Course Code: CHE1002	**Course Title:** Industrial Chemistry **Type of Course:** Program Core- Theory and Lab	**L- P- C**	2	1	3
Version No.	2.0				
Course Pre-requisites	NIL				
Anti-requisites	**NIL**				
Course Description	The primary objective of the course is to introduce the concepts and applications of chemistry in Engineering. The course also aims to enhance the knowledge of chemical composition and properties of chemical molecules as alternate fuels. It will also cultivate an ability to identify chemistry in each piece of smart engineered products used in households and industry. It targets to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications. The associated laboratory provides an opportunity to lay foundation for practical application of chemistry in engineering aspects				
Course Objective	The objective of the course is to **familiarize the learners with the concepts of "Industrial Chemistry" and attain EMPLOYABILITY SKILL through EXPERIENTIAL LEARNING techniques**.				
Course Outcomes	On successful completion of this course the students shall be able to: 1) identify the suitable polymers to replace the conventional materials 2) Discuss the importance of different inorganic materials in various engineering fields 3) describe the processes involved in the oil refineries 4) apply the knowledge of electrochemistry principles for protection of different metals from corrosion.				
Course Content:					
Module 1	**Polymers and Lubricants**	Case study	Data Collection and analysis	**7 Classes**	
Polymers: Introduction, Types of Polymerization, Zeigler Natta Polymerization, Thermoplastics & thermosetting polymers. Preparation, properties, and applications of the Teflon, PVC, Nylon and Phenol formaldehyde; Elastomers: Natural rubber, Vulcanization of rubber, Synthetic rubber and Inorganic rubbers, Polymer composites **Lubricants:** Types of Lubricants, Functions of lubricant, Mechanism of lubrication, Fluid or Hydrodynamic Lubrication, Thin film or Boundary lubrication & Extreme pressure lubrication. Lubricants for Extreme ambient conditions and for special applications. Properties of lubricants and tests.					
Module 2	Inorganic Engineering Materials	Assignment	Data Collection	6 Classes	

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Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Refractories: Definition, Classification with Examples; Criteria of a Good Refractory Material; Causes for the failure of a Refractory Material.

Module 3	**Fuels and Combustion**	Case study and Assignment	Data analysis	**07 Classes**

Topics: Fuels and Combustion

Fuels –Basics of hydrocarbon chemistry; Classification, Calorific value determination, **Solid fuels**: Proximate and Ultimate analysis of Coal; **Liquid Fuels**: Petroleum: Cracking, reforming, Knocking, Synthetic petrol, Power alcohol; **Gaseous Fuels**: Natural gas, CNG, LPG. Alternate fuels: Bio-diesel

Combustion: flue gas analysis; Rocket propellants and Explosives – classification, storage and handling

Module 4	**Corrosion and its control**	Case study	Data analysis	**05 Classes**

Dry and Wet Corrosion – detrimental effects to buildings, machines, devices and decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress Corrosion cracking. Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Corrosion Control – Cathodic protection- Sacrificial anodic protection, Advanced protective coatings : electro plating, electroless plating, PVD and CVD

List of laboratory tasks

1. Determination of total acid number of an oil (Comprehensive)
2. Determination of pKa of a weak acid using pH meter (Knowledge)
3. Potentiometric estimation of iron in the given rust solution using standard $K_2Cr_2O_7$ solution. (Comprehensive)
4. Determination of calorific value of a solid fuel using Bomb calorimeter (Comprehensive)
5. Synthesis of polyaniline and its conductivity measurement (Comprehensive)
6. Estimation of copper from industrial effluents by colorimetric method and smart phone digital imaging method (material analysis) (Knowledge)
7. Determination of Viscosity of different natural /synthetic polymers Using Ostwald Viscometer (Knowledge)
8. Determination of Critical Micelle Concentration (Comprehensive)
9. Electroplating technique (Knowledge)
10. Estimation of water hardness by EDTA method and its removal (by zeolite/ ion exchange method) (Comprehensive)
11. Estimation of water quality monitoring using conductivity method(Comprehensive)

Preparation of a working model relevant to syllabus and its demonstration

1. Preparation of gas sensing polymeric material for sensing (student can fabricate a chemical sensor and demonstrate) (Application)
2. Student can select any mitigation method (preferably coating methods) to control corrosion (Application)

Targeted Application & Tools that can be used:

Application areas are Polymer, oil and gas, Boiler, automotive and mechanical industries

Tools: Statistical analysis of Corrosion in materials using tools like Design expert software (ANOVA, RSM, etc.)

Project work/Assignment:

Assessment Type

- **Midterm exam**
- **Lab experiments conduction**
- **Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)**
- **Quiz**

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- **End Term Exam**
- **Self-Learning**

Assignment: 1 Report writing on recycling plastic waste into plastic lumber

Assignment 2: Identify a corrosion problem encountered in your immediate surroundings and discuss your choice of mitigation

Text Book

1. Engineering Chemistry, Shika Agrawal (2018), Cambridge University Press

Reference Books

1. Engineering Chemistry, Jain and Jain (18th Edition) Dhanpat Rai Publishing Company

E resources

2. https://www.mdpi.com/books/pdfview/book/1069
3. https://www.mdpi.com/books/pdfview/book/333
4. https://www.bloomsburycollections.com/book/fuel-an-ecocritical-history/
5. https://eng.oversea.cnki.net/kns55

Topics related to Skill development

1. Lubricants for Extreme ambient conditions and for special applications
2. Applications of Engineering Materials
3. Dry and Wet Corrosion – detrimental effects to buildings, machines, devices and decorative art forms

Topics related to Energy and Sustainability

1. Applications of Thermoplastics & thermosetting polymers
2. Polymer composites
3. Petroleum: Cracking, reforming, Knocking, Synthetic petrol, Power alcohol
4. Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Topics relevant to Employability Skill Development:

Corrosion control and lab experiments for Developing Employability Skills through Experiential Learning Techniques. This is attained through assessment components mentioned in course handout

Topics relevant to Environment and Sustainability: All topics in theory and lab component are relevant to Environment and Sustainability.

Lab Skill sets

1. An attitude of enquiry.
2. Ability to interpret events and results.
3. Ability to work as a leader and as a member of a team.
4. Observe and measure physical phenomena.
5. Write reports.
6. Select suitable equipment, instrument and materials.
7. The ability to follow standard test procedures.
8. An awareness of the Professional Ethics.
9. Need to observe safety precautions.

Catalogue prepared by	Dr. Dileep R
Recommended by the Board of Studies on	PU/SOE/CHE/BOS-07/2022-23 7th BOS held on 25/07/22
Date of Approval by the Academic Council	18th Academic council, PU/AC-18/MEC/2019-2023/2021 03rd August, 2022

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-8[2021] COURSE HAND OUT [Integrated Course]

SCHOOL: School of Engineering DEPT.: Chemistry DATE OF ISSUE: 23.03.2022

NAME OF THE PROGRAM: B. Tech

P.R.C. APPROVAL REF.: PU/AC-17/EEE/2021

SEMESTER/YEAR: 2nd Semester/I year

COURSE TITLE & CODE: Industrial Chemistry, CHE1002

COURSE CREDIT STRUCTURE: 2-2-3

CONTACT HOURS: 30 (theory) 15 (Practical)

COURSE IN-CHARGE: Dr. Dileep R

PROGRAM OUTCOMES:

Graduates of the B. Tech. Engineering Program will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems (H).

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (H).

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations (M).

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PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (L).

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (M).

PO10: Communication: Communicate effectively on complex engineering activities with the engineering 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 (H).

PO11: Project management and finance: Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES: Nil

COURSE DESCRIPTION: The primary objective of the course is to introduce the concepts and applications of chemistry in Engineering. The course also aims to enhance the knowledge of chemical composition and properties of chemical molecules as alternate fuels. It will also cultivate an ability to identify chemistry in each piece of smart engineered products used in households and industry. It targets to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications.

The associated laboratory provides an opportunity to lay foundation for practical application of chemistry in engineering aspects

This course caters to Environment and Sustainability.

COURSE OBJECTIVE: The objective of the course is to **familiarize the learners with the concepts of "Industrial Chemistry" and attain EMPLOYABILITY SKILL through EXPERIENTIAL LEARNING techniques**.

COURSE OUTCOMES: On successful completion of this course the students shall be able to:

- CO1: identify the suitable polymers to replace the conventional materials

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- CO2: Discuss the importance of different surfactants in various fields
- CO3: describe the processes involved in the oil refineries
- CO4: apply the knowledge of electrochemistry principles for protection of different metals from corrosion.

MAPPING OF C.O. WITH P.O.

[H-HIGH, M- MODERATE, L-LOW]

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12
1	M			M		L				L		
2	M			H		M	L			L		
3	M			H			M			L		
4	M	H		M		M				L		

COURSE CONTENT (SYLLABUS):

Module:1: Polymer Chemistry [7 Hrs] [Blooms 'level selected: Knowledge]

Polymers: Introduction, Zeigler Natta Polymerization, Polymerization techniques, Plastics as engineering materials: Thermo plastics and thermosetting plastics-advantages, limitations and industrial applications. Compounding and moulding process (injection and Compression molding) Polymer composites, Conducting polymers and biodegradable polymers

Module: 2: Introduction to Surfactants and Lubricants [4 Hrs] [Blooms 'level selected: Knowledge]

Surfactant Chemistry: Basic terminology: Surfactants, classification, micelle formation, emulsifying agents, foaming agents, wetting agents (basics), and Industrial application of surface active agents. Lubricants: classification and mechanism of lubrication

Module: 3: Fuels and Combustion [7 Hrs] [Blooms 'level selected: Comprehension]

Fuels –Classification, Calorific value determination, Solid fuels: Proximate and Ultimate analysis of Coal; Liquid Fuels: Petroleum: Basics of Catalysis, types and importance in Cracking and reforming; Knocking, Synthetic petrol, Power alcohol; Gaseous Fuels: Natural gas, CNG, LPG. Alternate fuels: Bio-diesel. **Combustion:** flue gas analysis; Rocket propellants and Explosives – classification, storage and handling

Module: 4: Corrosion and its control [7 Hrs] [Blooms 'level selected: Comprehension]

Dry and Wet Corrosion – detrimental effects to buildings, machines, devices and decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress Corrosion cracking. Factors that enhance corrosion and choice of parameters to mitigate corrosion. **Corrosion Control** –

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Cathodic protection- Sacrificial anodic protection, advanced protective coatings: electro plating, electroless plating, PVD and CVD

SKILL SETS TO BE DEVLOPED: [Select the appropriate skill/skills and make them bold]

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. Ability to interpret events and results.
4. Ability to work as a leader and as a member of a team.
5. Assess errors in systems/processes/programs/computations and eliminate them.
6. **Observe and measure physical phenomena.**
7. Write reports.
8. **Select suitable equipment, instrument, materials & software**
9. Locate faults in system/Processes/software.
10. Manipulative skills for setting and handling systems/Process/ Issues
11. **The ability to follow standard /Legal procedures.**
12. An awareness of the Professional Ethics.
13. **Need to observe safety/General precautions.**
14. **To judge magnitudes/Results/issues without actual measurement/actual contacts**

COURSE CONTENT &TASK SCHEDULE FOR LABORATORY COMPONENT:

Sl. No.	Session Number and Date	Task No	Task	Level 01	Level 2	Number of Lab Sessions required to complete the task	Skills to be developed	Course Outcome to be developed
01	**1**	**1**	Determination of total acid number of an oil	**Yes**		**1**	1, 6, 11	

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02	**2**	**2**	Determination of pKa of a weak acid using pH meter	**Yes**		**1**	1, 6, 8, 11	
03	**3**	**3**	Potentiometric estimation of iron in the given rust solution using standard $K_2Cr_2O_7$ solution		**Yes**	**1**	1, 6, 8, 11	
04	**4**	**4**	Determination of calorific value of a solid fuel using Bomb calorimeter		**Yes**	**1**	1, 6, 8, 11	
05	**5**	**5**	Estimation of copper from industrial effluents by colorimetric method		**Yes**	**1**	1, 6, 8, 11	
06	**6**	**6**	Determination of Viscosity of different natural /synthetic polymers Using Ostwald Viscometer		**Yes**	**1**	1, 6, 8, 11	
07	**7**	**7**	Determination of Critical Micelle Concentration		**Yes**	**1**	1, 6, 8, 11	
08	**8**	**8**	Estimation of water hardness by EDTA method and its removal (by zeolite/ ion exchange method)		**Yes**	**1**	1, 6, 8, 11	

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09	**9**	**9**	Electroplating technique		**Yes**	**1**	1, 6, 8, 11	
10	**10**	**10**	Synthesis of polyaniline and its conductivity measurement		**Yes**	**1**	1, 6, 8, 11	

DELIVERY PROCEDURE (PEDAGOGY):

Theory

a. Procedure Adopted: As Industrial Chemistry is an integrated course where the concepts other than that mentioned above, are explained through lectures and power point presentations. Review classes are conducted periodically so that students are able to apply the concepts taught in the previous classes.
b. Self-learning topics: Bulk and Suspension polymerization,
c. Experimental Learning: Corrosion through lab activities
d. Topics for Participative learning: Fuels, types of corrosion and control through group discussion and seminar.
e. Topics for Technology Enabled Learning: NIL
f. Topics for problem based learning: Types of corrosion
All other topics will be delivered through lecture with necessary visual aids

Lab

g. Procedure adopted: This is a lab-based course where the concepts other than that mentioned above, are explained through practical demonstration. Viva-voce will be conducted and the results of every experiments will be discussed with students, so that students are able to apply their theoretical knowledge for performing the practical experiments.
h. Participative learning: Performing all the ten experiments in the laboratory.
i. Experimental learning: Estimation of hardness, amount of copper in industrial effluents, estimation of iron in rust determination of pH, pKa and conductivity of the acids, and viscosity of the liquids.

REFERENCE MATERIALS:

Text Book

1. Engineering Chemistry, Shika Agrawal (2018), Cambridge University Press

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Reference Books

1. Engineering Chemistry, Jain and Jain (18th Edition) Dhanpat Rai Publishing Company
2. An introduction to Surfactants (2014) Tharwat F. Tadros, De Gruyter Publishers

Course material:

1. Power point presentations/notes of modules 1-4 will be shared in Microsoft teams
2. Lab manual for each experiment and a Power point presentation will be shared in Microsoft teams

Web link

E-resources

1. https://nptel.ac.in/courses/104/105/104105039/
2. https://nptel.ac.in/content/storage2/courses/103104045/pdf_version/lecture21.pdf
3. https://nptel.ac.in/courses/103/105/103105110/
4. https://nptel.ac.in/courses/113/104/113104082/

Video Links

1. https://youtu.be/0dcQcNARKOI
2. https://youtu.be/xzFCexGwVmU

GUIDELINES TO STUDENTS:

- Attend classes regularly and do not miss any topics.
- Maintain running notes of each and every class.
- Never hesitate to ask doubts.
- Revise the previous classes before attending the next class.
- Understand the chemical reactions and try to write equations for the same on your own.
- Learn how to draw the diagrams which helps to memories the topics easily.

