the time of graduation, our under graduates would be able to:

**PSO 1-** Evaluate, analyze, interpret and effectively apply the basic laws, principles, phenomena, processes and mechanisms involved in the domain of organic, inorganic, physical and analytical Chemistry

**PSO2 -** Demonstrate the knowledge of Chemistry in the domain of research, education and perspective entrepreneurship.

**PSO3 -** Evaluate distinct problems in the field of chemical data analysis, scientific interpretation and reaction mechanisms with an understanding on basic tools to be employed.

## Course outcome & Program outcome mapping

1: Low =1; 2: Moderate = 2 ; 3: High = 3 ; 4: No Correlation = 0

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1	1	3	2	3
CO2	3	3	3	3	2	1	1	3	3	3
CO3	3	3	3	3	3	1	2	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
Average	3.0	2.75	3.0	3.0	2.5	1.25	1.75	3.0	2.75	3.0

### Course with focus on employability/entrepreneurship/Skill Development modules

Skill Development		Employability		Entrepreneurship	
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# ORCH-XV(A) ANALYSIS OF ORGANIC COMPOUNDS

## Syllabus:

### Unit I: Nuclear Magnetic Resonance (NMR) spectroscopy 9 hours

Principles of nuclear magnetic resonance, equivalent and non-equivalent protons, position of signals. Chemical shift, NMR splitting of signals - spin-spin coupling, coupling constants.

Applications of NMR with suitable examples - ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene, and acetophenone.

### Unit II Mass Spectrometry :9 hours

A brief introduction to the analysis of organic compounds

Basic principles, Instrumentation - Mass spectrometer, electron Ionization (Electron Impact, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butyraldehyde, and Propionic acid.

### Unit-III: Structural elucidation of organic compounds using IR, NMR & mass spectral data- 9 hours

2,2,3,3-Tetramethyl butane, Butane-2,3-dione, Propionic acid, and methyl propionate. Phenyl acetylene, acetophenone, cinnamic acid, and p-nitroaniline.

### Unit-IV: Separation techniques-1 9 hour

Solvent extraction- Principle and theory, Batch extraction technique, application of batch extraction in the separation of organic compounds from mixture- acid & neutral, base & neutral.

Chromatography - Principle and theory, classification, types of adsorbents, eluents, R<sub>f</sub> values, and factors affecting R<sub>f</sub> values.

Thin layer chromatography - principle, experimental procedure, advantages and applications.

### Unit-V: Separation techniques - 9 hours

Paper chromatography- Principle, experimental procedure, ascending, descending, radial and Two-dimensional applications.

Column chromatography - Principle, classification, experimental procedure and applications.

HPLC- Principle, Instrumentation – block diagram and applications.

### Referencebooks:

1. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition Pearson
2. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
3. Organic Spectroscopy by William Kemp, Third Edition, Palgrave USA
4. Spectroscopic Methods in Organic Chemistry by Ian Fleming and Dudley Williams, Seventh edition, Springer.
5. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
6. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Seventh edition, Wiley.
7. Quantitative analysis by R. A. Day Jr. and A. L. Underwood, Sixth edition, Pearson.
8. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

### Textbooks: :

- 1) Organic Spectroscopy by William Kemp, Third Edition, Palgrave USA.
- 2) Introduction to Spectroscopy by Pavia, Lampman, Kriz and Vyvyan, Fifth edition, Cengage.
- 3) Organic Spectroscopy: Principles and Applications by Jag Mohan, Second edition, Alpha Science.
- 4) Spectroscopy of Organic Compounds by P. S. Kalsi, Seventh edition, New Age International.
- 5) **Organic Spectroscopy** by Jag Mohan, Narosa Publishing House
- 6) **Organic Spectroscopy: Principles and Applications** by Y. R. Sharma, Krishna Prakashan Media (P) Ltd.
- 7) **Chromatography: Concepts and Contrasts** by James M. Miller, Wiley India Pvt. Ltd.
- 8) **Advanced Organic Chemistry** by B. S. Bahl and Arun Bahl, S. Chand Publishing

