	P.R. GOVERNMENT COLLEGE(A),KAKINADA	**Program & Semester** III B.Sc **ANALYTICAL CHEMISTRY** (SEMESTER – V)			
Course Code AC-12	TITLE OF THE COURSE **COURSE -12: ENVIRONMENTAL CHEMISTRY**				
Teaching	Hours Allocated: 45 (**Theory**) (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

CLO-PLO Mapping:

(1: Slight [Low]; 2: Moderate [Medium]; 3: Substantial [High], '-': No Correlation)

	CLO\PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	CLO\PLO	PLO1
CLO1	3	2	3	2	2	2	3	3	2	2	3	3	3
CLO2	2	3	3	3	3	2	1	2	2	3	2	2	3
CLO3	3	3	3	2	2	1	1	2	3	1	2	3	3
CLO4	2	1	2	1	3	2	3	1	2	3	2	3	2
CLO5	2.5	2.25	2.75	2.0	2.5	1.75	2.0	2.0	2.25	2.25	2.25	2.75	2.75

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 modem 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) KAKINADA

III B.Sc ANALYTICAL CHEMISTRY SEMESTER–V

COURSE-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 carrys 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

III B.Sc ANALYTICAL CHEMISTRY SEMESTER –V
COURSE-12: ENVIRONMENTAL CHEMISTRY
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.

	PITHAPUR RAJAH'S GOVERNMENT COLLEGE(A) KAKINADA	Program & Semester III B.Sc. ANALYTICAL CHEMISTRY (SEMESTER – V)			
Course Code **AC-12**	**TITLE OF THE COURSE** **COURSE -12: ENVIRONMENTAL CHEMISTRY**				
Teaching	Hours Allocated: 30 (**Practical**)	L	T	P	C
Pre-requisites	Preparation of standard solutions and handling of laboratory apparatus and instruments	-	-	2	1

Course Objectives:

- To demonstrate basic knowledge about the handling of laboratory apparatus
- To illustrate knowledge about the preparation of standard solutions
- To provide hands-on training for the determination of different organic compounds

Course Outcomes:

On Completion of the course, the students will be able to	
CO1	Learn to Handle and calibrate the common laboratory glass apparatus and instruments
CO2	Get practical skill to the preparation of different standard solutions used for quantitative analysis
CO3	Identify and confirm the structure of a given organic compounds
CO4	Principles and applications of different molecular spectra

Course with focus on employability / entrepreneurship / Skill Development modules

Skill Development		Employability		Entrepreneurship	-

LABORATORY COURSE

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

30 hrs (2 h / W) 50M

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)

	CLO\PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	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

SCEME 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

	Pithapur Rajah's Govt College(A) Kakinada	Program& Semester			
Course Code AC-13	TITLE OF THE COURSE **COURSE-13-CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES**	III B.Sc ANALYTICAL CHEMISTRY (V Semester)			
Teaching	HoursAllocated:60 (**Theory**)	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. High performance liquid chromatography
2. Atomic absorption spectroscopy
3. Atomic emission spectroscopy (Flame photometry)
4. Characteristics of quality control

Decomposition Learning Objectives:

1. Understand the importance of analytical chemistry
2. Engage in AAS and AES spectroscopic techniques.
3. Demonstrate skills using the alternative solvents in synthesis.
4. Analyze alternative analysis of analytical techniques.
5. Carry out the dissolution's techniques ..

CourseOutcomes:

On Completion of the course, the students will be able to	
CO1	Student will acquire knowledge on basic concepts in different types of Analytical techniques
CO2	Student will get the knowledge in understanding the fundamental concepts involved in HPLC and gets acquainted with new kind of analytical skills.
CO3	Student shall have opportunity to understand the importance of analytical chemistry in which is a key analysis in recent research trends.
CO4	Students shall Comprehend the applications of different novel techniques in AAS and AES in analytical chemistry

Course with focus on Skill Development/Employability/Entrepreneurship modules

Skill Development		Employability		Entrepreneurship	

Syllabus:

UNIT-1

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY: 9hrs

Introduction, Theory, Instrument description of the different parts of equipment's, Selection of Mobile phase, different types of columns, detectors-UV Detector, Fluorescence Detectors, Applications in the separation of organic compounds.

