Mahatma Education Society's

Pillai HOC College of Arts, Science & Commerce (Autonomous)

Rasayani

Affiliated to University of Mumbai

NAAC Accredited with "A+" Grade in cycle II

ISO 9001:2015 Certified

SYLLABUS

Bachelors of Science (B. Sc.)
S. Y. B. Sc.

As per National Education Policy 2020

Academic Year 2026-27

Mahatma Education Society's
College Code: 870
PILLAI HOC COLLEGE OF ARTS, SCIENCE & COMMERCE
Pillai HOCL Educational Campus, HOC Colony, Rasayani, Via. Panvel, Dist. Raigad. Pin 410207
Tel: 02192 - 669000 / 01 / 02 / 03 / 04 / 05 / 06 / 07 / 08 / 09 *Website : www.phcasc.ac.in Email : phcasc@mes.ac.in*
(NAAC Accredited 'A+' Grade , CGPA – 3.26 in Cycle 2 & ISO 9001:2015 Certified)
Affiliated to the University of Mumbai, Approved by Government of Maharashtra
(AUTONOMOUS COLLEGE)

PHCASC/116/BoS/25-26

March 27, 2026

ATTENDANCE SHEET

Meeting of Board of Studies
Natural and Physical Sciences

A meeting of members of the Board of Studies of **Natural and Physical Sciences** for the term I of the Academic Year 2026-27 is scheduled on Friday, 27th March 2026 at 11.30 am in Conclave I, Pillai HOCL Educational campus. The meeting is presided by Dr. Richa Chauhan, Chairperson, to discuss the agenda mentioned below. Following members are present for the meeting.

Sr. No	Name	Category	Signature
1	Dr. Dinesh Navale	Expert nominated by the Vice-Chancellor	
2	Ms. Komal Kamble	Subject experts from outside the parent University	
3	Dr. Anand K Singh	Subject experts from outside the parent University	Dr. Anand Singh
4	Dr. Bapu Gawade	Industry representative	
5	Mr. Rushikesh Ghodvinde	College Alumnus	
6	Dr. Rinkoo Shantnu	Principal	
7	Dr. Richa Chauhan	Chairperson	
8	Ms. Remya MG	Member (Env. Sci.)	
9	Dr. Archana Bhagwat	Member (Chemistry)	
10	Dr. Sulochana Bhalekar	Member (Chemistry)	

11	Dr. Vineetha P	Member (Physics)	
12	Ms. Komal Gunjal	Member (Chemistry)	
13	Ms. Shruti C. Hogale	Member (Physics)	Shruti C. Hogale
14	Ms. Juilee Shirke	Member (Physics)	

Dr. Richa Chauhan

Chairperson

Dr. Rinkoo Shantnu

Principal

M.E.S. PILLAI HOC COLLEGE OF ARTS, SCIENCE AND COMMERCE
AUTONOMOUS
RASAYANI

1. Introduction

A **B.Sc. in Physics, Chemistry, and Mathematics** is a three-year undergraduate program designed to build a strong foundation in scientific principles while connecting theoretical understanding with practical experimentation. The program aims to develop a deep insight into the laws of nature, chemical processes, and mathematical reasoning, equipping students with interdisciplinary scientific competence.

In S.Y. B.Sc., the curriculum is comprehensive and integrates core concepts from physics, chemistry, and mathematics, along with their modern applications in research, industry, and technology. Students develop key abilities throughout the course:

1. **Scientific Inquiry and Problem-Solving**

   Students learn to approach scientific problems analytically, interpret experimental data, and design solutions using logical and quantitative reasoning. This strengthens their ability to understand and investigate natural phenomena.

2. **Technical and Laboratory Proficiency**

   The program provides extensive exposure to laboratory techniques, mathematical modelling, computational tools, and experimental methods. Students gain practical experience in areas such as spectroscopy, thermodynamics, quantum mechanics, material science, mathematical analysis, and applied statistics.