## WebLinks:

- 1) • [Introduction to NMR Spectroscopy](#)
- 2) • [NMR Spectroscopy Explained \(Prof. Dave\)](#)
- 3) • [Visualizing NMR Spectroscopy](#)
- 4) • [NMR Spectroscopy in Under 8 Minutes](#)
- 5) • [Mass Spectrometry Basics](#)
- 6) • [Mass Spectrometry Advanced Concepts](#)
- 7) • [Mass Spectrometry for Organic Compounds](#)
- 8) • [IR Spectroscopy Basics](#)
- 9) • [Functional Groups in IR Spectroscopy](#)
- 10) • [IR Spectroscopy Practice Problems](#)
- 11) • [Solvent Extraction Basics](#)
- 12) • [Separation of Acidic and Neutral Compounds](#)
- 13) • [Performing Thin Layer Chromatography \(TLC\)](#)
- 14) • [TLC Technique by Royal Society of Chemistry \(RSC\)](#)
- 15) • [High Performance Liquid Chromatography \(HPLC\) Basics](#)
- 16) • [HPLC Operation and Applications](#)

### Weightage to content Semester -V : Paper-ORCH XV A

S.No	Course Content	Long Answer	Short Answer	Total marks	As per Blooms Taxonomy
1	Nuclear Magnetic Resonance (NMR) spectroscopy	1	2	20	Understanding, Evaluating
2	Mass Spectrometry	1	1	15	Analyzing, Applying
3	Structural elucidation of organic compounds using IR, NMR & mass spectral data	1	1	15	Analyzing, Applying
4	Separation techniques-1	2	2	25	Remembering, Applying
5	Separation techniques-2	1	1	20	Evaluating, Creation
	<b>TOTAL</b>	<b>6</b>	<b>7</b>	<b>95</b>	

# P.R. GOVERNMENT COLLEGE(A),KAKINADA

III YEAR B.Sc. ORGANIC CHEMISTRY (Examination at the end of V semester)

ORCH-XV(A): Analysis of Organic Compounds MODEL PAPER

Duration: 2hrs.30Min

Max.Marks:50

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## Section -I

Answer any three of the following questions. Must attempt at least one question from each part. Each question carries 10 Marks.

3 X 10 = 30M

### Part - A

1. i) Explain the Principle of nuclear magnetic resonance Spectroscopy.  
ii) Identify and explain the NMR signals of the following compounds: acetaldehyde & toluene.
2. i) What is the significance of Isotopic abundance in Mass Spectrometry?  
ii) What are metastable ions? How can you describe their characteristics?
3. Write the IR, NMR, and Mass spectral analysis for 2,2,3,3-tetramethyl butane and methyl propionate.

### Part - B

4. Explain the Principle, experimental procedure and advantages of Thin-Layer Chromatography?
5. How would you elaborate ascending, descending, radial and two-dimensional paper chromatography. Suggest any of its applications.
6. Explain the Principle, experimental procedure of separation of acid and neutral compounds from their mixture.

## Section -II

Answer any four of the following questions. Each question carries 5 marks. 4 X 5 = 20M

7. Explain equivalent and non-equivalent protons with suitable examples.
8. Define Chemical shift and coupling constant
9. Elaborate on McLafferty rearrangement.
10. What is the IR & NMR spectral data analysis for Propionic acid.
11. Explain Batch extraction.
12. Define R<sub>f</sub> value, explain factors affecting R<sub>f</sub> value.
13. Explain the principle involved in HPLC chromatography.

## QUESTION BANK

### Unit I: Nuclear Magnetic Resonance (NMR) Spectroscopy

#### Essay Questions:

1. Explain the principles of Nuclear Magnetic Resonance (NMR) spectroscopy and discuss the significance of chemical shift.
2. Describe spin-spin coupling and explain how splitting patterns are formed in NMR spectra with suitable examples.
3. Discuss the applications of NMR spectroscopy with reference to ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene, and acetophenone.

#### Short Answer Questions:

1. Define chemical shift and mention the factors influencing it.
2. What are equivalent and non-equivalent protons? Give examples.
3. What is coupling constant? State its importance.
4. Draw the NMR splitting pattern of ethanol.

### Unit II: Mass Spectrometry

#### Essay Questions:

1. Explain the basic principles and instrumentation of mass spectrometry with a block diagram.
2. Discuss the types of ions formed in mass spectrometry and explain the significance of molecular and metastable ions.
3. Describe the fragmentation patterns of Toluene, 2-Butanol, Butyraldehyde, and Propionic acid.

#### Short Answer Questions:

1. What is the molecular ion peak in mass spectrometry?
2. Define metastable ions and their role in mass spectra.
3. What is electron ionization (EI) in mass spectrometry?
4. Write the basic fragmentation of 2-butanol.