UNIT-II

ATOMIC ABSORPTION SPECTROSCOPY: AAS 9hrs

Principle - Instrumentation - Radiation sources (line sources) - Hollow cathode lamps and

Discharge lamps. Interferences - Analytical techniques for AAS - Calibration plots.

Applications - Determinations of Calcium and Magnesium in tap water

UNIT-III

ATOMIC EMISSION SPECTROSCOPY (Flame photometry): 9hrs

Principle - Instrumentation - Interferences - Analytical techniques for Flame photometry

Calibration plots (Working curves). Applications - Determination of Alkali and Alkaline earth

metals in natural water

UNIT-IV

CHARACTERISTICS OF QUALITY CONTROL: 9hrs

Qulity of an Analytical procedure, Limit of Detection, Sensitivity, Safety, Cost measurability, Selectivity, and Specficity, Quality control principles of ruggedness test, Control charts, Youden plot,

And Ranking test, ICH guidelines on drug substances and Products.

UNIT-V

DECOMPOSITION: 9hrs

Principles of decomposition and dissolution, Difference between dissolution a decomposition of organic and inorganic substances, importances of decomposition techniques in analysis. Principle of dissolution of an inorganic substance.

Decomposition of samples with acids-H_2O, HCl, HF, HNO_3, $H2SO_4$.

List of Reference books:

1. "Principles of Analytical Chemistry: A Textbook" by Miguel Valcarcel
2. "Analytical Chemistry: Principles" by Kennedy J H
3. Practical Manual for Agricultural Chemistry" by Gupta A K and Varshney M

WebLinks:

1. https://youtu.be/MPqCzsntjAE https://youtu.be/pCafvltuo0M
2. https://youtu.be/KHpRNb_38OM?list=PLj_Alq7xw30lA27RYdlOdrIa66CBWrOWZ

CO-PO Mapping:

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

	PO1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO1 0	PSO1	PSO2	PSO 3
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 Analytical 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 analytical 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 analyticachemistry.

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
Analytical Chemistry
Course code- AC-13

S.No	Course Content	Long Answer	Short Answer	Total marks	As per Blooms Taxonomy
1	High performance liquid chromatography	2	1	25	Understanding , Application
2	Atomic absorption spectroscopy	1	2	20	Remembering, Understanding
3	Atomic emission spectroscopy (Flame photometry)	1	1	15	Analyzing & Creation
4	Characteristics of quality control	1	1	15	Evaluation, Understanding
5	Decomposition	1	2	20	Application & Creation
	TOTAL	**6**	**7**	**95**	

P.R. GOVERNMENT COLLEGE (A), KAKINADA

III B.Sc. Analytical Chemistry

(Examination at the end of V semester)

(COURSE – 13 CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES)

MODEL PAPER

Duration: 2hr **Max. Marks: 50M**

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- 1

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-2
10. UNIT-3
11. UNIT-4
12. UNIT-5
13. UNIT-5

SEMESTET-V

LABORATORY COURSE

COURSE -13: CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES

(at the end of semester V)

30hrs (2h/W) 50Marks

Laboratory course Syllabus:

1. **Separation of amino acids by thin layer chromatography (glycine, alanine)**
2. **Separation of green leaf pigments by thin layer chromatography and determine R_f value.**
3. **Separation of methylene blue , methyl orange by thin layer chromatography**
4. **Separate a mixture of methyl orange and methylene blue by the chromatographic separation method using column chromatography**
5. **Separate a mixture of ortho nitroaniline and para nitroaniline by the chromatographic separation method using column chromatography**

List of Reference books:

1. Practical Manual for Agricultural Chemistry" by Gupta A K and Varshney M
2. Web related references suggested by teacher

SCHEME OF VALUTION

Practical Paper -13 :: CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES

Chromatographic Experiment :

Procedure -10M
Principle -5M
Mobile Phase and Stationary Phase composition -5M
Detection of Spots -5M
R_f values Calculation – 2X5=10M
Error -5M
Viva-voce -5M
Record-5M

III B.Sc. Analytical Chemistry
(Examination at the end of V semester)
(COURSE : AC 13- CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES)

QUESTION BANK

Unit-I

ESSAY QUESTIONS:
1.What is HPLC. Explain the Instrumentation of HPLC?
2. What is the principle of HPLC. Explain Applications of HPLC?
3.Explain the different types of columns used in HPLC?

SHORT QUESTIONS:
1.Write about the selection of mobile phase in HPLC
2.Write about any two detectors in HPLC

Unit-II

ESSAY QUESTIONS:
1 what is Atomic Absorption Spectroscopy. Write about principle and Applications of AAS?
2.Explain the Instrumentation of Atomic Absorption Spectroscopy?

SHORT QUESTIONS:
1.Write a note on Hollow cathode lamps?
2.Write about calibration plots of AAS?

Unit-III

ESSAY QUESTIONS:
1.what is Atomic Emission Spectroscopy. Write about principle and Applications of AES?
2. Explain the Instrumentation of Atomic Emission Spectroscopy?

SHORT QUESTIONS:
1.Write about Interferences of AES?
2.Write about calibration plots of AES?

Unit-IV

ESSAY QUESTIONS:
1.Discuss about ICH guidelines on Drug substances and Products?
2. Explain the following terms
a) Limit of Detection b) Youden Plot

SHORT QUESTIONS:
1.Write about control charts
2.Discuss about Ranking Test?
3.Define the terms Sensitivity, Selectivity.

III B.Sc. Analytical Chemistry
(Examination at the end of V semester)
(COURSE : 13- CHROMATOGRAPHY AND ANALYTICAL TECHNIQUES)

QUESTION BANK

Unit-V

ESSAY QUESTIONS:

1.Explain the decomposition of samples with HCl, $H2SO_4$

2.Explain the decomposition of samples H_2O, HNO_3

SHORT QUESTIONS:

1.Write the differences between decomposition and dissolution.

2.Write the Importances of decomposition techniques in analysis

3 Write the principle of dissolution of an inorganic substance.

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	Pithapur Rajah's Govt College(A) Kakinada	Program & Semester			
Course Code AC-14	**Course-14 -Instrumental methods of Analysis 2023-24 AB**	III B.Sc Analytical Chemistry Hons (V Semester)			
Teaching	Hours Allocated: 45 (**Theory**)	L	T	P	C
Pre-requisites	Gravimetric analysis, Mass spectroscopy, Refraction	45	0	30	3+1

Course Objectives:

1. Thermogravimetric Analysis (TGA)
2. Differential Thermal Analysis (DTA)
3. Mass spectroscopy
4. Refractometry
5. Structural elucidation of organic compounds

Course Outcomes:

On Completion of the course, the students will be able to	
CO1	Understand the concept of Thermogravimetric analysis
CO2	Understand the concept of Differential Thermal analysis
CO3	Able to get knowledge on mass spectrometry
CO4	Apply the concepts of spectroscopy to elucidate the structure of organic compound

Course with focus on employability / entrepreneurship / Skill Development modules

Skill Development		Employability		Entrepreneurship	

UNIT-I : THERMOGRAVIMETRIC ANALYSIS (TGA) (9 h)

Introduction to Thermogravimetric Analysis (TGA), Types of Thermogravimetric Analysis - Principle - Instrumentation - Factors effecting TGA results - Application of TGA to $CaC_2O_4.H_2O$

UNIT- II : Differential Thermal Analysis (DTA) (9 h)

Introduction to Differential Thermal Analysis (DTA) - Principle - Instrumentation - Factors effecting TGA results - Application of DTA to $(CH_3COO)_2$ $Ca.H_2O$

UNIT-III : REFRACTOMETRY **9h**

Introduction – Refractive index - Specific and molecular refractivity – Instrumentation (Refractometers) – optical exaltation - calculation of molar refraction for Benzene, 1,2 di bromo ethene.