3. **Innovation, Research Orientation, and Professionalism**

   Learners are encouraged to stay updated with emerging developments in sciences, fostering curiosity, scientific thinking, and innovative approaches. The program instils professionalism through teamwork, research projects, and ethical scientific practices.

This interdisciplinary training prepares graduates for diverse scientific careers, higher studies, research opportunities, and roles in industry. It also empowers students to explore entrepreneurial ventures in science-based fields, supported by strong academic guidance, placement assistance, and exposure to modern advancements across physics, chemistry, and mathematics.

Programme Outcomes (POs)

PO. No.	PO Title	POs in brief
PO1	**Fundamental Knowledge Acquisition**	Graduates will demonstrate a comprehensive and foundational knowledge of their chosen discipline along with an awareness of interdisciplinary connections.
PO2	**Critical Thinking and Analytical Reasoning**	Graduates will be able to analyse complex problems, synthesize data from multiple sources (qualitative and quantitative), and employ logical reasoning to formulate well-supported conclusions and arguments.
PO3	**Effective Communication**	Graduates will exhibit proficiency in both written and oral communication, articulating ideas clearly, persuasively, and ethically to diverse audiences
PO4	**Problem Solving**	Graduates will possess the ability to identify, formulate, and design solutions for real-world problems in their professional or social contexts, applying relevant theoretical knowledge and practical skills.
PO5	**Information and Digital Literacy**	Graduates will demonstrate the capability to locate, evaluate, and effectively use information from various sources, and utilize modern tools and Information and Communication Technology (ICT) for professional and academic tasks.
PO6	**Research Skills and Scientific Temperament**	Graduates will develop a sense of inquiry and research methodology, including the ability to design experiments (where applicable), collect and analyse data, and interpret results while maintaining scientific rigor and intellectual honesty.
PO7	**Ethical Reasoning and Professional Integrity**	Graduates will recognize ethical dilemmas, commit to professional and academic ethics, and demonstrate an understanding of moral and social responsibilities in their personal and professional conduct.
PO8	**Employability and Professional Skills**	Graduates will acquire the necessary job-ready skills, managerial competencies, and professional values to secure gainful employment or pursue advanced education in their respective fields.
PO9	**Environmental and Sustainability Consciousness**	Graduates will understand the importance of environmental conservation and sustainable development, displaying responsibility toward ecological challenges and advocating for healthy environmental practices.
PO10	**Life-Long Learning**	Graduates will develop the capacity for independent and self-directed learning to continuously upgrade their knowledge and skills, enabling them to adapt to rapid technological and societal changes.
PO11	**Civic and Social Responsibility**	Graduates will act as responsible citizens with an informed awareness of constitutional values, engaging proactively in community development and addressing social needs.
PO12	**Empathy and Social Intelligence**	Graduates will be able to cultivate and demonstrate affective, interpersonal, social and emotional intelligence.

Programme Specific Outcomes (PSOs)

PSOs. No.	PSO Title	PSOs in brief
PSO1	**Advanced Learning and Research Capabilities for Physical Sciences**	To develop analytical skills for real-world problem solving, gain familiarity with recent scientific and technological developments, enhance learning through practical activities and projects, and acquire fundamental knowledge of optics.
PSO2	**Holistic Educational Framework for Building Foundational and Professional Competence in Chemistry**	To understand fundamental principles of inorganic, organic, and physical chemistry; foster continuous learning and scientific curiosity; explore career paths in chemistry-related fields; and apply foundational skills to entry-level roles in relevant industries.
PSO3	**Integrated Framework for Mathematical Knowledge, Analytical Skills, and Global Awareness**	To develop a strong understanding of fundamental mathematical principles and methods, and to use them effectively in modelling, solving, and interpreting real-world problems. To build mathematical tools for advanced study across scientific fields, and to enhance overall growth through problem-solving skills, modelling abilities, creativity, and communication. To provide students with exposure to global and local issues related to the mathematical sciences.
PSO4	**Teamwork, Project Management & Lifelong Career Growth**	Graduates will work effectively both independently and in teams, conduct scientific investigations and research projects efficiently, and pursue continuous learning to excel in higher studies, research, and emerging opportunities in science and technology.