### Unit III: Structural Elucidation using IR, NMR & MS Data

#### Essay Questions:

1. Explain the combined use of IR, NMR, and mass spectral data in the structural elucidation of organic compounds.
2. Elucidate the structure of acetophenone and cinnamic acid using IR, NMR, and mass spectra.
3. Discuss the interpretation of spectral data for Phenylacetylene, Propionic acid, and p-Nitroaniline.

#### Short Answer Questions:

1. What is the role of IR spectroscopy in identifying functional groups?
2. Mention any two compounds commonly studied in combined spectral analysis.
3. Define structural elucidation.

4. Write the molecular formula and functional group of Phenylacetylene.

#### Unit IV: Separation Techniques - I (Solvent Extraction, TLC)

##### Essay Questions:

1. Explain the principle and procedure of solvent extraction and its application in separating acid, base, and neutral organic compounds.
2. Describe the principle, experimental procedure, and advantages of Thin Layer Chromatography (TLC).
3. Explain the factors affecting  $R_f$  values in chromatography and the classification of adsorbents and eluents.

##### Short Answer Questions:

1. Define solvent extraction.
2. What is the significance of  $R_f$  value in chromatography?
3. Write any two advantages of Thin Layer Chromatography.
4. What are eluents? Give examples.

#### Unit V: Separation Techniques - II (Paper Chromatography, Column Chromatography, HPLC)

##### Essay Questions:

1. Explain the principle and applications of paper chromatography. Describe the ascending and descending techniques.
2. Discuss the principle, classification, and experimental procedure of column chromatography.
3. Describe the principle, instrumentation, and applications of High-Performance Liquid Chromatography (HPLC).

##### Short Answer Questions:

1. Define paper chromatography.
2. Mention any two types of paper chromatography techniques.
3. What is the mobile phase in column chromatography?
4. Write the full form of HPLC and its major application.

# LABORATORY COURSE

Practical Paper – ORCH XV :: Analysis of Organic Compounds

(at the end of semester V) 30hrs(2h/W)

50Marks

## Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1. **Understand the principle of solvent extraction** – Students will learn how differences in solubility and acid-base properties of organic compounds are exploited for their separation.
2. **Develop skill in practical separation techniques** – Students will acquire hands-on experience in using a separating funnel, handling immiscible solvents, and performing systematic extractions.
3. **Differentiate between acidic, basic, and neutral organic compounds** – Students will gain the ability to identify and separate organic compounds in a mixture based on their chemical nature.
4. **Apply acid-base reaction concepts in organic separations** – Learners will understand how protonation and deprotonation (e.g., formation of salts) help in selective extraction of acidic or basic components.
5. **Enhance analytical and problem-solving skills** – Students will learn to plan and execute a separation strategy, interpret the experimental outcome, and confirm the identity of separated compounds.
6. Perform the organic qualitative analysis for the detection of N, S and halogens using the green procedure.

## Practical (Laboratory) Syllabus:

- 1) Identification of various equipment in the laboratory.
- 2) Separation of organic compounds in a mixture (acidic compound + neutral compound) using solvent extraction.
- 3) Separation of organic compounds in a mixture (basic compound+ neutral compound) using solvent extraction.

## List of Reference books :

- 1) Vogel A.I. Practical Organic Chemistry, Longman Group Ltd.
- 2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 3) Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press. Mann F.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.
- 4) *Practical Organic Chemistry by* O.P. Agarwal , Krishna Prakashan Media (P) Ltd.

## WebLinks:

- 1) [Green Acetanilide Synthesis \(Acetylation of Amine\)](#)
- 2) [Acetylation using Acetic Anhydride](#)
- 3) [Benzilic Acid Rearrangement Process](#)
- 4) [Mechanism and Example: Benzil to Benzilic Acid](#)
- 5) [Benzilic Acid Rearrangement Explanation](#)
- 6) [Solvent Extraction Principle and Process](#)
- 7) [Liquid-Liquid Extraction Procedure](#)

### SCHEME OF VALUATION

Practical Paper –ORCH-XIII A :: Analysis of Organic Compounds (at the end of semester V)

Component	Marks
Principle / Theory	5
Chemicals & Apparatus	5
Procedure	10
Experimental Skill	10
Observation / Yield / Purity	10
Result / Report	5
Practical Record Submission	5
Viva-Voce	5
<b>Total</b>	<b>50</b>