COURSE SCHEDULE FOR THEORY COMPONENT: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivery, about 10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course	23.03.2022	23.03.2022	1

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02	Module : 01	24.03.2022	13.04.2022	7
02	Module: 02	15.04.2022	30.04.2022	4
03	Assignment	1.04.2022	20.04.2022	
04	Mid Term Exam	09.05.2022	12.05.2022	
05	Module:03	01.05.2022	20.05.2022	7
06	Module:04	21.05.2022	15.06.2022	7
07	Revision Sessions	16.06.2022	23.06.2022	4

COURSE SCHEDULE FOR LABORATORY COMPONENT:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course	23.03.2022	23.03.2022	1
02	Laboratory Familiarization	23.03.2022	23.03.2022	1
02	Conduct of first set of experiments	24.03. 2021	30.04.2022	5
03	Assignment/ Test or any other activity/Guest Lecture/ Field Visit			1
04	Conduct of second set of experiments	01.05.2022	05.06.2022	5
05	Summary of the Laboratory tasks	06.06.2022	06.06.2022	1
06	End Term Evaluation			1

SCHEDULE OF INSTRUCTION FOR THE THEORY COMPONENT

Sl. no	Session no [date if possible]	Lesson Title	Topics	CO No.	Delivery Mode &Tools used	Reference
1	1	Introduction	Course integration			
2	2	Polymers: Introduction,	Zeigler Natta Polymerization	1	Participative learning	T1
3	3	Polymerization techniques	Bulk, Suspension, Emulsion and solution polymerization	1	Black board teaching and PPT	T1

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4	4	Plastics as engineering materials	Thermo plastics and thermosetting	1	Black board teaching and PPT	T1
5	5	Plastics as engineering materials	plastics- advantages, limitations and industrial applications.	1	Black board teaching and PPT	T1
6	6	Compounding and moulding process	injection and Compression molding	1	Black board teaching and PPT	T1
7	7	Advanced polymers	Polymer composites, Conducting polymers and biodegradable polymers	1	Black board teaching and PPT	T1
8	8	Applications of the concepts learnt in previous classes	Review of previous classes and discussion on outcome of previous classes	1	Participative learning	T1
Module 1 concluded						
9	9	Surfactant Chemistry	Basic terminology: Surfactants, classification,	2	Participative learning	T1
10	10	micelle formation	micelle formation, emulsifying agents, foaming agents, wetting agents (basics),	2	Black board teaching and PPT	T1
11	11	Applications of surfactants	Industrial application of surface active agents	2	Black board teaching and PPT	T1
12	12	Lubricants:	classification and mechanism of lubrication	2	Black board teaching and PPT	T1
13	13	Applications of the concepts learnt in previous classes	Review of previous classes and discussion on outcome of previous classes	2	Participative learning	T1
Module 2 concluded						

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14	14	Chemical energy sources	Fuels –Classification, Calorific value determination	3	Participative learning	T1
15	15	Solid Fuels	Proximate and Ultimate analysis of Coal	3	Black board teaching and PPT	T1
16	16	Liquid Fuels	Petroleum: Basics of Catalysis, types and importance in Cracking and reforming	3	Black board teaching and PPT	T1
17	17	Liquid Fuels	Knocking, Synthetic petrol, Power alcohol	3	Black board teaching and PPT	T1
18	18	Gaseous Fuels	Natural gas, CNG, LPG. Alternate fuels: Bio-diesel	3	Black board teaching and PPT	T1
19	19	Combustion	flue gas analysis; Rocket propellants	3	Black board teaching and PPT	T1
20	20	Explosives	classification, storage and handling	3	Black board teaching and PPT	T1
21	21	Applications of the concepts learnt in previous classes	Review of previous classes and discussion on outcome of previous classes	3	Participative learning	T1
Module 3 concluded						
22	22	Corrosion types	Dry and Wet Corrosion –	4	Black board teaching and PPT	T1
23	23	Effects of Corrosion	detrimental effects to buildings, machines, devices and decorative art forms,	4	Black board teaching and PPT	T1
24	24	Types of wet corrosion	emphasizing Differential aeration, Pitting, Galvanic	4	Black board teaching and PPT	T1

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			and Stress Corrosion cracking.			
25	25	Factors affecting Corrosion	Factors that enhance corrosion and choice of parameters to mitigate corrosion.	4	Black board teaching and PPT	T1
26	26	Corrosion Control	Cathodic protection- Sacrificial anodic protection,:	4	Black board teaching and PPT	T1
27	27	Advanced protective coatings	electro plating, electroless plating	4	Black board teaching and PPT	T1
28	28	Advanced protective coatings	PVD and CVD	4	Black board teaching and PPT	T1
29	29	Applications of the concepts learnt in previous classes	Review of previous classes and discussion on outcome of previous classes	4	Participative learning	T1
Module 4 concluded						
30	30		Review of previous classes and discussion on outcome of previous classes		Participative learning	T1

SCHEDULE OF INSTRUCTION FOR THE LAB COMPONENT (any 6 experiments)

Sl. no	**Session no [date if possible]**	**Experiment**	**Reference**
1	1	Lab Introduction	
2	2	Determination of Viscosity of different natural /synthetic polymers Using Ostwald Viscometer	Lab manual
3	3	Determination of pKa of a weak acid using pH meter	Lab manual

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4	4	Potentiometric estimation of iron in the given rust solution using standard $K_2Cr_2O_7$ solution	Lab manual
5	5	Estimation of copper from industrial effluents by colorimetric method	Lab manual
6	6	Estimation of strength of mixture of acids by conductometric titration	Lab manual
7	7	Determination of total acid number of an oil	Lab manual
8	8	Determination of calorific value of a solid fuel using Bomb calorimeter	Lab manual
9	9	Determination of Critical Micelle Concentration	Lab manual
10	10	Review of previous classes and discussion on outcome of previous classes	Lab manual

ASSESSMENT SCHEDULE FOR THEORY COMPONENT: (Here mention the details of all the formal and informal evaluation methods. Formal evaluation refers to Test 1, Test 2 and the End Term Final Examination. All other evaluation components come under informal evaluation.)

[Some of the samples are: Test 1, Test 2, Term End Exam, Surprise Test, Open Book test, Pre Course and Post course Test, Unit/Module wise Tests Quiz,

COURSE CLEARANCE CRITERIA:

Minimum attendance requirement: 75%

A student with shortage of attendance (i.e., less than 75% of the classes actually conducted in the course under Clauses 7.3 to 7.5), shall not be permitted to appear in the End Term Final Examinations of the Course irrespective of the student's academic performance in the other components of Continuous Assessments. The student shall be given a placeholder grade "NP" (Not Permitted) (refer Section 8.0), to indicate that the student has not been permitted to appear for the End Term Final Examinations due to shortage of attendance during the Academic Term in the concerned Course.
Further, a student who has shortage of attendance (received placeholder grade "NP") in ONLY ONE (O1) Course in the concerned Semester, shall be eligible to re-register for the concerned Course in the following Summer Term, subject to all the conditions stated in Clauses 15.4 and 15.5. The student is cautioned that this may result in the loss of an Academic Year for the student.

Assessment: Minimum performance criteria

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[1] Continuous assessment:

Components: Test 2, Test 2, Assignment, Quiz and Surprise test
A student must obtain a minimum of 40% of the total marks/weightage assigned for Continuous Assessments (other than the End Term Final Examination) in the Course.
A student failing to get the minimum requirement of 40% of the total marks/weightage assigned for components of Continuous Assessments (other than the End Term Final Examination), shall not be eligible to appear in the End Term Final Examination of the Course. The student shall be given the grade "NE" (Not Eligible) as a placeholder grade in the Course.
A student who has received "NE" grade in a Course or Courses, due to failure to obtain a minimum of 40% of the total marks/weightage assigned for Continuous Assessments (other than the End Term Final Examination), in the concerned Course(s), shall have to repeat the concerned Course(s) by re-registering for the Course(s) whenever the concerned Course(s) is (are) offered by the respective Department/School. Further, the student is cautioned that she/he shall have to register for the Course(s) in which she/he has received the placeholder grade "NE" (as per Clause 8.6) only in the concerned Semester of the next Academic Year when the concerned Course(s) shall be offered, which may result in the loss of an Academic Year for the student.

[2] End Term Exam:

The student must obtain a minimum of 30% of the total marks/weightage assigned for End Term Final Examination in the Course.
A student failing to get the minimum requirement of 30% of the total marks/weightage assigned for the End Term Final Examination shall be declared as "Failed" and given "F" Grade in the concerned Course, regardless of the marks obtained in the other components of Continuous Assessments in the concerned

The student shall have to re-appear in the "Make-Up Examinations" (refer Clause 14.3) as scheduled by the University, or, re-appear in the End Term Final Examination of the same Course when it is scheduled at the end of the following Semester or Summer Term, if offered. The marks obtained in the Continuous Assessments (other than the End Term Final Examination) shall be carried forward and be included in computing the final grade, if the student secures the minimum requirements (as per Sub-Clauses 8.5.2 and 8.5.3) in the "Make-Up Examinations" of the concerned Course.

The Student must have secured a minimum of 40% of the AGGREGATE of the marks/weightage of the components of the Continuous Assessments and the End Term Final Examination in the concerned Course.

Topics relevant to Employability Skill Development:

Corrosion control and lab experiments for Developing Employability Skills through Experiential Learning Techniques This is attained through the following assignment components.

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Sl. No.	Assessment type [Include here assessment method for self-learning component also]	Contents	Course outcome Number	Duration (In Hours)	Marks	Weightage	Venue, Date & Time
1	Mid term	Module 1 & 2	1, 2	1.5	50	25%	May 2022
2	Assignment	Module 1 & 2	1, 2	-	25	12.5%	May to June 2022
3	Assignment (Review of digital/ e-resource from Presidency University link given in references section (mandatory to submit screen shot accessing digital resource, otherwise it will not be evaluated)	All modules https://nptel.ac.in/courses/103/105/103105110/			5	2.5%	May to June 2022
4	Quiz	Module 3 & 4	3, 4	-	20	10%	May to June 2022
5	End Term	All	1-4	3	100	50%	June 2022

ASSESSMENT DETAILS FOR LABORATORY COMPONENT:

Sl. No.	Assessment type [Include here assessment method for self-learning component also]	List of Tasks	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME
1	Lab Exercise	Session wise evaluation	1-4	2 hr each	40	20%	Lab

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Assessment Matrix for Daily Task Evaluation for Laboratory component:

Sl. No.	Task No.	Marks for activity 01 [Mention the activity]	Marks for activity 02 [Mention the activity]	Marks for activity 03 [Mention the activity]	Total Marks
1	Performance	4			10 marks
2	Participation		3		
3	Report writing			3	

COURSE CLEARANCE & EVALUATION CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: (Here mention the fixed slots on any of the week days for students to come and interact with you)

SAMPLE THOUGHT PROVOKING QUESTIONS

1. Describe the technique of polymerization involved in the manufacture of polyacrylic acid
2. Give any five types of additives used in compounding of plastics with their respective functions
3. Describe the technique of polymerization involved in the manufacture of Styrene-butadiene rubber
4. Give any five reasons why the Fibre reinforced plastics have a very broad industrial applications
5. Explain the mechanism involved in the coordination polymerization for the formation of Polyethylene
6. Paraffin or new cotton cloth barely wetted by water, but when surfactant is added to water their surface easily becomes wet. Explain that property of a surfactant involved in the statement

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7. Describe the conditions involved in depositing a superior metal over an inferior metal by means of electrolysis using chromic acid in sulphuric acid solution.
8. Explain the type of corrosion observed when a buried iron pipeline is connected to zinc bar. Provide two more similar examples and preventive measures
9. Explain the type of corrosion that occurs when two different parts of the same metal are exposed to different concentration of oxygen. Give two examples and preventive measures
10. Explain the procedure in manufacture of a secondary fuel derived from coal

Sample Assignment questions

1. A 0.5g of which when burnt in a bomb calorimeter raised the temperature of water from 293K to 296. 4K. The mass of water is 1000 g and water equivalent of calorimeter is 350 g. The specific heat of water is 4.187 kJ/kg/K, latent heat of steam is 2454 kJkg-1 . The coal sample contains 93% carbon, 5% hydrogen and 2% ash. What parameters can be calculated from the given data. Calculate the same.
2. 0.7 g of chemical fuel containing 6% hydrogen, when burnt in a bomb calorimeter raises the temperature of water from 291 K to 295.2 K. The mass of water is 1.3 kg and water equivalent of calorimeter is 350 g. The specific heat of water is 1 kcal/kg/°C, latent heat of steam is 538.5 cal/g. Mention the parameters that can be found and calculate the same
3. Polymers are different than low-molecular weight oligomers. For example an oligomeric polyethylene is wax, oligomeric polystyrene is similar to naphthalene (moth balls), oligomeric rubber is oil or grease. One way to quantify the difference between an oligomer and a polymer is through rheology. a) Give Newton's law for viscosity. b) Define the shear stress. c) Define the rate of strain. d) Define the velocity gradient. e) The tensile (or extensional) viscosity is used to describe the ability of a fluid to form a fiber. Explain how the tensile (or extensional) viscosity is defined. f) Sketch the behavior of viscosity as a function of velocity gradient showing how the zero-shear-rate viscosity or Newtonian-plateau viscosity are obtained. g) Sketch the dependence of the zero-shear-rate viscosity on molecular weight. h) How can your plot of part "b" be used to define a polymer
4. a) What are the three main stages of chain growth polymerization? b) Write an expression for the rate of propagation for chain growth polymerization in terms of the monomer concentration and the initiator concentration. c) Obtain an exponential expression for the monomer concentration from part c and show that this is linear for early stages of the reaction. d) Obtain an expression for the kinetic chain length for chain growth polymerization in terms of the monomer concentration and the initiator concentration.

Sample Thought Provoking Questions to be asked to assess the Students' Preparedness to carry out the Task [For Laboratory Component]:

(Here type sample typical questions for students 'reference)

SL. NO	QUESTIONS
1	1. Alkalinity is the capacity to neutralize a) base c) salt

	b) acid d) none 2. The type of Chemical reaction involved in conductometric titration is a) Neutralization reaction c) Redox Precipitation reaction b) Complexometric reaction d) Precipitation reaction 3. In the case of oxidation-reduction titration of FAS using standard dichromate solution, a standard calomel electrode (SCE) is used as the, a) reference electrode c) counter electrode b) indicator electrode d) combination of all the above 4. According to Henderson- Hasselbalch equation, at half equivalence point, a) PH= 0 c) pH=pka b) pka =0 d) pH>pka 5. In acidic medium MnO_4^- is reduced to a) Mn^{2+} c) Mn^{5+} b) Mn^{7+} d) Mn^{4-} 6. Alkalinity is due to the presence of a) hydroxyl, carbonate, and bicarbonate ions in water b) chloride, fluoride, and bromide ions in water c) sulphate, phosphate, and nitrate ions in water d) all 7. Name the complex obtained when ammonia is treated with copper sulphate solution? a) cuprammonium complex c) Ammonium sulphate b) Copper sulphate d) None of the above 8. The quantity measured in conductometric titration is a) Potential b) Conductance c) Resistance d) Absorbance 9. The type of reaction involved in permanganometric titration is a) Redox c) Displacement b) Neutralization d) Decomposition 10. Salt responsible for temporary hardness a) Calcium Chloride b) Magnesium Sulphate b) c) Calcium Bicarbonate d) All the above
2	How will you find the hardness of water by simple test at home?
3	What is the role of EDTA in cement sample analysis?
4	The Molecular wt of $KMnO_4$ is 158g whereas the equivalent weight is 31.6 g account for the difference?