Evaluation Pattern

Marking Code	Marking Scheme
A	50 Marks Semester End Exam, 50 Marks Continuous Assessment (distributed within 15 Marks Class Test, 15 Marks Presentation & Assignment, 10 Marks Online Quiz, 10 Marks Attendance & Class Participation)
B	50 Marks Semester End Exam
C	100 marks Continuous Assessment (distributed within 30 Marks Class Test, 30 Marks Presentation & Assignment, 30 Marks Online Quiz, 10 Attendance & Class Participation)
D	50 Marks of Continuous Assessment (distributed within 15 Marks Class Test, 15 Marks Presentation & Assignment, 10 Marks Online Quiz, 10 Marks Attendance & Class Participation)
E	50 Marks Practical Examination (distributed within 30 Marks Practical Module 1 & 2, 10 Marks Journal, 10 Marks Viva)

Course Structure

Semester III							
Course Code	**Course Type**	**Course Title**	**Theory/ Practical**	**Marks**	**Credits**	**Lectures / Week**	**Evaluation Pattern**
Chemistry& Mathematics							
HUSCY201	Major	PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY I	Theory	100	2	2	A
HUSCY201P	Major-Practical	PRACTICAL(HUSCY201)	Practical	50	1	2	E
HUSCY202	Major	PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY II	Theory	100	2	2	A
HUSCY202P	Major-Practical	PRACTICAL(HUSCY202)	Practical	50	1	2	E
HUSCY203	Major	BASICS OF ANALYTICAL CHEMISTRY I	Theory	100	2	2	A
HUSCY203P	Major-Practical	PRACTICAL (HUSCY203)	Practical	50	1	2	E
HUSMT204	Minor	ESSENTIAL MATHEMATICS IN REAL LIFE I	Theory	100	2	2	A
HUSMT204P	Minor - Practical	Practical (HUSMT204)	Practical	50	1	2	E
HUSCY205P	SEC	Skills In Chemistry	Practical	100	3	4	E
	AEC	हिंदी भाषा एवं साहित्य संवर्धन	Theory	50	2	2	D
	OE	Financial Literacy	Theory	100	3	3	C
	CC	NSS	Theory	50	2	2	D
Chemistry & Physics							
HUSCY201	Major	PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY I	Theory	100	2	2	A
HUSCY201P	Major-Practical	PRACTICAL(HUSCY201)	Practical	50	1	2	E
HUSCY202	Major	PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY II	Theory	100	2	2	A
HUSCY202P	Major-Practical	PRACTICAL(HUSCY202)	Practical	50	1	2	E
HUSCY203	Major	BASICS OF ANALYTICAL CHEMISTRY I	Theory	100	2	2	A
HUSCY203P	Major-Practical	PRACTICAL(HUSCY203)	Practical	50	1	2	E
HUSPH204	Minor	FUNDAMENTALS OF LIGHT	Theory	100	2	2	A