Unit-4 : MASS SPECTROMETRY **(9 h)**

A brief introduction to analysis of organic compounds

Basic principle, Instrumentation - Mass spectrometer, electron Ionization (Electron Impactionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butnaldehyde, Propionicacid.

Unit-5: Structural elucidation of organic Compounds using IR,NMR & mass spectral data- 9h

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

Reference & Text books:

1.

Weightage to content

S.No	Course Content	Long Answer	Short Answer	Total marks
1	Thermogravimetric Analysis (TGA)	1	2	20
2	Differential Thermal Analysis (DTA)	1	1	15
3	Refractometry	1	2	20
4	Mass spectroscopy	2	1	25
5	Structural elucidation of organic compounds	1	1	15
	TOTAL	**6**	**7**	**95**

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

III YEAR B.Sc Chemistry Hons (2024-25AB)

(Examination at the end of V semester)

Course-14 :: Instrumental methods of Analysis

MODEL PAPER

Duration: 2hrs **Max. Marks: 50**

PART- A

Answer any **THREE** of the following questions by choosing at least **ONE** from each section. Each carries **TEN** marks 3 X 10 = 30 M

SECTION -A

1. Unit - I
2. Unit - II
3. Unit – IV

SECTION -B

4. Unit - III
5. Unit - IV
6. Unit – V

PART- B

Answer any **FOUR** questions. Each carries FIVE marks 4 X 5 = 20 Marks

7. Unit – I
8. Unit – I
9. Unit – II
10. Unit – III
11. Unit – III
12. Unit – IV
13. Unit – V

Course outcome & Program outcome mapping

On Completion of the course, the students will be able to	
CO1	Understand the concept of Thermogravimetric analysis
CO2	Understand the concept of Differential Thermal analysis
CO3	Able to get knowledge on mass spectrometry
CO4	Apply the concepts of spectroscopy to elucidate the structure of organic compound

CO-PO Mapping:

CO	PO1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PSO1	PSO2	PSO 3
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 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 modem 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.

PITHAPUR RAJAH'S GOVERNMENT COLLEGE (A) :: KAKINADA
III YEAR B.Sc Chemistry Hons (2024-25 AB)
(Examination at the end of V semester)
Practical Paper 14 :: Instrumental methods of Analysis

Credits: 01 30 hrs (2 h / W) **50Marks**

Organic preparations

Course outcomes:

On the completion of the course, the student will be able to do the following:

1. Able to learn how to operate colorimeter
2. Able to analyze the mass spectra of organic compunds.

Syllabus - Organic preparations (50M)

i. Determination of concentration of $KMnO_4$ solution by colorimetrically.

ii. Determination of concentration of $K_2Cr_2O_7$ solution by colorimetrically.

iii. Analysis of mass spectral data of the given organic compound

iv. Co-curricular activities and Assessment Methods;

1. Continuous Evaluation: Monitoring the progress of student's learning

2. Class Tests, Worksheets and Quizzes

3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality

4. SEMESTER -End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the SEMESTER .

SCHEME OF VALUATION

S.No	Description	Marks
1	Experiment	30
2	Mass spectral analysis	10
3	Viva voce	05
4	Record	05