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5	Three acids found in foods are lactic acid (in milk products), oxalic acid (in rhubarb, beets), and malic acid (in apples). The pKa values are 3.88, 1.23, and 3.40 respectively. Identify which food product is most acidic in nature?
6	Why glass electrode is called an ion selective electrode?
7	During the redox titration, H_2SO_4 is added to titrate why?
8	What is colorimetry? And what is the difference between colorimetry and turbidimetry?
9	Without any indicator, how the end point is detected using Conductometric titration method for estimation of strength of acids?
10	Two glass cups are taken and filled with (a) Petrol and (b) honey respectively. A small glass rod is kept on both the glass cups to stir by applying some force. In which liquid greater force is required to stir?

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	To relate the knowledge learnt for various industrial Applications of polymers.	35
02	CO2	To Discuss the importance of different surfactants in various fields	45
03	CO3	To describe the processes involved in the oil refineries	45
04	CO4	To apply the knowledge of electrochemistry principles for protection of different metals from corrosion.	50

Signature of the Course Instructor

(Dr.Dileep R)

This course has been duly verified Approved by the D.A.C: 3rd DAC meeting held on 15th March 2022

Signature of the Chairperson D.A.C.

(Dr.Shahsikala A R)

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Course Completion Remarks &Self-Assessment.[*This has to be filled after the completion of the course*]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl. No.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl. No.	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
01	CO1				
02	CO2				
03					
04					

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D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

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Experiment - 5

Estimation of Mixture of Acids by Conductometer Titration

Name: Asma Thasnim
Roll. No.: 20211PET0016

AIM: To estimate the concentration of mixture of acids by conductometric titration.

PRINCIPLE: When a mixture of acids (strong acid [HCl], weak acid [CH_3COOH]) are titrated against a strong base [NaOH], strong acid reacts first followed by a weak acid. After both the acids are consumed, there is a steep increase in conductivity observed on the graph.

REACTIONS:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

$$CH_3COOH + NaOH \longrightarrow CH_3COO^- + Na^+ + H_2O.$$

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CHEMICALS: St. NaOH solution, acid mixture and distilled water.

PROCEDURE:

1) The burette is filled with st. NaOH solution and the mixture (strong acid + weak acid) of 50ml is taken in a 100ml Beaker.

2) The conductivity cell connected to the instrument dip is dipped in the beaker with the mixture and NaOH is titrated at 0.5ml intervals

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the readings are noted down.

3) Conductance decreases, stays constant and increases later. A graph is plotted and vol. base is calculated.

TABLE :

Volume of NaOH (ml)	Conductance (mho)	Volume of NaOH (ml)	Conductance (mho)
0.0	18.5	8.5	7.2
0.5	17.3	9.0	8.0
1.0	15.6	9.5	8.8
1.5	14.1	10.0	9.5
2.0	12.6	10.5	10.2
2.5	10.8	11.0	11.1
3.0	9.6	11.5	11.8
3.5	8.3	12.0	12.7
4.0	6.8	12.5	13.5
4.5	5.5	13.0	14.0
5.0	5.2	13.5	14.9
5.5	5.5	14.0	15.6
6.0	5.8	14.5	16.3
6.5	6.1	15.0	17.0
7.0	6.3	15.5	17.7
7.5	6.6	16.0	18.4
8.0	6.9	16.5	

CALCULATION:

Estimation of HCl :-

Normality of St. NaOH – 0.5N

Vol. mixture of acids pipetted out = 50ml

Vol. NaOH required to neutralize HCl = V_1 ml

$$\text{Normality of HCl} = \frac{\text{Nor. NaOH} \times \text{Vol of NaOH}}{50}$$

$$= \frac{(0.5)(4.6)}{50}$$

$$= 0.046\ N$$

$$\text{Wt. HCl} = \text{Normality of HCl} * \text{Eq. Wt of HCl}$$

$$= 0.046 \times 36.5$$

$$= 1.6799\ g.$$

Estimation of CH_3COOH -

Vol of NaOH required to neutralize $CH_3COOH = (V_2 - V_1)$ ml

$$= 8.5 - 4.6 = 3.9\ ml$$

$$\text{Normality of } CH_3COOH = \frac{\text{Nor. NaOH} \times \text{Vol. of NaOH}}{50}$$

$$= \frac{(0.5)(4.6)}{50}$$

$$= 0.046N$$

$$\therefore \text{Wt of } CH_3COOH/L = \text{Nor. } CH_3COOH * \text{Eq. Wt of } CH_3COOH$$

$$= (0.046)(60.05)$$

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REPORT :

$V_1 = 4.6ml$

$V_2 = 8.5ml$

Weight g HCl/L = 1.679 g

Weight g CH_3COOH/L = 2.76239

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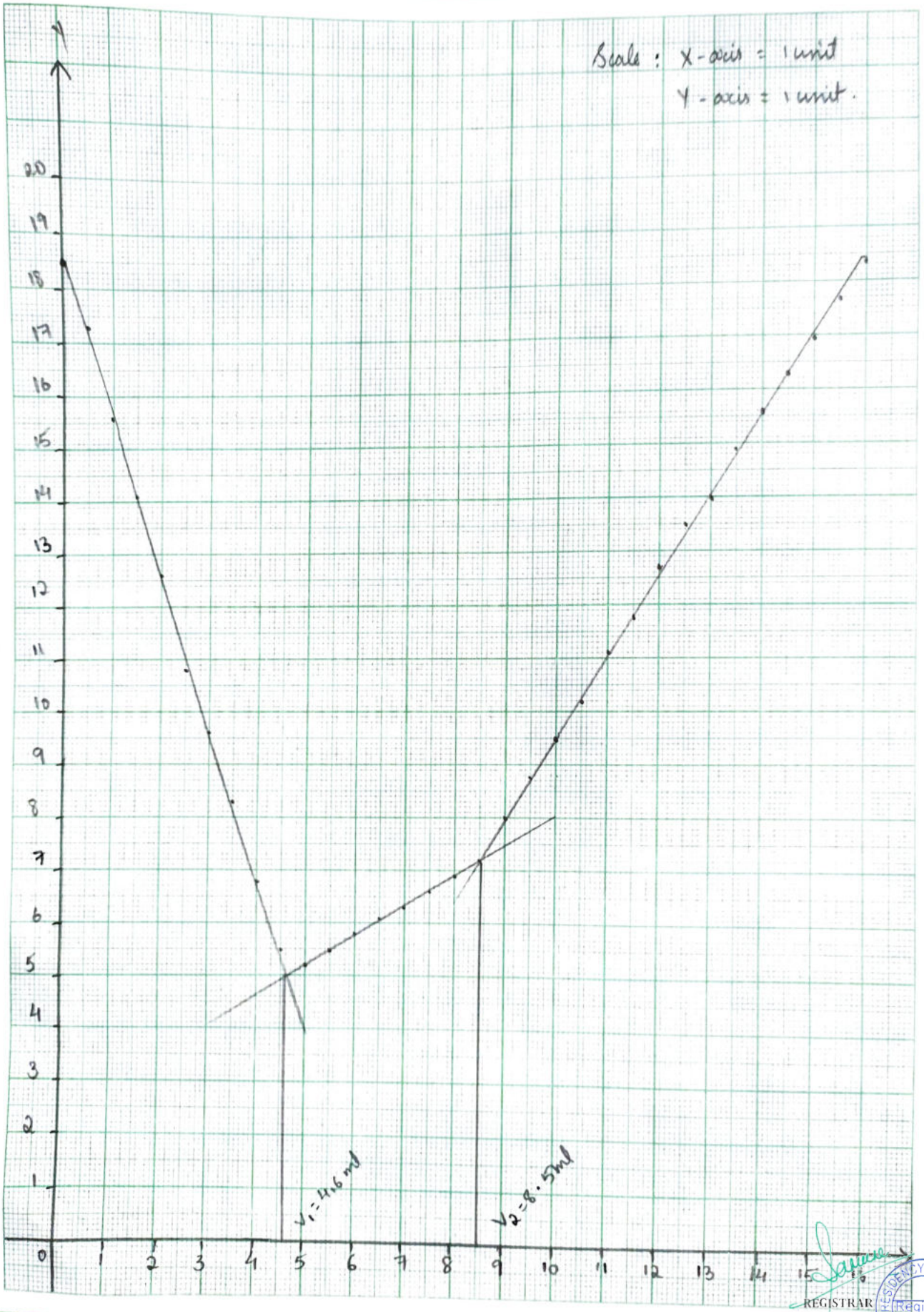
Asma Thasnim
2021IPET0016

Date :

Batch No



→ Vol. of NaOH

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BHASKAR'S

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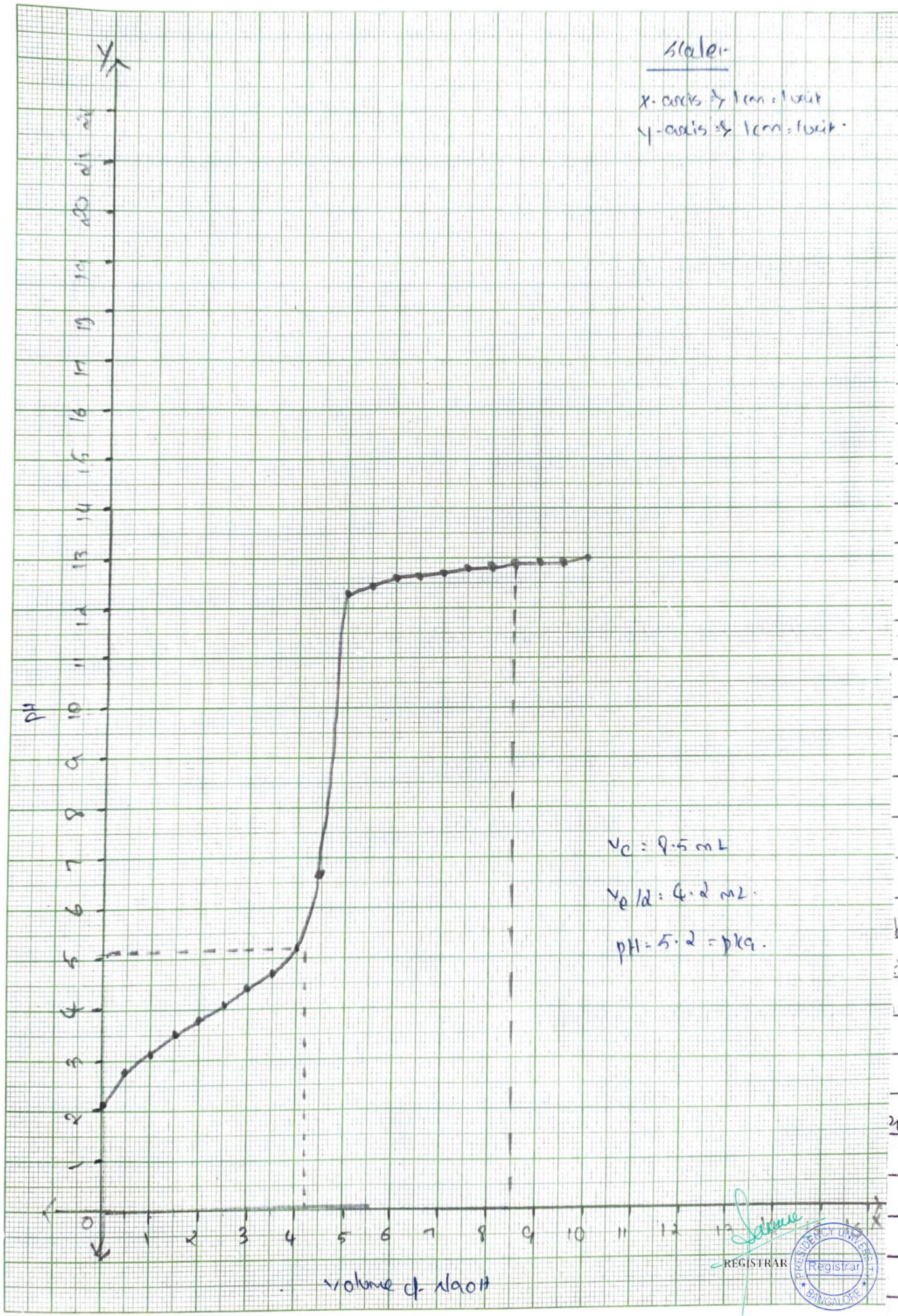

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Naif Nihad
2021IPET0012

PAGE NO:
DATE: 29/03/2022

Experiment 11-(Determination of pka value of weak acid using pH meter)

Aim:-

To determine the pka value of given weak acid using pH meter.

Principle

$$HA(aq) + H_2O \rightleftharpoons [H_3O^+] + A^-$$

$$K_a = \frac{[H_3O^+] \cdot [A^-]}{[HA]}$$

$$pH = pK_a + \log_{10} \frac{[salt]}{[acid]}$$

Apparatus & chemical required-

Apparatus: 100 ml beaker, 50 ml beaker, 25 ml pipette, glass rod, 50 ml burette, burette stand, glass-calomel electrode assembly connected to pH-meter

Chemicals: weak acid, NaOH & distilled water

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Procedure :-

→ To the given 25 mL of weak acid solution add 25 mL of distilled water in 100 mL beaker.

→ A glass electrode - calomel electrode assembly is rinse with distilled water & immerse in the beaker, switch on the pH ~~xxx~~ meter & record the pH.

→ Add standard NaOH solution from the burette in the intervals of 0.5 mL at the time & the solution is bubble using glass tube for mixing. Record the pH value of solution after each addition of NaOH & continue till the equivalent point is read (pH 10-11)

→ Tabulate the readings & plot derivative graph using $\Delta pH / \Delta V$ value on y-axis v/s volume of NaOH on x-axis to determine the equivalence point & plot the second graph using pH value on y-axis v/s volume of NaOH on x-axis to determine equivalence point, half equivalence point & pKa values. The pH at half equivalence point is gives pKa value of the acid.

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Table1-

Volume of NaOH ('V' mL)	pH	ΔV	ΔpH	ΔpH/ΔV
0.0	2.05	NIL	NIL	NIL
0.5	2.80	0.5	2.3	4.6
1.0	3.18	0.5	2.18	4.36
1.5	3.56	0.5	2.06	4.12
2.0	3.86	0.5	1.86	3.72
2.5	4.09	0.5	1.59	3.18
3.0	4.43	0.5	1.43	2.86
3.5	4.78	0.5	1.28	2.56
4.0	5.16	0.5	1.16	2.32
4.5	6.72	0.5	2.21	4.44
5.0	12.30	0.5	7.3	14.6
5.5	12.43	0.5	6.93	13.86
6.0	12.58	0.5	6.58	13.16
6.5	12.69	0.5	6.19	12.38
7.0	12.77	0.5	5.72	11.44
7.5	12.84	0.5	5.34	10.68
8.0	12.89	0.5	4.89	9.78
8.5	12.93	0.5	4.43	8.86
9.0	12.95	0.5	3.95	7.9
9.5	12.98	0.5	3.48	6.96
10.0	13.01	0.5	3.01	6.01

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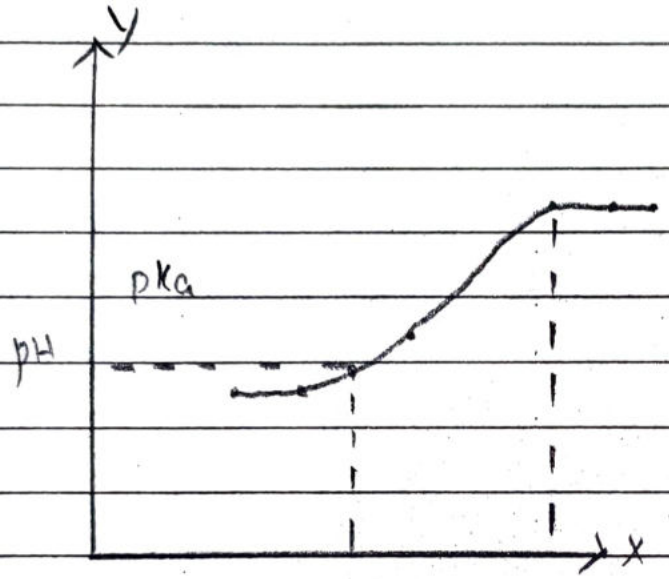
Graph:-



Calculations / Results:-

Volume of NaOH at equivalence point V_e : 8.5 mL

Volume of NaOH at half equivalence point : $V_e/2$: 4.2 mL

Therefore pKa value of weak acid : 5.2

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20211PET0002

Potentiometeric Estimation of Iron Using Standard Potassium Dichromate Solution

:= **Aim:**

To determine the amount of Iron present in the given solution using standard $K_2Cr_2O_7$.