HUSMT204P	Minor - Practical	Practical (HUSPH204)	Practical	50	1	2	E
HUSCY205P	SEC	Skills In Chemistry	Practical	100	3	4	E
	AEC	हिंदी भाषा एवं साहित्य संवर्धन	Theory	50	2	2	D
	OE	Financial Literacy	Theory	100	3	3	C
Physics & Maths							
HUSPH201	Major	ELECTRODYNAMICS	Theory	100	2	2	A
HUSPH201P	Major-Practical	PRACTICAL(HUSPH201)	Practical	50	1	2	E
HUSPH202	Major	ADVANCED ELECTRONICS	Theory	100	2	2	A
HUSPH202P	Major-Practical	PRACTICAL(HUSPH202)	Practical	50	1	2	E
HUSPH203	Major	OPTICS	Theory	100	2	2	A
HUSPH203P	Major-Practical	PRACTICAL(HUSPH203)	Practical	50	1	2	E
HUSMT204	Minor	ESSENTIAL MATHEMATICS IN REAL LIFE I	Theory	100	2	2	A
HUSMT204P	Minor - Practical	Practical (HUSMT204)	Practical	50	1	2	E
HUSPH205P	SEC	BATTERY AND INVERTER TESTING AND MAINTENANCE	Practical	100	3	4	E
	AEC	हिंदी भाषा एवं साहित्य संवर्धन	Theory	50	2	2	D
	OE	Financial Literacy	Theory	100	3	3	C
Mathematics & Physics							
HUSMT201	Major	REAL ANALYSIS	Theory	100	2	2	A
HUSMT201P	Major-Practical	PRACTICAL(HUSMT201)	Practical	50	1	2	E
HUSMT202	Major	LINEAR ALGEBRA I	Theory	100	2	2	A
HUSMT202P	Major-Practical	PRACTICAL(HUSMT202)	Practical	50	1	2	E
HUSMT203	Major	ORDINARY DIFFERENTIAL EQUATIONS	Theory	100	2	2	A
HUSMT203P	Major-Practical	PRACTICAL(HUSMT203)	Practical	50	1	2	E
HUSPH204	Minor	FUNDAMENTALS OF LIGHT	Theory	100	2	2	A
HUSPH204P	Minor - Practical	Practical (HUSPH204)	Practical	50	1	2	E
HUSMT205P	SEC	INTRODUCTION TO PYTHON PROGRAMMING	Practical	100	3	4	E
	AEC	हिंदी भाषा एवं साहित्य संवर्धन	Theory	50	2	2	D
	OE	Financial Literacy	Theory	100	3	3	C

Abbreviations:

SEC: Skill Enhancement Course
AEC: Ability Enhancement Course
VAC: Value Added Course
VEC: Value Education Course
IKS: Indian Knowledge System
OE: Open Elective

SEMESTER III

BOS	**NATURAL AND PHYSICAL SCIENCES**				
Course	**PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY I**				
Course Code	**HUSCY201**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To understand and apply the basic concept of Free energy, Chemical potential
2	To understand and apply the principles of electrolyte conductance, transference number.
3	To understand and apply the concept of ideal solutions, partially miscible and immiscible liquid pairs
4	To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.
5	To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
6	To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Explain and apply concept of Free energy, Chemical potential
CO2	Understand the principle of electrolyte conductance, terms associated and experimental technique to determine transport no. of ions
CO3	Explain the concept of Chemical bonding
CO4	Explain the various terms involved in inorganic and organic chemistry
CO5	Describe the bonding, reactions and reactivity of organic compounds.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Chemical Thermodynamics-II, Electrochemistry	10	CO1, CO2, CO3
2	Chemical Bonding	10	CO3, CO4
3	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides	10	CO4, CO5

Syllabus

Module No.	Content	No. of Lectures
1	**Physical Chemistry** **1.1Chemical Thermodynamics-II(6L)** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature. **1.1.2** Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature. **1.2 Electrochemistry: (4L)** 1.2.1 Electrolytes: Definition, Strong and Weak electrolytes and their conductance measurement, ions and electrical conductivity by ions. 1.2.2 Kohlrausch law of independent migration of ions. 1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte.	10
2	**Inorganic Chemistry** **2.1 Non-Directional Bonding (4L)** 2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. Types of Ionic Crystals 2.1.2 Radius Ratio Rules 2.1.3 Born-Haber Cycle and its Application **2.2. Directional Bonding: Orbital Approach & MOT (6L)** 2.2.1 Definition, concept of Homonuclear diatomic molecules only for He_2 & Ne_2 molecules. 2.2.2 Resonance and the Concept of Formal Charge; Rules for Resonance or Canonical Structures. 2.2.3 Bonding in Polyatomic Species: The Role of Hybridization. And types of hybrid orbitals sp, sp^2,sp^3, sp^3d, sp^2d^2 and sp^2d sp^3d^2 2.2.4 Equivalent and Non-Equivalent hybrid orbitals 2.2.5 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2, O_2^+ O_2^-,O_2^{2-}	10
3	**Organic Chemistry** **3.1Reactions and reactivity of halogenated hydrocarbons: [4L]** 3.1.1 Alkyl halides: Nucleophilic substitution reactions: SN1, SN2 and SNi mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions, nature of substrate, solvent, nucleophilic reagent and leaving group. 3.1.2 Aryl halides: Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (SNAr) addition-elimination mechanism and benzyne mechanism. **3.2 Alcohols, phenols and epoxides: [6L]** 3.2.1 Alcohols: Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols 3.2.2 Phenols: Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance	10