PITHAPUR RAJAH'S GOVERNMENT COLLEGE(A) KAKINADA

Course Code AC-15	TITLE OF THE COURSE COURSE-15 PHYSICAL CHEMISTRY-III	Program & Semester III B.Sc Analytical Chemistry (V Semester)			
Teaching	**Hours Allocated:45 (Theory)**	**L**	**T**	**P**	**Cr**
Pre-requisites	• Basic knowledge of algebra and logarithms • Understanding of SI units and conversions • Familiarity with physical quantities (energy, pressure, temperature, volume) • Basic concepts of atoms, molecules, and bonding • Ability to plot and interpret graphs • Basic understanding of chemical equations and stoichiometry	**45**	**10**	**30**	**3+2**

Course Objectives:

1. Understand the rate of chemical reactions and how it is influenced by various factors such as concentration, temperature, and catalysts.
2. Derive and apply rate laws for zero, first, and second-order reactions.
3. Understand the fundamental principles of photochemistry, including the interaction of electromagnetic radiation with matter.
4. Explain electronic excitation, singlet and triplet states, and Jablonski diagram.
5. Apply concepts such as quantum yield, energy transfer, and photophysical/photochemical processes.
6. Understand the basic concepts of thermodynamics, including system, surroundings, and types of thermodynamic processes.
7. Explain and apply the First Law of Thermodynamics and the concept of internal energy and enthalpy.
8. Distinguish between state functions and path functions.

Course Outcomes:

	On Completion of the course, the students will be able to
CO1	Apply the principles of chemical kinetics to determine reaction order, rate constants, and activation energy using experimental data and mathematical models.
CO2	Interpret and evaluate experimental data related to photochemical reactions, kinetic studies, and thermodynamic measurements using appropriate graphical and analytical methods.
CO3	Explain the fundamental concepts of photochemistry, including electronic transitions, singlet and triplet states, and photochemical laws.
CO4	Analyze thermodynamic processes by applying the First Law of Thermodynamics, and calculate changes in internal energy, enthalpy, work, and heat for physical and chemical systems.

Programme Outcomes (PO):

PO-1 Foundational Knowledge: Graduates will demonstrate a comprehensive understanding of the fundamental principles and theories of analytical chemistry.

PO-2 Laboratory Skills: Graduates will possess practical laboratory skills, including proficiency in using a wide range of analytical instruments and techniques.

PO-3 Data Analysis and Interpretation: Graduates will be able to collect, analyze, and interpret experimental data using statistical methods and computational tools.

PO-4 Quality Assurance: Graduates will understand and apply quality assurance principles to ensure the accuracy and reliability of analytical results.

PO-5 Problem-Solving Abilities: Graduates will develop critical thinking and problem-solving skills to address challenges encountered in analytical chemistry research and practice.

PO-6 Communication Skills: Graduates will effectively communicate scientific concepts and research findings through written reports, oral presentations, and visual aids.

PO-7 Ethical Conduct: Graduates will adhere to ethical principles and professional standards in conducting research and interacting with colleagues and stakeholders. PO1 PO2 PO3 PO4 PO5 PO6 PO-8 Continuous Learning: Graduates will recognize the importance of lifelong learning and professional development to stay updated with advancements in the field of analytical chemistry.

PO-9 Interdisciplinary Collaboration: Graduates will collaborate effectively with professionals from other disciplines to address complex scientific problems requiring multidisciplinary approaches.

PO-10: Career Readiness: Graduates will be prepared for various career pathways in analytical chemistry, including roles in academia, industry, government, and research institutions.

Programme-Specific Outcomes (PSO):

PSO-1 Instrumentation Proficiency: Graduates will demonstrate advanced proficiency in operating and troubleshooting analytical instruments specific to analytical chemistry, such as spectrophotometers, chromatographs, and mass spectrometers.

PSO-2 Method Development and Optimization: Graduates will have the ability to develop and optimize analytical methods tailored to specific sample matrices and analytical targets.

PSO-3 Specialization in Separation Techniques: Graduates will specialize in separation techniques, including chromatography and electrophoresis, for the analysis of complex mixtures and compounds.

PSO-4 Applications in Industry and Research: Graduates will apply analytical chemistry principles and techniques to address industry-specific challenges in fields such as pharmaceuticals, environmental science, food and beverages, and materials science.