:= **Principle:**

This experiment involves the determination of FAS in an unknown sample by redox titration with standard potassium dichromate solution.

:= **Reaction:**

$$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O \quad \cdots (1)$$

:= **Equation:** [Nernst Equation]

$$E = E^\circ + \frac{0.0591}{n} \log \frac{A_{ox}}{A_{red}} \quad — (2)$$

$$E = E^\circ + \frac{0.0591}{3} \log \frac{Cr^{6+}}{Cr^{3+}} \quad — (3)$$

:= **Procedure:**

(i) 25 ml of given iron solution is pipetted out. 10 ml of dil. H_2SO_4 and 90 ml of water adding upto 100 ml of a 250 ml beaker.

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Weight of Iron present in 1 litre of this solution ⇒

$[N_{FAS} \times$ equivalent weight of Iron$)$

$= (0.014)(55.85)$ g/L

$\Rightarrow \boxed{0.7819 \text{ g/L}}$

:= Report:

Volume of $K_2Cr_2O_7$ $(V_1) =$ 3.5 mL

Normality of $K_2Cr_2O_7$ $(N_1) =$ 0.1N

Normality of Iron Solution $(N_{FAS}) = 0.014N$

Weight of Iron Present = 0.7819 g/L.

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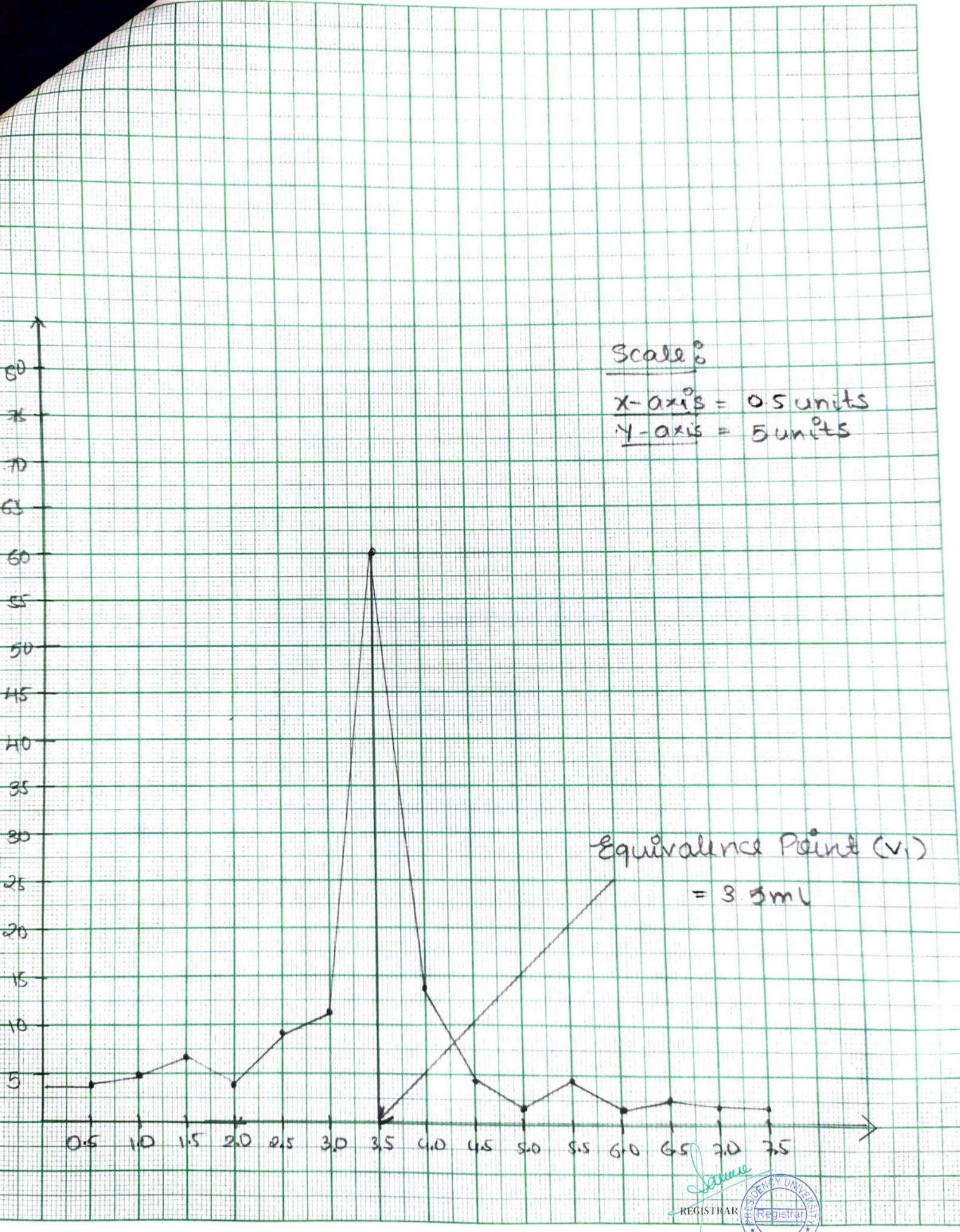

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- Experiment 05 -

[20211PET0002]

Estimation of Mixture of Acids By Conductometer Titration

:= **Aim:**

To Estimate the Concentration of mixture of acids by conductometric titration.

:= **Principle:**

When a mixture of acids [Strong acid (HCL)], Weak acid [CH_3COOH] are titrated against a Strong base [NaOH], Strong acid reacts first followed by a Weak Acid. After both the acids are Consumed, There is a Steep increase in the Conductivity observed on the graph.

:= **Reactions:**

$$NaOH + HCL \longrightarrow NaCL + H_2O$$

$$CH_3COOH + NaOH \longrightarrow CH_3COO^- + Na^+ + H_2O.$$

:= **Chemicals:**

St. NaOH Solution, Acid mixture and distilled water.

:= **Procedure:**

(1) The burette is filled with St. NaOH Solution and the mixture [Strong acid + Weak acid] of 50ml is taken in a 100 ml Beaker.

(2) The Conductivity cell is Connected to the instrument is dipped in the beaker with the mixture and NaOH is titrated at 0.5 ml intervals and the readings are

(3) Conductance decreases, Stays Constant and increases
A graph is plotted and Volume base is Calcula

:: Table:

Volume of NaOH (ml)	Conductance (mho)	Volume of NaOH (ml)	Conducta (mho)
0.0	18.5	8.5	7.2
0.5	17.3	9.0	8.0
1.0	15.6	9.5	8.8
1.5	14.1	10.0	9.5
2.0	12.6	10.5	10.2
2.5	10.8	11.0	11.1
3.0	9.6	11.5	11.8
3.5	8.3	12.0	12.7
4.0	6.8	12.5	13.5
4.5	5.5	13.0	14.0
5.0	5.8	13.5	14.9
5.5	6.1	14.0	15.6
6.0	6.3	14.5	16.3
6.5	6.6	15.0	17.0
7.0	6.7	15.5	17.7
7.5	6.8	16.0	18.4
8.0	6.9	16.5	—

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:= Calculation:

Estimation of HCL

Normality of St. NaOH — 0.5N

Vol. mixture of acids pipetted out — 50mL

Vol. NaOH required to neutralize HCL — V_1 mL

Normality of HCL = $\frac{\text{Nor. NaOH} \times \text{Vol of NaOH}}{50}$

$= \frac{(0.5)(4.6)}{50} = 0.046$

Wt. HCL = Normality of HCL x Eq. wt of HCL

$= 0.046 \times 36.5$

$= 1.679$ g:

:= Estimation of CH_3COOH:

Vol. of NaOH required to neutralize $CH_3COOH = (V_2 - V_1)$ ml

$\Rightarrow 8.5 - 4.6 = 3.9$ mL

Normality of CH_3COOH = $\frac{\text{Nor. of NaOH} - \text{Vol. NaOH}}{50}$

$= \frac{(0.5)(4.6)}{50}$

$\Rightarrow$ 0.04 ON

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$\therefore$ Wt of CH_3COOH/L = Nor. of CH_3COOH x Eq. Wt. of CH_3COOH

$\Rightarrow (0.046)(60.05)$

$\Rightarrow \boxed{2.762g}$ //

:= Report:

$V_1 = 4.6$ ml

$V_2 = 8.5$ ml

Weight of $HCl/L = 1.679g$

Weight of $CH_3COOH/L = 2.762g$ //

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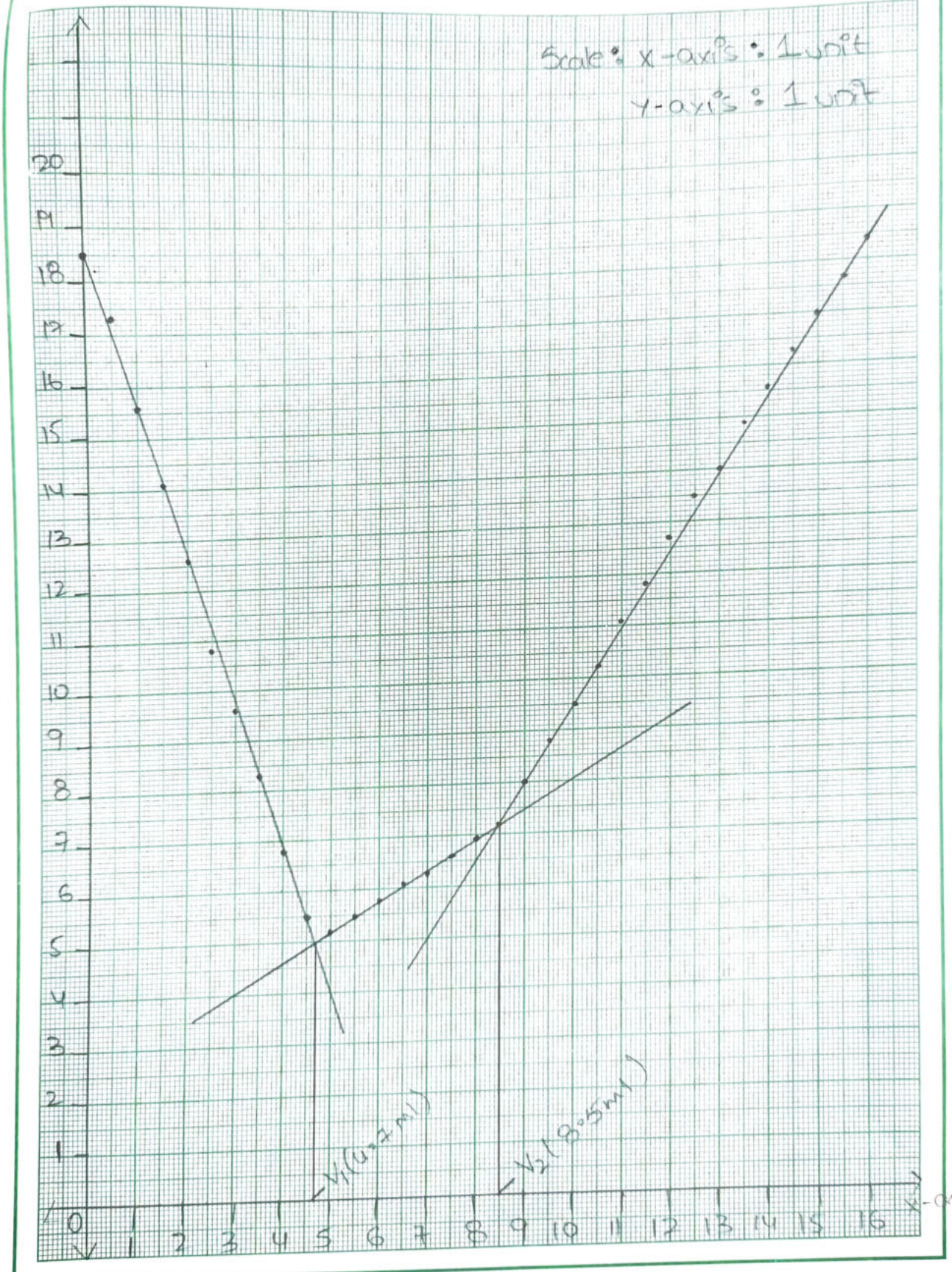

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Estimation of Copper from industrial elements by The Colorimeter Method-

:= **Aim:**

To estimate the amount of Copper present in given solution by colorimeter method.

:= **Principle:**

$$A = \varepsilon C t$$

{ is the molar extinction co-efficient Constant at a given wavelength), t is the thickness.

The absorbance (vs) Concentration graph gives balance of the standard series solution is measured using Photoelectric Colorimeter at 610 nm and plotted against Vol. $CuSO_4$ to get the curve. A deep blue Copper ammonium Complex ion is formed when Cu^{2+} ions are mixed with ammonia according to the following reaction,

$$Cu^{2+} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}$$

:= **Formula:**

When mono-Chromatic light is Passed

$$I_0 = I_t + I_a + I_r$$

I_0 = Intensity of light,
I_t = Reflected light,
I_a = Absorbed light,
I_t = Transmitted light.

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$$T = I_t / I_0$$

T = Transmittance

$$-\log T = \log [I_0 / I_t] = A$$

A = Absorbance

:= Procedure:

(i) Fill up the burette with ammonia. Take 5ml of ammonia in each of the flasks. Add 5, 10, 15, 20 & 25ml of $CuSO_4$ solution from a rinsed burette into the flasks & dilute them with water up to the mark.

(ii) Add distilled water to the unknown solution upto the mark.

(iii) Measure the absorbance of all the 6 solutions against blank [5ml ammonia + Water] at 610nm using photoelectric Colorimeter.

(iv) Plot a graph with absorbance (y-axis) and Vol-$CuSO_4$ (x-axis) to find out the amount of $CuSO_4$ present in the unknown solution.

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:= Observation Table:

Flask No.	Vol. $CuSO_4$ (ml)	Vol. NH_3 (ml)	Absorbance
0	Blank	5	0 (Nil)
1	5	5	0.03
2	10	5	0.06
3	15	5	0.09
4	20	5	0.12
5	25	5	0.15
6	Test Solution	5	0.06

:= Calculation:

4 mg of $CuSO_4$ = $\frac{63.55}{249.6}$ mg of Cu × 4 = 'y' mg of Cu

$y = 1.018$ mg of Cu.

Given test solution Contains = $V * y$

$= (12.5)(1.018)$

$\Rightarrow$ 12.725 mg of Cu

:= Result:

Amount of Copper present in the Unknown solution is 12.725 mg.