	stabilization of phenoxide ion. 3.2.3 Epoxides: Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring-opening reactions by nucleophiles (a) In acidic conditions: hydrolysis. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides	
Case Study Scenario		
M1	Given data for NaCl: • Sublimation energy = 108 kJ/mol • Ionization energy = 496 kJ/mol • Bond dissociation energy of Cl_2 = 242 kJ/mol • Electron affinity of Cl = –349 kJ/mol • Enthalpy of formation = –411 kJ/mol Calculate lattice energy.	
M2	A chemical plant produces ethylene oxide and studies its reaction with different reagents. Ethylene oxide reacts with aqueous acid (H^+/H_2O) to form a product. What is the product formed in it?	

References Books:

Physical Chemistry

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).

Inorganic Chemistry

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.

Organic Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt any three out of five (05M) Module I	15
Q2	Attempt any three out of five (05M) Module II	15
Q3	Attempt any three out of five (05M) Module III	15
Q4	Case study/application-based question- One question of five marks	05
	Total	50

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	To verify Ostwald's dilution law for weak acid conductometrically.	2	CO1,CO2, CO3,CO4, CO5
2	To determine dissociation constant of weak acid conductometrically.	2	CO1,COC O3,CO4,C O5
3	To determine the critical solution temperature (CST) of phenol – Water System.	2	CO1,CO2, CO3,CO4, CO5
4	Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.	2	CO1,CO2, CO3,CO4, CO5
5	To investigate the reaction between K2S2O8 and KI with equal initial concentrations of the reactants	2	CO1,CO2, CO3,CO4, CO5
6	To determine solubility of sparingly soluble salts (any two) conductometrically.	2	CO1,CO2, CO3,CO4, CO5
7	Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]	2	CO1,CO2, CO3,CO4, CO5
8	Crystallisation of potassium iodate and to estimate its purity before and after the separation.	2	CO1,CO2, CO3,CO4, CO5

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**NATURAL AND PHYSICAL SCIENCES**				
Course	**PROGRESSIVE INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY II**				
Course Code	**HUSCY202**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To understand the concept of Chemical Kinetics.
2	To understand and imbibe the basic concept of Polymers.
3	To imbibe the basic concept of chemistry of boron and silicon compound
4	To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.
5	To examine the structure, nomenclature, and preparation methods of aldehydes and ketones.
6	To analyze nucleophilic addition reactions and their applications in organic synthesis.
7	To learn key name reactions and transformations.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Explain and apply the concept of Chemical Kinetics.
CO2	Understand the concept of Polymers.
CO3	Explain the concept of chemistry of boron, nitrogen and silicon compound
CO4	Explain the nucleophilic addition reactions and their applications in organic synthesis.
CO5	Describe the name reactions and transformations of organic compounds.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Chemical Kinetics-II, Solutions, Polymer Chemistry-I	10	CO1, CO2
2	Selected topics on p block elements	10	CO3
3	Carbonyl Compounds	10	CO4, CO5