CO-PO Mapping

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

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	2	1	2	1	3	3	2	1	2
CO2	3	3	3	2	3	2	1	2	1	3	3	3	2	3
CO3	3	2	2	1	2	2	1	2	1	2	2	1	1	2
CO4	3	2	3	2	3	2	1	2	1	3	3	2	1	3
Average	**3.0**	**2.5**	**2.75**	**1.75**	**2.75**	**2.0**	**1.0**	**2.0**	**1.0**	**2.75**	**2.75**	**2.0**	**1.25**	**2.5**

Coursewithfocusonemployability/entrepreneurship/Skill Development modules

Skill Development		**Employability**		**Entrepreneurship**	

SYLLABUS

UNIT-I :Chemical Kinetics-I: 9H

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions (similar and different reactants). Half–life of a reaction. General methods for determination of order of a reaction.

UNIT-II :Chemical Kinetics-II : 9H

Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Enzyme catalysis- Specificity, factors affecting enzyme catalysis, Inhibitors and Lock & key model. Michaels- Menten equation- derivation, significance of Michaelis-Menten constant.

UNIT-III:PHOTO CHEMISTRY: 9 H

Difference between thermal and photochemical processes. Laws of photochemistry- Grothus-Draper's law and Stark-Einstein's law of photochemical equivalence. Quantum yield- Photochemical reaction mechanism- hydrogen- chlorine, hydrogen- bromine reaction. Qualitative description of fluorescence, phosphorescence, and Photosensitized reactions- energy transfer processes (simple example) – Jablonski diagram

UNIT- IV :Thermodynamics:-I 9H

The first law of thermodynamics-statement, definition of internal energy and enthalpy. Heat

capacities and their relationship. Joule-Thomson effect- coefficient. Calculation of w, for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes. State function. Temperature dependence of enthalpy of formation-Kirchhoff's equation.

UNIT- V :Thermodynamics:-II 9H

Second law of thermodynamics. Different Statements of the law. Carnot cycle and its efficiency. Carnot theorem. Concept of entropy, entropy as a state function, entropy changes in reversible and irreversible processes. Entropy changes in spontaneous and equilibrium process

III. Text books

1. **Principles of Physical Chemistry** by Puri, Sharma, and Pathania,Vishal Publishing Co.
2. **Physical Chemistry** by P.L. Soni, O.P. Dharmarha, and U.N. Dash, Sultan Chand & Sons
3. **Physical Chemistry** by A.S. Negi and S.C. Anand, International Publishers
4. **Physical Chemistry** by Bahl and Tuli, S. Chand & Company Pvt. Ltd.
5. **Physical Chemistry** by Gurdeep Raj, Goel Publishing House
6. Advanced Physical Chemistry by Atkins
7. A Textbook of Physical Chemistry by Puri and Sharma

IV. Reference books

1. **Thermodynamics for Chemists** by S. Glasstone, Affiliated East-West Press Pvt. Ltd.
2. **Chemical Kinetics** by K.K. Rohatgi-Mukherjee,New Age International Publishers
3. **Physical Chemistry through Problems** by S. Dogra and S. Dogra, New Age International Publishers
4. **Selected Topics in Physical Chemistry** by Malik, Tuli, and Madan, S. Chand & Company Pvt. Ltd.
5. **Physical Chemistry** by R. L. MadanS. Chand & Company Pvt. Ltd.
   A well-organized book with simple language, suitable for quick revision and concept clarity.