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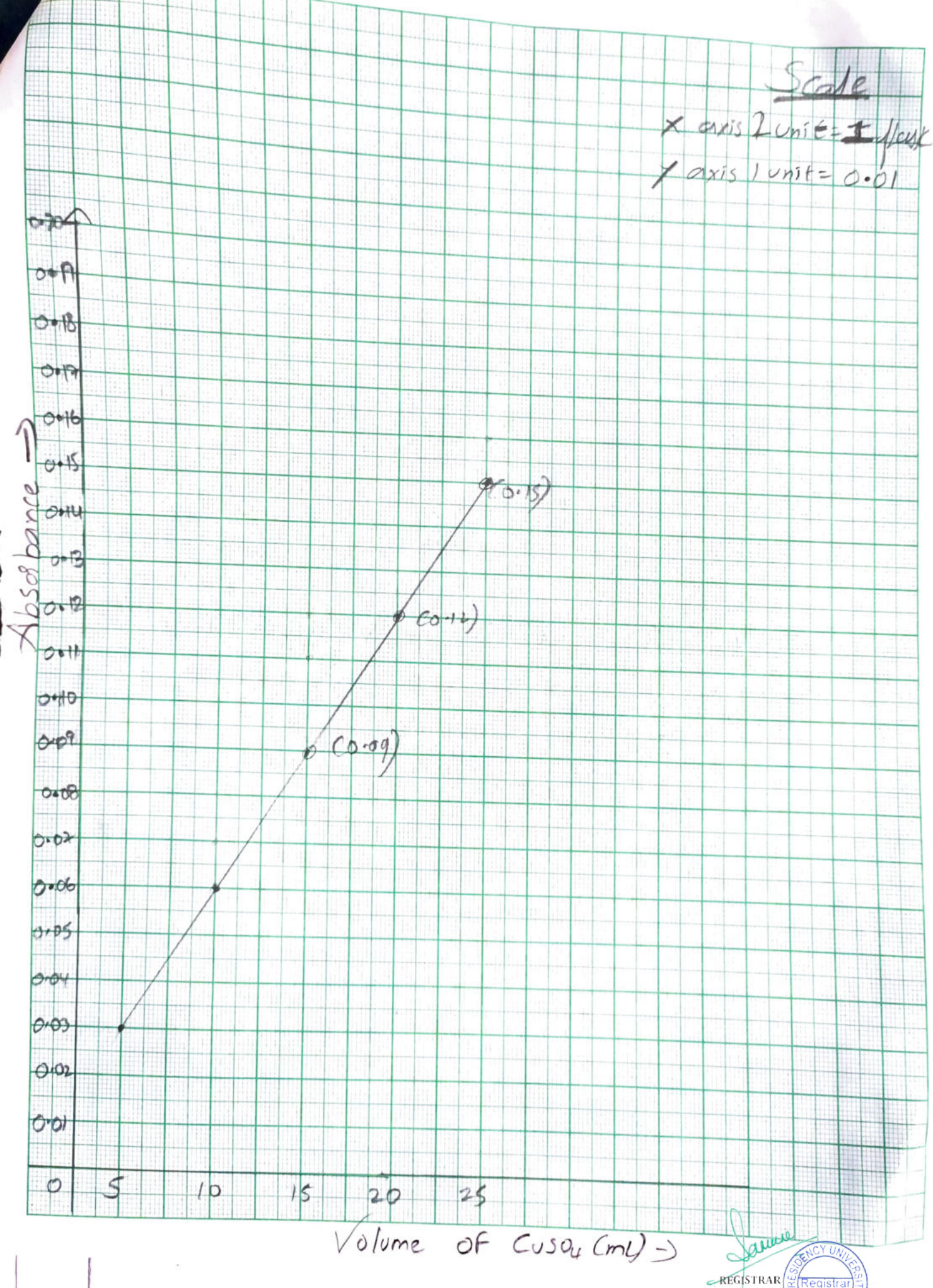

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Mohamed Saadullah. S
20211PET0001

Experiment : 5

Estimation of Strength of mixture of acids by conductometric titration.

Aim:

To estimate the concentration of mixture of acids by conductometric titration.

Principle:

The conductivity of the solution is related to the mobility of ions which in turn related with the size of the ions. When a mixture of strong acid like (HCl) and weak acid, are titrated against a followed by weak acid.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

38

When the whole strong acid is consumed, base reacts with weak acid and conductivity increases as unionised weak acid becomes the ionised salt.

$$CH_3COOH + NaOH \longrightarrow CH_3COO^- + Na^+ + H_2O$$

After both the acids are consumed, there is a step increases in conductivity which gives the endpoint and this increased in conductivity is due to the fast moving hydroxyl ions from the base.

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Apparatus : 100 ml. flasken - 2, 50ml - beaker - 1, 50 ml measuring glass rod - 1, 50ml burette - 1, burette stand - 1, conductivity cell connected to conductivity meter.

Chemicals : Std. NaOH solution, Acid mixture and distilled water.

Procedure :-

1. Take 50ml mixture of strong acid and weak acid in 100ml beaker.
2. Fill the burette with standard NaOH solution.
3. The conductivity cell (Pair of Plantinum electrode) connected to the instrument dip in the test solution. so that the electrodes are completely immersed in the acid solution and record the conductance.
4. Add std. NaOH at the interval of 0.5 ml with uniform string and note the conductance after each addition.
5. Conductance will decrease initially, remain almost constant in middle region and increase later.
6. After complete neutralization, the amount of acid present in the given mixture can be determined based on alkali consumed.

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Sr. No.	Vol. of NaOH (ml)	Conductance (Ω^{-1}) (mho)
1	0	18.8
2	0.5	17.6
3	1.0	16.8
4	1.5	16.2
5	2	15.4
6	2.5	13.9
7	3	12
8	3.5	10.4
9	4	9.2
10	4.5	7.7
11	5	7.1
12	5.5	7.0
13	6	7.2
14	6.5	7.5
15	7	7.9
16	7.5	8.1
17	8	8.4
18	8.5	8.7
19	9	8.9
20	9.5	9.2
21	10	10
22	10.5	10.8
23	11	11.4
24	11.5	12.2
25	12	13.1
26	12.5	13.7
27	13	14.2
28	13.5	14.7
29	14	15.3
30	14.5	15.8
31	15	16.3
32	15.5	16.8
33	16	17.2
34	16.5	17.7
35	17	18.3
36	17.5	18.6
37	18	19
38	18.5	19.4
39	19	19.7
40	19.5	20.1
41	20	20.3

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Estimation of HCl:

Normality of the NaOH soln = 0.5N

Volume of mixture of acids pipetted out = 50ml

Volume of NaOH required to neutralize HCl = V_1 ml

= 4.75 ml

Normality of HCl = $\frac{\text{Normality of NaOH} \times \text{Vol of NaOH}}{50}$

$= \frac{0.5 \times 4.75}{50}$

Normality of HCl = 0.047N

∴ Weight of HCl/L = Normality of HCl × eq. wt of HCl (36.5)

$= 0.047 \times 36.5$

Wt. of HCl = 1.71g

Estimation of CH_3COOH:

Vol. of NaOH required to neutralize $CH_3COOH = (V_2 - V_1)$ ml

= 4.75 ml

Normality of CH_3COOH = $\frac{\text{Normality of NaOH} \times \text{Vol. of NaOH}}{50}$

$= \frac{0.5 \times 4.75}{50}$

Normality of CH_3COOH = 0.047N

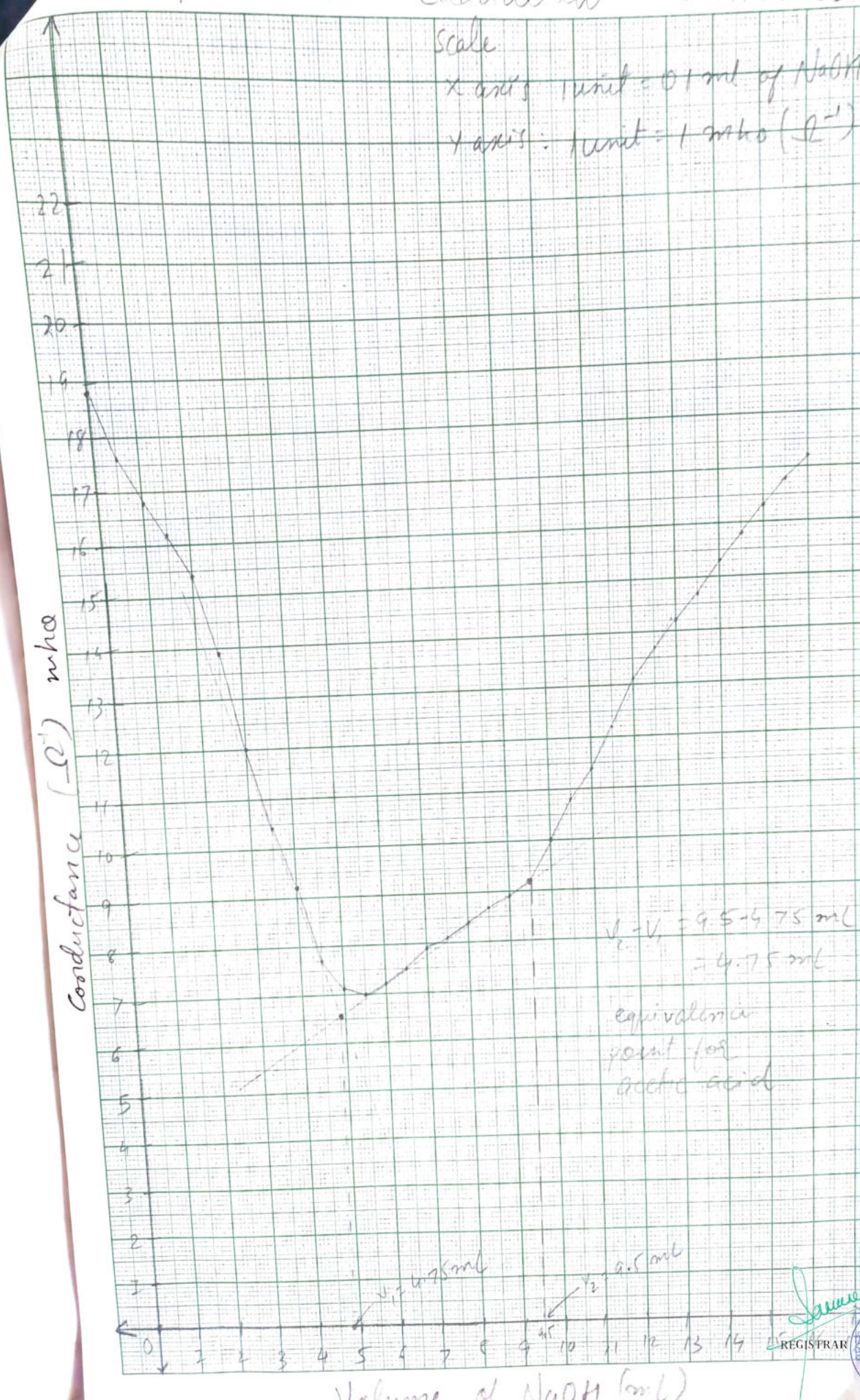
Therefore.

Weight of CH_3COOH/L = Normality of CH_3COOH × Eq. wt of CH_3COOH

Wt. of CH_3COOH/L = 0.047×60.05

= 2.82g

Experiment 3 Saadullah 2021IPET0001



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Mohamed Saadullah. S

20211PET0001

Date 10-4-2022

Experiment -2

Potentiometer estimation of iron using standard potassium dicromate Solution.

Aim: To determine the amount of iron present in the given solution using $K_2Cr_2O_7$

Principle: Potentiometer titration involves measurement of change in Potential of a solution at constant current on addition of tritrant with the help of highly sensitized electrodes. The electrodes commonly used are standard calomel electrode and pt wire electrode for redox reaction.

During titrimetric process, addition of tritrant results in change in concentration of irons presents in test sol^n. This change in concentration of iron leads to change in potential according. The endpoint of such titration is detected by an immidiate sharp change in Potential value determine by plotting a graph manually using the potential values obtained during titration.

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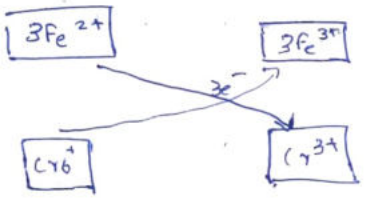
This experiment involves the determination of ferrous ammonium sulphate (FAS) in an unknown sample by redox titration with standard potassium dichromate soln. Here the titrate is FAS solution where Fe (II) reacts with titrant Cr^{6+}

The net reaction is given

$$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^{+} \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$



The Nernst equation relates a solution potential to the concentration of reactants and products participating in the redox reaction Therefore, Nernst equation is used to calculate the potential value (E).

$$E = E^0 + \frac{0.0591}{n} \log \frac{A_{oxi}}{A_{red}}$$

Where, A_{oxi} is oxidised from metal; A_{red} is reduced form of material E is standard potential; n is the number of electrons involved in redox reaction ∴ for the reaction Nearest equation can be written as:

Apparatus :- 100 ml Beaker - 2, 50ml - beaker - 1, 25ml pipette - 1 glass rod - 2, 50ml burette - 2, burette stand - 1, calomel and platinum electrodes connected to potentiometer.

Chemicals: Iron, Std - $k_2Cr_2O_7$ solution, Dil H_2SO_4 and Distilled water

Procedure: 1. Pipette out exactly 25ml of given iron solution, add 10ml of dilute H_2SO_4 to maintain acidic reaction and add water up to 100ml in a 250ml beaker.

2. Rinse the std. calomel electrode and bright platinum electrode assembly with distilled water.

3. Immerse them in the reaction mixture to connect the electrode assembly to the potentiometer. Switch on the Potentiometer and make sure initial value is 400 mV.

4. Add 0.5ml of standard N/n $K_2Cr_2O_7$ from the burette, mix thoroughly and note down the reading after each addition.

5. Continue to procedure the till the potential increase more rapidly near the equivalence point (10ml, ie 20 readings) Go to the equivalence is past there will be only slight change in Potential for the successive addition of $K_2Cr_2O_7$ sol

Determine of Equivalence Point:

1. Plot a graph of $\Delta E / \Delta V$ values along (y-axis)
   Vs Volume of $K_2Cr_2O_7$ (along x-axis)

2. The maximum $\Delta E / \Delta V$ value corresponds to equivalence point, from the equivalence point, draw x intercept to obtain the volume (V_1) of $K_2Cr_2O_7$ solution.

3. Use V_1 value to calculate the normality of the solution.

Precautions:

1. Electrodes are sensitive and easily, Handle it carefully
2. Always keep the electrodes dipped in Soln
3. Chromic is toxic. Handle carefully

Calculation:-

Volume of $K_2Cr_2O_7$ Soln corresponding to the equivalence Point (V_1) = 4.0 ml (Obtained from graph)

Normality of $K_2Cr_2O_7$ Sol^n $N_1 = 0.1\ N$

Normality of Iron Solution (N_{Fas}) = $\frac{N_1 \times V_1}{V_{iron}} = \frac{0.1 \times 4}{28}$

$N_{FAS} = 0.016$

Weight of Iron present in 1 lt of its Solution = N_{Fas} × equivalent weight of iron

= $N_{Fas} \times 55.85$ g/L

= 0.8936 g/L

$E = E^{\circ} + \frac{}{3}$ Cr^{3+}

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Volume of $K_2Cr_2O_7$ (ml)	EMF or E (mV)	ΔE	ΔV	$\Delta E/\Delta V$
0.0	400	-	-	-
0.5	411	11	0.5	22
1.0	418	07	0.5	14
1.5	428	10	0.5	20
2.0	438	10	0.5	20
2.5	456	16	0.5	32
3.0	470	14	0.5	28
3.5	495	25	0.5	50
4.0	606	111	0.5	222
4.5	645	39	0.5	78
5.0	650	05	0.5	10
5.5	654	04	0.5	8
6.0	660	06	0.5	12
6.5	665	05	0.5	10
7.0	668	03	0.5	6
7.5	671	03	0.5	6
8.0	675	04	0.5	10
8.5	677	02	0.5	4
9.0	679	02	0.5	4
9.5	681	02	0.5	4
10.0	683	02	0.5	4

2022

Yaxis : 1 unit = 10 mV

Xaxis : 1 unit = 1 cm

given

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4 APR 22

Potentiometric Estimation of Iron using standard Potassium Dichromate Solution.