Syllabus

Module No.	Content	No. of Lectures
1	**Physical Chemistry** **1.1 Chemical Kinetics-II (3L)** 1.1.1 Introduction to reaction mechanism (concept of elementary steps, intermediates, and the overall reaction mechanism with an example of Thermal chain reactions: H_2. and Br_2 reaction) 1.1.2 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected) **1.2 Solutions: (4 L)** 1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature -composition curves of ideal and non-ideal solutions. Azeotropes and Zeotropes definition and significance in solution behavior. 1.2.2 Immiscibility of liquids- Nernst distribution law and its applications **1.3 Polymer Chemistry – I (3L)** 1.3.1 Basic Terms: Macromolecule, monomer, repeat unit, Polymerisation, (addition and condensation polymerization) Degree of Polymerisation. 1.3.2 Polymer structures linear, branched and cross-linked 1.3.3 Molecular weight of Polymers: Definition and formulae of Number average molecular weight, weight average molecular weight, and viscosity average molecular weight. (numerical expected)	10
2	**Inorganic Chemistry** **Selected topics on p-block elements(10L)** **2.1 Chemistry of Boron Compounds** 2.1.1 Electron deficient compounds–BH_3,BF_3,$BCl_3$with respect to Lewis acidity and applications. 2.1.2 Preparation of simple boranes like diborane and tetraborane. 2.1.3 Structure and bonding in diborane and tetraborane(2e-3cbonds) **2.2. Chemistry of Silicon** 2.2.1 Silicon compounds: Occurrence, Structure and Inertness of SiO_2 2.2.2 Preparation of structure of $SiCl_4$ **2.3 Chemistry of Nitrogen family** 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. 2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2.	10
3	**Organic Chemistry** **Carbonyl Compounds [10L]** 3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, Rosenmund reduction.	10

	3.2 General mechanism of nucleophilic addition, and acid-catalyzed nucleophilic addition reactions. 3.3 Reactions of aldehydes and ketones with HCN, RMgX, alcohol, amine, phenylhydrazine, 2,4-Dinitrophenyl hydrazine, LiAlH4 and NaBH4. 3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation and Cannizzaro reaction. 3.5 Keto-enol tautomerism: Mechanism of acid and base catalyzed enolization 3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilized enols.	
Case Study Scenario		
M1	A pharmaceutical company needs to prepare benzaldehyde from benzoyl chloride without further reduction to alcohol. They apply Rosenmund reduction under controlled conditions. Rewrite the mechanism for it.	
M2	A chemical plant produces ethylene oxide and studies its reaction with different reagents. Ethylene oxide reacts with aqueous acid (H^+/H_2O) to form a product. What is the product formed in it?	

References Books:

Physical Chemistry

1. Barrow, G.M. Physical Chemistry Tata McGraw‑Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).

Inorganic Chemistry

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.

Organic Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt any three out of five (05M) Module I	15
Q2	Attempt any three out of five (05M) Module II	15
Q3	Attempt any three out of five (05M) Module III	15
Q4	Case study/application-based question- One question of five marks	05
	Total	50

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Estimation of total hardness	2	CO1,CO2, CO3,CO4, CO5
2	Investigation of the reaction between Copper supfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).	2	CO1,CO2, CO3,CO4, CO5
3	**Short organic preparation and their purification:** Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. **Preparation of:** 1. Cyclohexanone oxime from cyclohexanone. 2. Glucosazone from dextrose or fructose 3. Tribromoaniline from aniline. 4. β-Naphthylbenzoate 5. m-Dinitrobenzene from nitrobenzene 6. Phthalic anhydride from phthalic acid by sublimation 7. Acetanilide from aniline 8. p-Bromoacetanilide from acetanilide 9. Iodoform from acetone (Any eight preparations)	2	CO1,CO2, CO3,CO4, CO5

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Basics of Analytical Chemistry I**				
Course Code	**HUSCY203**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To select a method of analysis.
2	To decide how to identify a sample and prepare it for analysis.
3	To select a procedure for analysis
4	To identify sources of possible errors in the results obtained.
5	To introduce classical methods of chemical analysis.
6	To know the various instrumental methods of analysis