V. Web Links

1. **Chemical Kinetics – Effects of Temperature & Catalysts**
2. **Enzyme Kinetics – Michaelis–Menten Equation**
3. **Photochemistry – Stark–Einstein's Law**
4. **Thermodynamics – Joule–Thomson Effect**
5. **Thermodynamics – Carnot Cycle & Entropy**

6. Jablonski Diagram & Photophysical Processes
7. Arrhenius Equation – Activation Energy & Rate Constant
8. Difference Between Collision Theory & Transition State Theory
9. Photochemistry: Introduction & Jablonski Diagram
10. Collision Theory – Arrhenius Equation & Activation Energy

Weightage to content
Semester -V
Course-15

S.No	UNIT NAME	Long Answer	Short Answer	Total Marks	As per Bloom's Taxonomy
1	Chemical Kinetics - I	1	2	20	Understanding, Applying
2	Chemical Kinetics - II	1	1	15	Analysing, Applying
3	Photochemistry	1	1	15	Analysing, Applying
4	Thermodynamics - I	2	2	25	Remembering, Applying
5	Thermodynamics - II	1	1	20	Evaluating, Applying
	TOTAL	6	7	95	

P.R. GOVERNMENT COLLEGE (A), KAKINADA

III YEAR B.Sc. ANALYTICAL CHEMISTRY

(Examination at the end of V Semester)

COURSE -15 : PHYSICAL CHEMISTRY - III

MODEL PAPER

Duration: 2 hrs. 30 min **Max. Marks: 50**

Section - I

Answer any three of the following questions.Each question carries 10 Marks. 3 × 10 = 30 Marks

(Must attempt at least one question from each Part)

Part – A: Chemical Kinetics and Photochemistry

1) **i)Derive the integrated rate equation for a first-order reaction.**
   ii) Discuss the factors affecting the rate of a chemical reaction.

2) **Derive i) The Arrhenius equation and explain the effect of temperature on reaction rate.**
   ii) Compare Collision Theory and Activated Complex Theory of bimolecular reactions.

3) **Explain the laws of photochemistry:**
   i) Grothus-Draper's Law
   ii) Stark-Einstein Law of Photochemical Equivalence
   Also, write the mechanism of the hydrogen-chlorine photochemical reaction.

Part – B: Thermodynamics

4. **State and explain the First Law of Thermodynamics.**
   ii) Derive the expression for work done in an isothermal reversible expansion of an ideal gas.

5. **State and explain Carnot's theorem and derive the expression for efficiency of a Carnot engine.**
   ii) Discuss entropy changes in reversible and irreversible processes.

6. **Explain the Joule-Thomson effect. Discuss the significance of the Joule-Thomson coefficient and its applications.**

Section - II

Answer any four of the following questions.Each question carries 5 Marks. 4 × 5 = 20 Marks

7. **Explain the concept of half-life of a reaction. Derive the half-life formula for a first-order reaction.**
8. **What are enzyme catalysts? Explain the Lock and Key Model.**
9. **Write a brief note on Michaelis-Menten equation and its significance.**
10. **Explain fluorescence and phosphorescence with suitable examples.**
11. **Write the Carnot cycle steps and its efficiency formula.**
12. **Define entropy. Explain its significance in spontaneous and equilibrium processes.**
13. **What is Kirchhoff's equation? Explain its importance in thermodynamics.**

COURSE-15 : PHYSICAL CHEMISTRY-III
QUESTION BANK

UNIT - I: Chemical Kinetics - I

Essay Questions:

1. Explain the derivation of the integrated rate equation for a second-order reaction involving different reactants.
2. Discuss the factors affecting the rate of a chemical reaction.
3. Explain the methods used to determine the order of a reaction.

Short Answer Questions:

1. Define reaction rate.
2. What is molecularity of a reaction?
3. Write the integrated rate equation for a first-order reaction.
4. What is the significance of half-life in chemical kinetics?
5. Differentiate between order and molecularity of a reaction.

UNIT - II: Chemical Kinetics - II

Essay Questions:

1. Derive the Michaelis-Menten equation and explain the significance of the Michaelis constant.
2. Compare Collision Theory and Activated Complex Theory of reaction rates.
3. Discuss enzyme catalysis and the factors affecting enzyme activity.