[V. Jaisphoorthi]
[20211PET0008]

Aim:

To determine the amount of Iron present in the given solution using standard $K_2Cr_2O_7$.

Principle:

This experiment involves the determination of FAS in an unknown sample by redox titration with standard potassium dichromate solution.

Reaction:

$$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O \quad \cdots\cdots (1.)$$

Equation: [Nernst Equation]

$$E = E^0 + \frac{0.0591}{n} \log \frac{A_{ox}}{A_{red}} \quad (2.)$$

$$E = E^0 + \frac{0.0591}{3} \log \frac{Cr^{6+}}{Cr^{3+}} \quad (3.)$$

Procedure:

(1.) 25ml of given iron solution is pipetted out. 10ml of dil. H_2SO_4 and 90ml of water adding upto 100ml of a 250 ml beaker.

(2) The standard calomel electrode and platinum electrode are immersed in the beaker with the mixture and an initial of 400mV is set on the potentiometer before titration.

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(3) With every 0.5 ml of 0.1N $K_2Cr_2O_7$ from the burette ents in to the beaker, after mixed the values are noted. The process is continued for 20 readings.

Table:

Vol of $K_2Cr_2O_7$ (ml)	EMF or E (mV)	ΔE	ΔV	$\Delta E/\Delta V$
0.0	400	NIL	NIL	NIL.
0.5	408	8	0.5	4
1.0	416	8	0.5	4
1.5	425	9	0.5	4.5
2.0	438	13	0.5	6.5
2.5	446	8	0.5	4
3.0	463	17	0.5	8.5
3.5	486	23	0.5	11.5
4.0	607	121	0.5	60.5
4.5	634	27	0.5	13.5
5.0	643	9	0.5	4.5
5.5	645	2	0.5	1
6.0	654	9	0.5	4.5
6.5	657	3	0.5	1.5
7.0	661	4	0.5	2
7.5	663	2	0.5	1
8.0	665	2	0.5	1
8.5	666	1	0.5	0.5
9.0	668	2	0.5	1
9.5	670	2	0.5	1
10.0.	671	1	0.5	0.5

Calculation:

Volume of $K_2Cr_2O_7$ solution corresponding to the equivalence point (V_1) = 3.5 ml.

Normality of $K_2Cr_2O_7$ solution N_1 = 0.1N.

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Normality of Iron solution (N_{FAS}) = $\frac{N_1 \times V_1}{V_{Iron}}$

$= \frac{(0.1)(3.5)}{25}$

$= \frac{0.35}{25}$

$= 0.014$ N

weight of Iron present in on litre of the solution

= (N_{FAS} x equivalent weight of Iron)

$= (0.014)(55.85)$ g/L

$= 0.7819$ g/L.

Report:

Volume of $K_2Cr_2O_7$ (V_1) = 3.5 ml

Normality of $K_2Cr_2O_7$ (N_1) = 0.1 N

Normality of Iron Solution (N_{FAS}) = 0.014 N

Weight of Iron Present = 0.7819 g/L.

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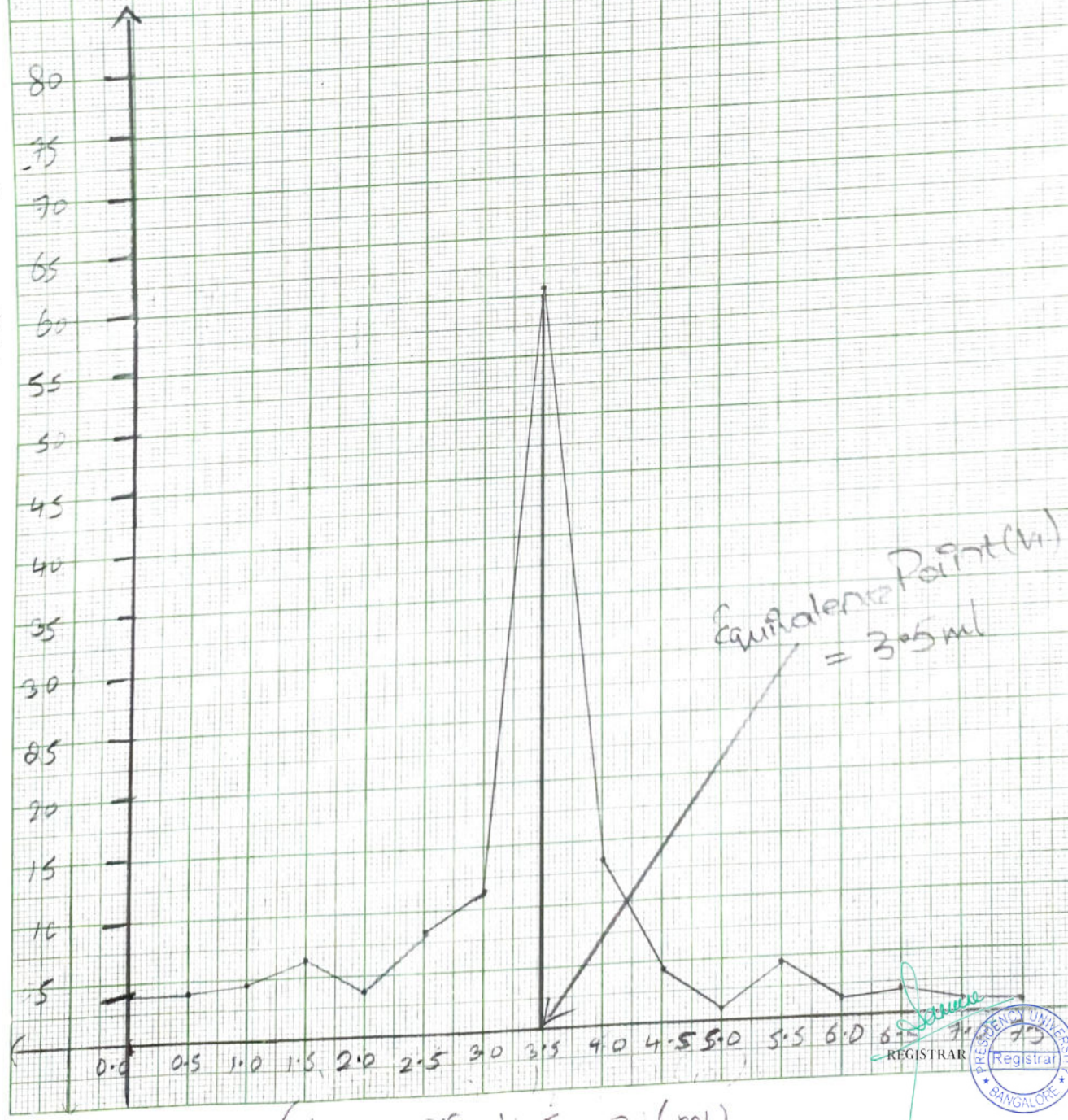
Scale:

x-axis = 0.5 units

y-axis = 5 units



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26 Mar 22

Exp 4: Estimation of copper from industrial effluents by colorimeter method.

2021IPET0008

Aim: To estimate the amount of copper present in given solution by colorimeter method.

Principle: $A = \varepsilon ct$ [Beer-Lambert's Law].

ε is the molar extinction co-efficient (constant at a given wavelength), t is the thickness.

The absorbance vs concentration graph gives a straight line passing through the origin. The absorbance of the standard series solution is measured using photoelectric colorimeter at 610nm and plotted against vol. CuSO4 to get the curve. A deep blue cuproammonium complex ion is formed when Cu^{2+} ions are mixed with ammonia according to the following reaction,

$$Cu^{2+} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}$$

Formula: When monochromatic light is passed,

$$I_0 = I_t + I_a + I_r$$

I_0 = intensity of light

I_t = reflected light

I_a = absorbed light

I_t = transmitted light (negligible).

$$T = I_t / I_0$$

T = Transmittance

$$-\log T = \log [I_0 / I_t] = A$$

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Procedure:

(i) Fill up the burette with ammonia. Take 5ml of ammonia in each of the flasks. Add 5, 10, 15, 20 & 25ml of $CuSO_4$ solution from a rinsed burette into the flasks and dilute them with water up to the mark.

(ii) Add distilled water to the unknown solution upto the mark.

(iii) Measure the absorbance of all the 6 solutions against blank (5ml ammonia + water) at 610nm using photoelectric colorimeter.

(iv) Plot a graph with absorbance (y-axis) and vol. $CuSO_4$ (x-axis) to find out the amount of $CuSO_4$ present in the unknown solution.

Observation Table:

Flask. No	Vol. $CuSO_4$ (ml)	Vol. NH_3 (ml)	Absorbance
0	Blank	5	0
1	5	5	0.03
2	10	5	0.06
3	15	5	0.10
4	20	5	0.13
5	25	5	0.17
6	Test Solution → 12.5ml	5	0.08

Calculation:

4 mg of $CuSO_4$ $= \frac{63.55}{249.6}$ mg of Cu $\times 4 =$ 'y' mg of Cu

$y = 1.018$ mg of Cu

Given test solution contains $= V * y$ mg of Cu

$= (12.5)(1.018) = 12.725$ mg of Cu

Result:

Amount of copper present in the unknown solution is 12.725 mg.

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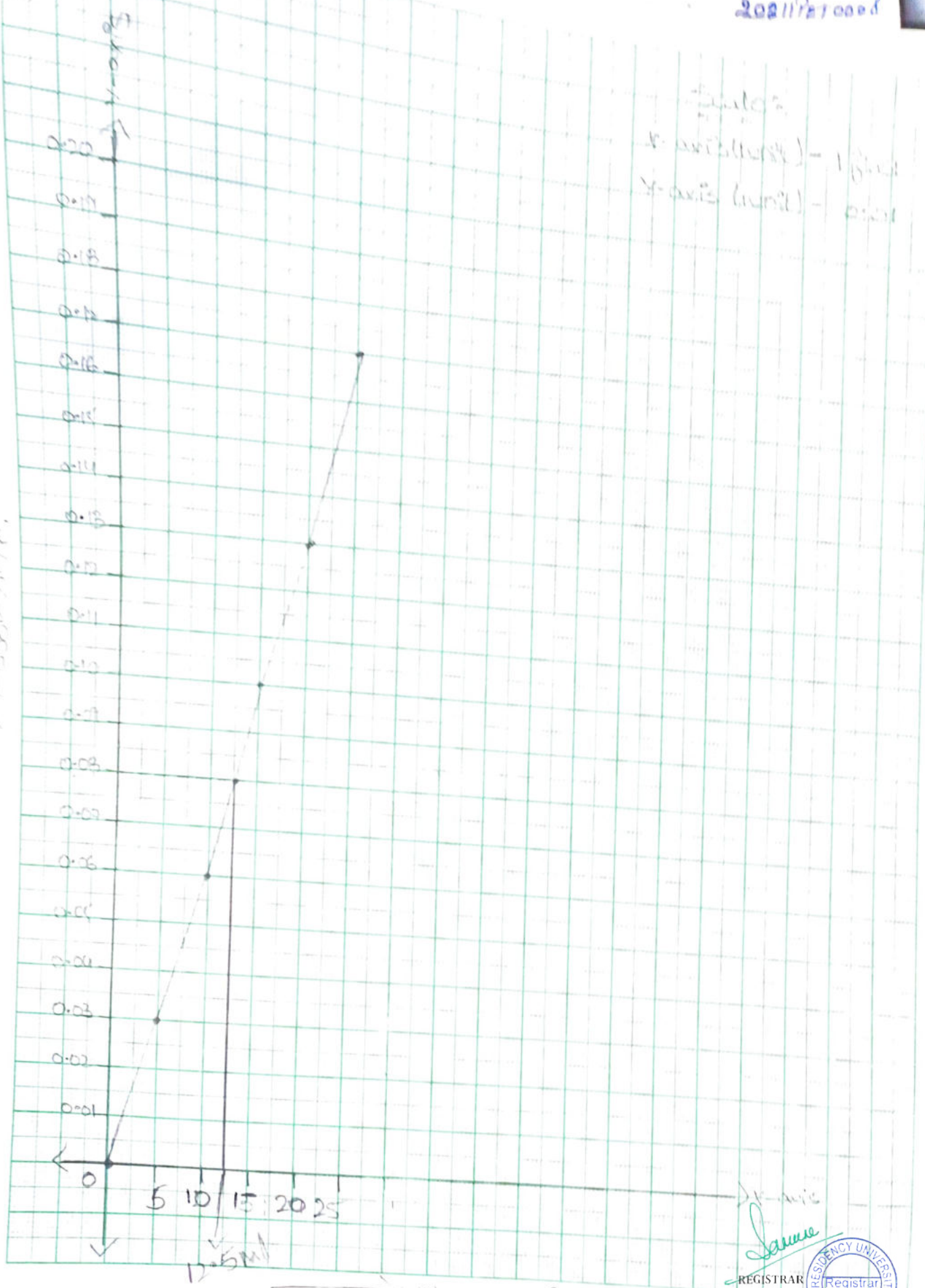
copper from industrial effluents

2021172 0008



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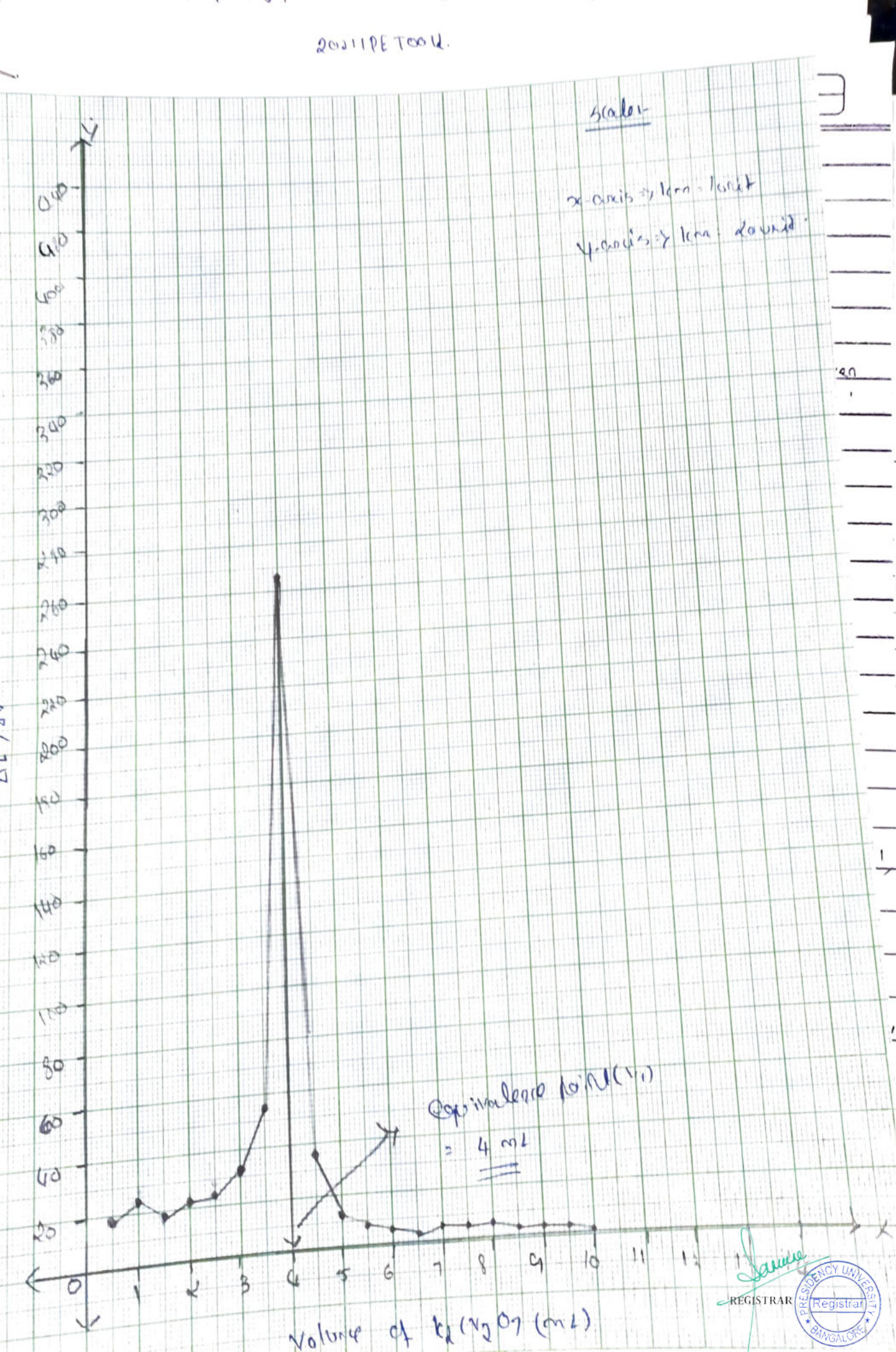
2021 IPE TOOL.