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	To understand and apply fundamental principles of analytical chemistry
CO2	To explain and perform classical methods of chemical analysis
CO3	To describe the principles and applications of basic instrumental analytical methods

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
1	Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I	10	CO1
2	Classical Methods of Analysis	10	CO2
3	Instrumental Methods-I	10	CO 3
	Practical Component	30	CO1,CO2,CO3

Syllabus

Module No.	Content	No. of Lectures
1	Introduction to Analytical Chemistry and Statistical Treatment of analytical data-[10L] 1.1. Role of Analytical Chemistry [02 L] 1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 1.1.2. Classical and Non-Classical Methods of Analysis; their types and Importance. 1.2. Significance of Sampling in Analytical Chemistry [02 L] 1.2.1. Terms involved in Sampling 1.2.2. Types of Sampling i) Random Sampling ii) Systematic Sampling 1.3. Results of Analysis [06 L] 1.3.1. Errors in Analysis and their types i) Determinate Errors ii) Indeterminate Errors 1.3.2 Methods of minimizing Determinate errors in analysis i) Calibration of apparatus ii) Carrying out Control determination iii)Carrying out Blank determination 1.3.3 Concept of Precision and Accuracy in Analysis and evaluation involved in the study of Precision and accuracy. i) Mean, Median, Mode, Absolute deviation, Average deviation, Relative average deviation, standard deviation, variance and coefficient of variation. ii) Absolute error and Relative error [Numerical problems on precision and accuracy expected]	10
2	Classical Methods of Analysis. [10 L] 2.1. Titrimetric Methods [04 L] 2.1.1.Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry 2.1.2.The Conditions suitable for titrimetry 2.1.3.Types of titrimetry i)Neutralisation (Acidimetry, alkalimetry) ii) Redox (Iodometry, Iodimetry,) iii) Precipitation iv) Complexometric titrations 2.1.4.Tools of Titrimetry: Graduated glassware and Calibration 2.2. Standard solutions[02L] 2.1.1 Primary and Secondary standards in Titrimetry 2.1.2 Calculations based on preparation of primary and secondary standards	10

	2.2 Neutralization Titration [02 L] 2.2.1 Concept of pH and its importance in Neutralization Titrations 2.2.2 Endpoint and Equivalence point of Neutralization titrations 2.2.3 Determination of End point by using Indicators causing colour change 2.3 Gravimetric analysis [02L] 2.3.1 Introduction and Principle of Gravimetric analysis 2.3.2 Types of Gravimetric Methods i) Volatilisation gravimetry ii) Precipitation gravimetry	
3	Instrumental Methods-I (10L) Basic Concepts in Instrumental Methods [03 L] 3.1 Relation between the Analyte, Stimulus and measurement of change in the observable property. 3.2 Block Diagram of an Analytical Instrument. 3.3 Types of Analytical Instrumental Methods based on i. Optical interactions (eg. Spectrometry: UV-Visible, Polarimetry) ii.Electrochemical interactions (eg. Potentiometry, Conductometry,) iii.Thermal interactions (eg. Thermogravimetry) 3.4 Spectrometry [07 L] 3.4.1 Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy 3.4.2 Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbtivity 3.4.3 Statement and derivation of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer Lambert's Law, 3.4.4 Validity and Deviations from Beer-Lambert's Law (Numerical problems based on Beer- Lambert's Law) 3.4.5 Block Diagrams for Single beam and double beam Colorimeter (Principle, Construction and working (Details of Components expected, i.e. source, Sample holder, Filter, Detectors)	10
Case Study Scenario		
M1	Solve the following: The transmittance of a 2×10^{-4} M solution of a substance was found to be 76.2%, when placed in a cell of 1 cm length. Calculate 1) absorbance 2) Molar absorptivity	
M2	In a KCl solution, the boundary moves 2.5 cm in 200 seconds. Current = 0.5 A. Cross-sectional area = 1.0 cm^2. Conc. of KCl = 0.02 mol/L. Find t^+ for K^+**.**	