Short Answer Questions:

1. Define activation energy.
2. Write the Arrhenius equation and explain each term.
3. What is the Lock and Key model of enzyme catalysis?
4. Write two differences between Collision Theory and Activated Complex Theory.
5. What is an enzyme inhibitor?

UNIT - III: Photochemistry

Essay Questions:

1. Explain Grothus-Draper's law and Stark-Einstein’s law of photochemical equivalence.
2. Describe the photochemical reaction mechanism of hydrogen-chlorine reaction.
3. Discuss fluorescence, phosphorescence, and photosensitized reactions with suitable examples.

Short Answer Questions:

1. What is quantum yield?
2. Differentiate between thermal and photochemical processes.
3. What is the Jablonski diagram?

4. Give an example of a photosensitized reaction.
5. Name one photochemical reaction of hydrogen and halogens.

UNIT - IV: Thermodynamics - I

Essay Questions:

1. State and explain the First Law of Thermodynamics.
2. Derive the expression for work done in an isothermal reversible expansion of an ideal gas.
3. Explain the Joule-Thomson effect and its significance.

Short Answer Questions:

1. Define internal energy.
2. What is enthalpy?
3. Write the relation between Cp and Cv.
4. What is the Joule-Thomson coefficient?
5. What is Kirchhoff's equation?

UNIT - V: Thermodynamics - II

Essay Questions:

1. State and explain the Second Law of Thermodynamics using Carnot's cycle.
2. Define entropy. Explain entropy changes in reversible and irreversible processes.
3. Explain Carnot's theorem and derive the expression for efficiency of Carnot engine.

Short Answer Questions:

1. Write any two statements of the Second Law of Thermodynamics.
2. What is a spontaneous process?
3. Define entropy as a state function.
4. Write the formula for efficiency of Carnot engine.
5. What is the condition for equilibrium in terms of entropy?

ANCH-XV: PHYSICAL CHEMISTRY-III

LABORATORY COURSE SYLLABUS

1. Determination Of Order Of The Hydrolysis Of Methyl/Ethyl Acetate Catalysed By Hydrogen Ion (Acid) At Room Temperature

2. Determination Of Rate Of Decomposition Of Hydrogen Peroxide

3. Determination Of Overall Order Of Saponification Of Ethyl Acetate

4. Determination Of Distribution Coefficient Of Iodine Between Water And Carbon Tetrachloride

5. Determination Of Molecular Status And Partition Coefficient Of Benzoic Acid In Toluene And Water.

Web Links

- Hydrolysis of Methyl Acetate – Kinetics Experiment (YouTube)
- Acid-Catalyzed Hydrolysis of Esters – Mechanism (Chemistry Steps)
- Hydrogen Peroxide Decomposition – Kinetics Experiment (YouTube)
- Order of Reaction for H_2O_2 Decomposition (ChemGuide)
- Saponification of Ethyl Acetate – Lab Experiment (YouTube)
- Saponification Reaction Kinetics – Procedure (Labmonk)
- Distribution Coefficient – Iodine Experiment (YouTube)
- Distribution Coefficient of Iodine – Full Procedure (Labmonk)
- Partition Coefficient of Benzoic Acid – Experiment (YouTube)
- Partition Coefficient – Practical Procedure (Labmonk)

SCHEME OF VALUATION

COURSE-15 : PHYSICAL CHEMISTRY-III PRACTICALS

Component	Maximum Marks	Detailed Marking Guide
Procedure/Principle	10 Marks	Clear explanation of principle and step-wise procedure.
Experiment/Performance	15 Marks	Proper handling of apparatus, accurate procedure, following safety measures.
Observations & Calculations	10 Marks	Correct observations, accurate calculations, proper units, logical sequence.
Result & Accuracy	5 Marks	Final result with correct units, accuracy close to expected values.
Record Submission	5 Marks	Neat, complete, on-time record with principles, procedures, tables, results.
Viva-Voce	5 Marks	Ability to answer basic concepts, definitions, formulas, and purpose clearly.
Total	**50 Marks**	