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Course Code: CHE1016	**Course Title: FORENSIC SCIENCE** **Type of Course: Open Elective**	**L- P-C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**NIL**				
Anti-requisites	**NIL**				
Course Description	This course is an introductory look at the various fields of forensic science and how to the background knowledge, forensic examinations and software tools to solve unusual topics. It also emphasizes on developing an algorithm to solve and restore lost data and reports.				
Course Objective	The objective of the course is to **familiarize the learners with the concepts of "Forensic Science" and attain EMPLOYABILITY SKILL through PROBLEM SOLVING LEARNING techniques.**				
Course Out Comes	On successful completion of the course the students shall be able to: 1] Identify the significance of forensic science to human society. 2] Locate the divisions in a Forensic Science Laboratory. 3] Use the of Trace Evidence, Ballistics and Document examination by forensic scientists. 4] Learn to generate the algorithm, documentation using softwares.				
Course Content:	This course includes a broad series of lessons and activities that offer a variety of modalities for ultimate student engagement and content retention. Each unit contains a series of lessons that include introduction of content, listing the forensic science laboratories, facilities in labs, instruments involved, tracing evidences and examination. It also includes forensic application in restoring lost data, documents, writing algorithm for the same and solving few case studies using software tools.				
Module 1	**INTRODUCTION**	Assignment	Fundamentals		**03 Classes**
Topics: Definitions and Pioneers. Historical development of Forensic Science. Principles of Forensic Science.					
Module 2	**FORENSIC SCIENCE LABORATORIES**	Assignment	Data Collection		**06 Classes**
Topics: Organization of Directorate of Forensic Institutions State Forensic Science Laboratories. Divisions of Forensic Science laboratories and its Functions. Use of important instruments – Microscopes, Spectroscopy, Video Spectral Comparator & Invisible Rays. Role of experts in crime investigation and detection.					

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Module 3	**TRACING EVIDENCES**	Case Study	Data Collection	**08 Classes**
Topics: Trace Evidences a) Hair and fiber. 10 b) Glass Fractures c) Tool marks d) Paint and Soil. Forensic Ballistics. a) Meaning, Classification of firearms and ammunition. b) Identification of firearm and the shooter. c) Explosives: meaning & classification Types				
Module 4	**FORENSIC EXAMINATION**	Case Study	Data Collection	**08 Classes**
Topics: Examination of Documents and Currency. a) Questioned Documents: Meaning and Types- (i) Forgeries – Meaning & Types b) Identification of hand written documents – Authors c) Differentiation of genuine and counterfeit currency coins & Notes.				
Module 5	**FORENSIC APPLICATIONS**	Assignment	Programming	**10 Classes**
Topics: Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science, Knowledge base systems, Quality base of system General concepts and tools, Arithmetic and logical operation, Developing an algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing , Reports and control breaks, Processing the date.				

Targeted Application & Tools that can be used:

1. Belkasoft live RAM Capturer
2. Magnet RAM Capture
3. Volatility

Project work/Assignment: Mention the Type of Project /Assignment proposed for this course

1.Probability population and sampler using tool (Volatility)
2. Develop an algorithm to solve how to restore lost data, reports.

Assessment Type

1. Midterm exam
2. Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)
3. Quiz
4. End Term Exam
5. Self-Learning

Text Book

1. Criminalistics: An Introduction to Forensic Science by Richard Saperstein, Prentice Hall.

2. Introduction to Forensic Sciences by William G Eckert, CRC Press.

References

1. Computer forensics: evidence collection and management by Robert C. Newman and Boca Raton FL, Taylor and Francis.
2. Forensic Computer Crime Investigation By Jr Thomas A Johnson, Taylor and Francis, CRC Press
3. Introduction to Statistics for Forensic Scientists by David Lucy, Wiley publications.
4. Digital Evidence and Computer Crime, Academic Press

E-resources:

5. http://www.mysciteacher.com/wp-content/uploads/2018/05/forensic-science_text.pdf

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6. https://notesmed.com/wp-content/uploads/2021/05/The-Essentials-Of-Forensic-Medicine-And-Toxicology-33rd-edition.pdf	
Topics relevant to Employability Skill Development: listing the forensic science laboratories, facilities in labs, instruments involved, tracing evidences and examination for Developing Employability Skills through Problem solving Techniques. This is attained through assessment components mentioned in course handout. **Topics relevant to Human Values & Professional Ethics**: Principles of Forensic Science.	
Catalogue prepared by	Dr. Chaitanya Lakshmi. G
Recommended by the Board of Studies on	PU/SOE/CHE/BOS-05/2021-22 5th BOS: 6th August 2021
Date of Approval by the Academic Council	16th Academic council, PU/AC-16/MEC/2018-2022/2021 23rd Oct, 2021

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act41 of 2013)

ACA-2[2019] COURSE HAND OUT

SCHOOL: School of Engineering **DEPT.:** Chemistry **DATE OF ISSUE:** 06th August 2021

NAME OF THE PROGRAM: Bachelor of Technology

P.R.C. APPROVAL REF.: PU/AC-16/CHE/2021

SEMESTER/YEAR: 7th Semester /4th Year

COURSE TITLE & CODE: Forensic Science & CHE1016

COURSE CREDIT STRUCTURE: 3-0-3

CONTACT HOURS: 3hours/week (42 Hours)

Course In-charge: Dr. Chaitanya Lakshmi. G

COURSE INSTRUCTOR(S): Dr. Chaitanya Lakshmi. G

PROGRAM OUTCOMES:

PO 1: Engineering knowledge: **Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (H)**

PO 2: Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (M)

PO 3: Design/development of solutions: **Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (L)**

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering 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. (L)

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (L)

COURSE PREREQUISITES: NIL

COURSE DESCRIPTION: This theory based course gives an introductory look at the various fields of forensic science, forensic examinations and software tools to solve unusual topics. It also emphasizes on developing an algorithm to solve and restore lost data and reports.

This course caters to **Human Values & Professional Ethics**

Course Objective: The objective of the course is to **familiarize the learners with the concepts of "Forensic Science" and attain EMPLOYABILITY SKILL through PROBLEM SOLVING LEARNING techniques.**

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

CO1	**Identify the significance of forensic science to human society.**	**Knowledge Level**
CO2	**Locate the divisions in a Forensic Science Laboratory.**	**Comprehension Level**
CO3.	**Use the Trace Evidence, Ballistics and Document examination by forensic scientists.**	**Application Level**
CO4.	**Learn to generate the algorithm, documentation using software.**	**Synthesis Level**

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MAPPING OF C.O. WITH P.O. [H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.03	P.O.10	P.O.12
C.O. 01	M			L	L
C.O. 02	L	M	L		L
C.O. 03	L	M	L		L
C.O. 04	L	M	L	L	M

COURSE CONTENT (SYLLABUS):

Module 1: Introduction **[5 Hours] [Knowledge Level (1)]**

Introduction to Forensic Science: Definitions and Pioneers. Historical development of Forensic Science. Principles of Forensic Science.

Module 2: Forensic Science Laboratories **[7 Hours] [Comprehension Level (2)]**

Organization of Directorate of Forensic Institutions State Forensic Science Laboratories. Divisions of Forensic Science laboratories and its Functions. Use of important instruments – Microscopes, Spectroscopy, Video Spectral Comparator & Invisible Rays. Role of experts in crime investigation and detection.

Module 3: Tracing Evidences **[10Hours] [Application Level (3)]**

Trace Evidences a) Hair and fiber. b) Glass Fractures c) Tool marks d) Paint and Soil. Forensic Ballistics. a) Meaning, Classification of firearms and ammunition. b) Identification of firearm and the shooter. c) Explosives: meaning & classification Types

Module 4: Forensic examination **[10 Hours] [Application Level (3)]**

Examination of Documents and Currency. a) Questioned Documents: Meaning and Types- (i) Forgeries – Meaning & Types b) Identification of hand written documents – Authors c) Differentiation of genuine and counterfeit currency coins & Notes.

Module 5: Forensic Applications **[10 Hours] [Synthesis Level (4)]**

Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science, Knowledge base systems, Quality base of system General concepts and tools, Arithmetic and logical operation, Developing an

algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing, Reports and control breaks, Processing the date.

DELIVERY PROCEDURE (PEDAGOGY):

Participative Learning: Probability population and sampler, weight of evidence and the Bayesian likelihood ratio (through Group Discussion).

Problem Based Learning: Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science (Scenario Based)

Technology Enabled Learning: Arithmetic and logical operation, Developing an algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing, Reports and control breaks, Processing the date. (NPTEL Videos) by Dr. Harisingh Gour Vishwavidyalaya, Sagar (M.P)

Active learning: Use of Volatility and Knowledge base systems, Quality base of system General concepts and tools

https://www.volatilityfoundation.org/

https://www.volatilityfoundation.org/releases

https://www.volatilityfoundation.org/releases-vol3

Self-learning topics: Arithmetic and logical operation, Developing an algorithm to solve problem,

Modularization, Function and procedures, Arrays, File processing, Reports and control breaks,

Processing the date.

REFERENCE MATERIALS: Textbooks, reference books, any other resources, like webpages.

Textbook:

1. Criminalistics: An Introduction to Forensic Science by Richard Saperstein, Prentice Hall.

2. Introduction to Forensic Sciences by William G Eckert, CRC Press.

Reference books:

1. Computer forensics: evidence collection and management by Robert C. Newman and Boca Raton FL, Taylor and Francis.
2. Forensic Computer Crime Investigation By Jr Thomas A Johnson, Taylor and Francis, CRC Press
3. Introduction to Statistics for Forensic Scientists by David Lucy, Wiley publications.
4. Digital Evidence and Computer Crime, Academic Press

E-resources:

1. http://www.mysciteacher.com/wp-content/uploads/2018/05/forensic-science-text.pdf
2. https://notesmed.com/wp-content/uploads/2021/05/The-Essentials-Of-Forensic-Medicine-And-Toxicology-33rd-edition.pdf

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Video Links:

1. https://onlinecourses.swayam2.ac.in/cec20_ge10/preview
2. https://www.youtube.com/watch?v=VVXMidZzifg
3. https://www.youtube.com/watch?v=pBogHJqCY08

GUIDELINES TO STUDENTS:

- Be attentive and regular to class
- Refer class materials and also you can refer online materials, YouTube videos, NPTEL etc.
- Students should come prepared with the basics of the topics that will be covered in the next class
- No make-up for Assignment and Quiz
- Recommended to take NPTEL online certification course
- All course related information will be displayed on the SoE notice board

COURSE SCHEDULE: [dates are subject to minor changes]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Over View of the course	23/8/2021	23/8/2021	1
02	Module : 01	24/8/2021	7/9/2021	5
03	Assessment 1	13/9/2021		1
04	Module: 02	14/9/2021	05/10/2021	7
05	Test-1	15/9/2021	17/9/2021	1
06	Assessment 2	18/10/2021		1
07	Module:03	11/10/2021	08/11/2021	9
08	Assessment 3	9/11/2021		1
09	Module:04	15/11/2021	22/11/2021	7
10	Test-2	15/11/2021	17/11/2021	1
11	Module:05	23/11/2021	7/12/2021	10
12	Assessment 4	7/12/2021		1

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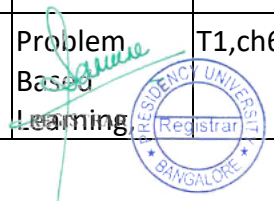
13	Revision	6/12/2021	8/12/2021	1
14	End Term	13/12/2021	5/1/2022	1

SCHEDULE OF INSTRUCTION:

Sl. no	Session no[date if possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1	Overview of Course	Introduction to Forensic Science	CO.No.1	PPT	T1,ch1
2	S2	Introduction to Forensic Science	Definitions and Pioneers.	CO.No.1	PPT	T1,ch1
3	S3	Histroy	Historical development of Forensic Science.	CO.No.1	PPT	T1,ch2
4	S4	Principles	Principles of Forensic Science.	CO.No.1	PPT	T1,ch2
5	S5	Principles	Principles of Forensic Science.	CO.No.1	PPT	T1,ch2
6	S6	Assessment 1 – Class Test				
Module 1 completed						
7	S7	Based on Principles of Forensic Science discussed in Module 1;	Role of experts in Crime Scene will be discussed along with uses of Important instruments	CO.No.1	PPT	T1,ch3
8	S8	Forensic Science Laboratories.	State Forensic Science Laboratories.	CO.No.1	PPT	T1,ch3
9	S9	Divisions and its Functions.	Divisions of Forensic Science laboratories and its Functions.	CO.No.2	PPT	T1,ch4
10	S10	Use of important instruments	Microscopes, Spectroscopy	CO.No.2	PPT	T1,ch4
11	S11	Use of important instruments	Video Spectral Comparator Invisible Rays	CO.No.2	PPT	T1,ch6
12	S12	Crime investigation and detection.	Role of experts in crime investigation and detection.	CO.No.2	Problem Based Learning	T1,ch6



13	S13	Assessment 3 – Quiz				
Module 2 completed						
14	S14	By the knowledge of use of important instruments analysis of Trace evidences:	e Evidences a) Hair and fiber	CO.No.3	PPT	T1,ch5
15	S15	Trace Evidences	Glass Fractures	CO.No.3	PPT	T1,ch5
16	S16	Trace Evidences	ool marks	CO.No.3	PPT	T1, ch5
17	S17	Trace Evidences	aint and Soil.	CO.No.3	PPT	T1,ch5
18	S18	Forensic Ballistics	Forensic Ballistics. a) Meaning, Classification of firearms and ammunition	CO.No.3	PPT	T1,ch5
19	S19	Forensic Ballistics	Forensic Ballistics. a) Meaning, Classification of firearms and ammunition	CO.No.3	PPT	T1, ch7
20	S20	Firearm.	. b) Identification of firearm and the shooter.	CO.No.3	PPT	T1, ch7
21	S21	Explosives	c) Explosives: meaning & classification Types	CO.No.3	Problem Based Learning	T1, ch7
22	S22	Explosives	c) Explosives: meaning & classification Types	CO.No.3	Problem Based Learning	T1, ch7
23	S23	Assessment 3 – Quiz				
Module 3 completed						

24	S24	By the knowledge trace evidence examination and use of important instruments:	Examination of Documents and Currency. a) Questioned Documents: Meaning and Types-	CO.No.4	Problem Based Learning	T1, ch8
25	S25	Examination of Documents	Examination of Documents and Currency. a) Questioned Documents: Meaning	CO.No.4	PPT	T1, ch8
26	S26	Examination of Documents	and Types- (i) Forgeries – Meaning & Types	CO.No.4	PPT	T1, ch8
27	S27	Examination of Documents	b) Identification of hand written documents – Authors	CO.No.4	PPT	T1, ch8

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28	S28	Examination of Documents	b) Identification of hand written documents – Authors	CO.No.4	PPT	T1, ch9
29	S29	Examination of Currency.	c) Differentiation of genuine and counterfeit currency coins & Notes.	CO.No.4	Participative Learning	T1, ch9
30	S30	Examination of Currency.	c) Differentiation of genuine and counterfeit currency coins & Notes	CO.No.4	PPT	T1, ch9
31	S31	Examination of Currency.	c) Differentiation of genuine and counterfeit currency coins & Notes	CO.No.4	PPT	T1, ch9
32	S32	Examination of Currency.	c) Differentiation of genuine and counterfeit currency coins & Notes	CO.No.4	PPT	T1, ch9
33	S33	Assessment 4 – Quiz				
Module 4 Completed						
34	S34	By the data collected during the trace evidence:	Probability population and sampler, weight of evidence	CO.No.4	PPT	T1, ch9
35	S35	Bayesian likelihood ratio	Bayesian likelihood ratio	CO.No.4	Technology Enabled Learning	T1,ch10
36	S36	Transfer evidence	Transfer evidence application of statistics to particular areas of forensic science,	CO.No.4	Problem Based Learning	T1,ch10
37	S37	Transfer evidence	Transfer evidence application of statistics to particular areas of forensic science,	CO.No.4	Problem Based Learning	T1,ch11
38	S38	Knowledge base systems	Knowledge base systems, Quality base of system	CO.No.4	Problem Based Learning,	T1, R2ch1
39	S39	Arithmetic and logical operation	General concepts and tools	CO.No.4	Problem Based Learning	T3,R2,ch2
40	S40	Quality base of system	Arithmetic and logical operation			
41	S41	Developing an algorithm to solve	Developing an algorithm to solve			

		problem	problem Modularization			
42	S42	Revision				
43	S43	Assignment 5 - Written assignment and upload in Edhitch /Quiz				
Module 5 completed						

Topics relevant to Employability Skill Development: listing the forensic science laboratories, facilities in labs, instruments involved, tracing evidences and examination for developing Employability Skills through Problem Solving Techniques. This is attained through assignments as mentioned in assessment schedule.

ASSESSMENT SCHEDULE:

Sl. No.	Assessment type	Contents	Course outcome Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1	Assessment 1 – Class Test/MCQ	Based on module 1	CO 1	1 hour	10	5%	CLASSROOM
2	Assessment 2 – Problem solving Assignment	Based on module 2	CO 2	1 hour	10	5%	CLASSROOM
3	Assessment 3 – Quiz	Based on module 3	CO 3	1 hour	10	5%	CLASSROOM
4	Assessment 4 - assignment 2 and upload in Edhitch/Quiz/MCQ	Based on module 4	CO 4	1 hour	10	5%	HOMEWORK
5	Test 1	Based on module 1 and 2	CO 1 and CO 2	1 hour	30	15%	15/9/2021 to 17/9/2021
6	Test 2	Based on module 2 and 3	CO 2 and CO 3	1 hour	30	15%	15/11/2021 to 17/11/2021
7	End Term	Based on module 1, 2, 3 &4	CO 1, CO 2, CO 3 & CO4	3 hours	100	50%	13/12/2021 to 5/1/2022

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COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment & term end examination, make-up exam policy and other details as per the academic regulations & PRC):

Students are advised to maintain a minimum attendance of 75% in this course. Failing which, the student will not be permitted to attend the end term examination and subsequently awarded "NP" grade.

Also, minimum performance of 40% (40 marks/100) in continuous assessment and 40% (40 marks/100) in end term exam is required to clear the course. Failing which, the student will be awarded "NE" (not eligible) grade and/or "F" (fail) grade respectively.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

To be notified by the Instructor based on the timetable.

SAMPLE THOUGHT PROVOKING QUESTIONS:

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	Which of the following is the best definition of forensic science? A. Using proper scientific techniques to understand the layout of a crime scene. B. The application of scientific knowledge and technology to the analysis of crime scene evidence. C. Understanding the process in which a crime was committed. D. The science studying the origins and background of crime scene investigation.	2	CO.No.1	Knowledge
2.	Light that has all its waves pulsating in unison is called (A) Maser	2	CO.No.1	Knowledge

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	(B) Laser (C) Monochromatic light (D) Polychromatic light			
3.	A scientist can determine the method of removal for a hair when analyzing hair samples. CH3 A. True B. False	1	CO.No2	Comprehension
4.	Which of the following is an example of an individual characteristic that can definitely be associated with one individual? CH3 A. Fingerprint ridges B. Custom paint on a vehicle C. Blood types D. Materials in plastic bags	2	CO.No.4	Knowledge
5.	Hollow Cathode Lamp (HCL) is used in the following: (A) Atomic Absorption Spectrometer (B) Atomic Emission Spectrometer (C) Infra Red Spectrometer (D) X-ray Fluorescence Spectrometer	2	CO.No.3	Comprehension

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SAMPLE ASSIGNMENT QUESTIONS:

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	The suspect one of a crime scene when investigated had particles of soil on this clothes, whereas the suspect two on investigation did not carry any. According to what Principle of Forensic Science the suspect one can be further investigated? State that principle.	10	CO.No.1	Knowledge
2.	In addition to physical sciences laboratory unit, which five other laboratory units you think are so important in a full-service a crime labs? List at least one function performed by these units.	10	CO.No2	Comprehension
3.	The document authenticity and verification for any type of erasure is carried out by an instrument. Name that instrument and elaborate the type of erasures that can be detected.	10	CO.No3	Comprehension
4.	From the crime scene the nature of evidence collected was found to be nonvolatile, complex mixture, name which analytical technique that should be made use in order to analyze the evidence and mention the principle involved.	2	CO.No.4	Application
5.	Write a flow chart to recover deleted email from a gmail account?	10	CO.No.4	Application

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Target set for Course Outcome attainment:

Sl. No.	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Identify the significance of forensic science to human society.	35
02	CO2	Locate the divisions in a Forensic Science Laboratory.	25
03	CO3	Use the of Trace Evidence, Ballistics and Document examination by forensic scientists.	30
04	CO4	Learn to generate the algorithm, documentation using softwares.	30

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment. [This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl. No.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Over View of the course	23/8/2021		
2	Module : 01	8/9/2021		

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3	Assessment 1	13/9/2021		
4	Module: 02	12/10/2021		
5	Test-1	17/9/2021		
6	Assessment 2	13/10/2021		
7	Module:03	10/11/2021		
8	Assessment 3	12/11/2021		
9	Module:04	4/12/2021		
10	Test-2	17/11/2021		
11	Assessment 4	5/12/2021		
12	Revision	8/12/2021		
13	End Term	5/1/2022		

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl. No.	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
01	CO1	Identify the significance of forensic science to human society.	35		
02	CO2	Locate the divisions in a Forensic Science Laboratory.	25		
03	CO3	Use the Trace Evidence, Ballistics and Document examination by forensic scientists.	30		
04	CO4	Learn to generate the algorithm, documentation using softwares.	30		

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Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use, write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized

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Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

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SCHOOL of ENGINEERING
DEPARTMENT OF CHEMISTRY

Ref.No.:PU/SOE/CHE /**Assignment announcemnet**/2020-21/3rd year/CHE1016

Course Title: Forensic science
Course Code: CHE1016

Name of the Instructor in Charge: Dr. Chaitanhya Lakshmi G

Name of the Instructor: Dr. Chaitanhya Lakshmi G

Answer All the questions. Each question carries 10 marks

1. Write a flow chart to recover deleted mail form G-mail.
2. Discuss any four advanced techniques used in forensic science.

Signature of Instructor In-Charge

(Dr. Chaitanhya Lakshmi G)

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GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

(Private University Estd. in Karnataka State by Act No.41 of 2013)

NAME: PUTLUR YASWANTHI

ID NUMBER: 20181COM0117

SECTION: 01

BRANCH: COM

SCHOOL: SOE

COURSE CODE: CHE1016

COURSE NAME: FORENSIC SCIENCE

SUBMITTED ON: NOV-2021

SUBMITTED TO: Dr. CHAITANYA LAKSHMI

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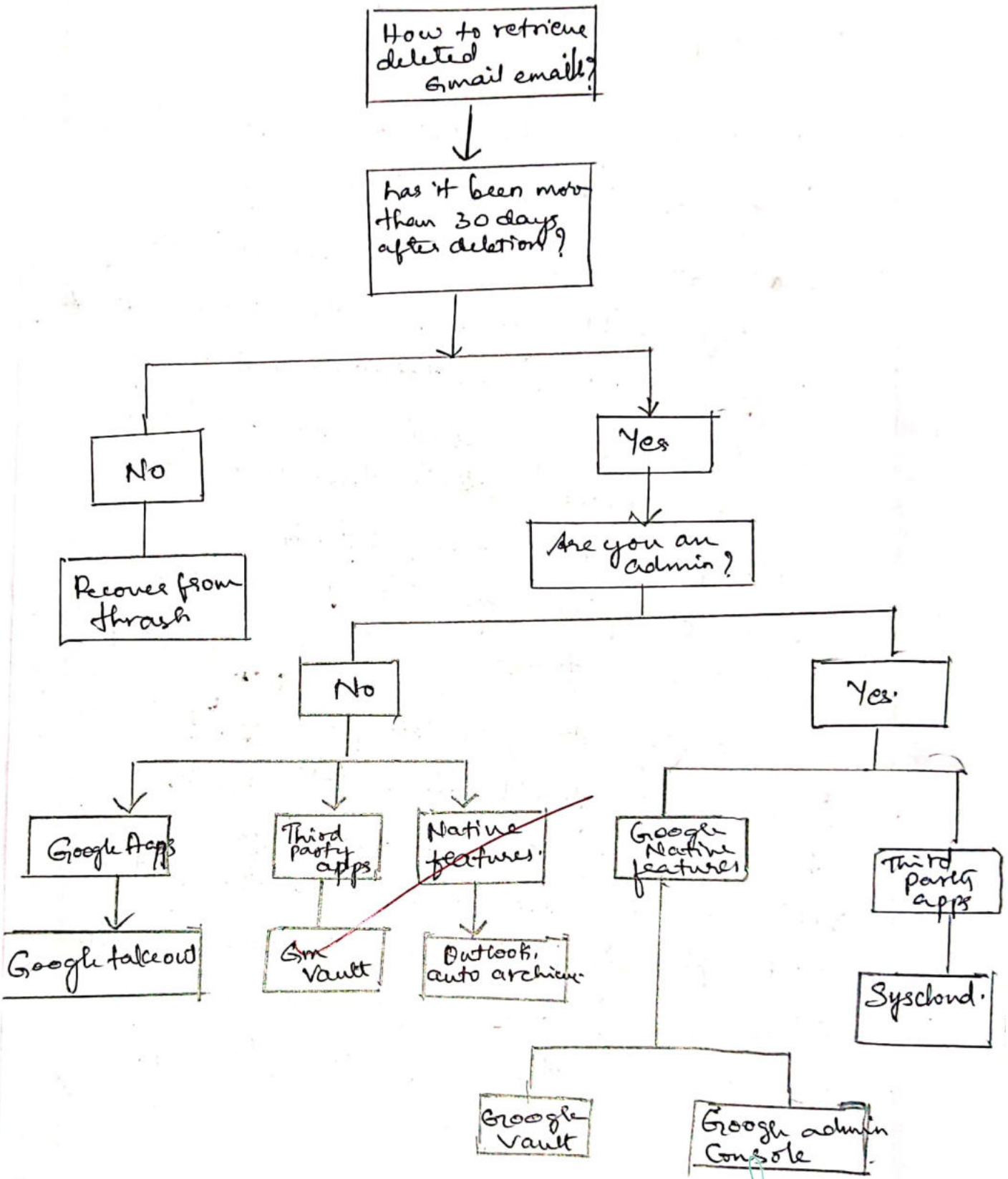
1. Write a flow chart to recover deleted email from a gmail account?



2. Explain any five advanced technologies used in forensic science?

1. DNA Phenotyping :

DNA fragments extracted from hair, body fluids and tissue can be incredibly useful in forensic science. However if the owner isn't registered in a database, turning DNA into useful information can be a challenge. ~~disease solver~~. This is where DNA phenotyping steps up. The field uses complex genetic information derived from genotyping or DNA sequencing to predict physical & biochemical traits. This can include characteristics such as sex, face shape hair & eye colour some of the latest DNA phenotyping techniques can predict skin colour, though the ethics surrounding this are complecated.

Carbon Dating

Carbon Dating is based on the idea that all living organisms observe atmospheric & radio active carbon also known as C14 as they age. Organisms stop absorbing atm. Carbon when they die, though C14 accumulated ones their life time continues to detoriate. Analysing C14 in human remains, is a useful way to determine when a person died & their age at the time.

Over the past decade an increase in fossil fuel emission as emerged as a unique challage for carbon dating, with experts warning concentrations of Carbon isotopes in the atmosphere are reaching unusally high levels. This could compromise the accuracy of carbon dating techniques.

Isotope Detection

From bullets to bomb debris, isotope analysis is used by forensic investigators to trace the origin of explosives. The technique is based on the fact that most powerful explosives contain carbon oxygen nitrogen and hydrogen atoms comparing isotopes can be a useful way to analyse explosives and trace the source of origin.

Forensic Palynology

Providing a connection between a person & a crime seen are object is often critical to building legal cases. Forensic palynology uses pollen grain & spores to establish links & help prove if a person is guilty or innocent. from tracking the origin of illegal drugs such as cocaine & fentanyl to linking offenders to incrimina -ting objects, palynology has a myriad of applications in forensic scien.

Immunochromatography

Body fluids are often invaluable evidence for forensic scientists.

Immunochromatographic strip tests can simultaneously allow scientists to examine biological stains & uncover valuable information about the origins of the fluid. The latest generation of immunochromatographic strip tests can simultaneously detect up to five body fluids. This eliminates the need for multiple tests & allows scientists to carry out multiple tests on a single sample.