Reference Books:

1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Shm K. Anand pp2.107-2.148
2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.
4. Skoog etal. “Fundamentals of Analytical Chemistry" Cengage Learning, Eight Edition,chapter13, 14 and 15
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt any three out of five (05M) Module I	15
Q2	Attempt any three out of five (05M) Module II	15
Q3	Attempt any three out of five (05M) Module III	15
Q4	Case study/application-based question- One question of five marks	05
	Total	50

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Tools of Analytical Chemistry-I: a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels. b) Weighing tools such as two pan balance and mono pan balance, digital balances: c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace, d) Drying Devices: Hot Air Oven, microwave oven, Desiccators, Vacuum desiccators e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a)and principle, construction and uses of items(b)to (e)in his journal.	2	CO1, CO2, CO3
2	Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error.(The learner is expected to know the role of the various reagents/chemicals used in the estimation, the various steps involved. They should write the complete and Balanced chemical reaction for the formation of the Ni(DMG)2 complex	2	CO1, CO2, CO3
3	Colorimetric Determination of Copper Ions in a given Solution by using calibration curve method and calculation of % error. (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).	2	CO1, CO2, CO3
4	Determination of buffer capacity of acid buffer and basic buffer. (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)	2	CO1, CO2, CO3
5	Estimation of Aspirin	2	CO1, CO2, CO3
6	Gravimetric estimation of barium ions using K2CrO4 as precipitant. Calculation of % error. (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)	2	CO1, CO2, CO3

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	viva	05

BOS	**NATURAL AND PHYSICAL SCIENCES**				
Course	**FUNDAMENTALS OF INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY I**				
Course Code	**HUSCY204**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To understand and apply the basic concept of Free energy, Chemical potential
2	To understand and apply the principles of electrolyte conductance, transference number.
3	To understand and apply the concept of ideal solutions, partially miscible and immiscible liquid pairs
4	To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.
5	To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
6	To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Explain and apply concept of Free energy, Chemical potential
CO2	Understand the principle of electrolyte conductance, terms associated and experimental technique to determine transport no. of ions
CO3	Explain the concept of Chemical bonding
CO4	Explain the various terms involved in inorganic and organic chemistry
CO5	Describe the bonding, reactions and reactivity of organic compounds.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
1	Chemical Thermodynamics-II, Electrochemistry	10	CO1, CO2, CO3
2	Chemical Bonding	10	CO3, CO4
3	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides	10	CO4, CO5

Syllabus

Module No.	Content	No. of Lectures
1	**Physical Chemistry** **1.1Chemical Thermodynamics-II(6L)** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature. **1.1.2** Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature. **1.2 Electrochemistry: (4L)** 1.2.1 Electrolytes: Definition, Strong and Weak electrolytes and their conductance measurement, ions and electrical conductivity by ions. 1.2.2 Kohlrausch law of independent migration of ions. 1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte.	10
2	**Inorganic Chemistry** **2.1 Non-Directional Bonding (4L)** 2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. Types of Ionic Crystals 2.1.2 Radius Ratio Rules 2.1.3 Born-Haber Cycle and its Application **2.2. Directional Bonding: Orbital Approach & MOT (6L)** 2.2.1 Definition, concept of Homonuclear diatomic molecules only for He_2 & Ne_2 molecules. 2.2.2 Resonance and the Concept of Formal Charge; Rules for Resonance or Canonical Structures. 2.2.3 Bonding in Polyatomic Species: The Role of Hybridization. And types of hybrid orbitals sp, sp^2,sp^3, sp^3d, sp^2d^2 and sp^2d sp^3d^2 2.2.4 Equivalent and Non-Equivalent hybrid orbitals 2.2.5 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2, O_2^+ O_2^-,O_2^{2-}	10
3	**Organic Chemistry** **3.1Reactions and reactivity of halogenated hydrocarbons: [4L]** 3.1.1 Alkyl halides: Nucleophilic substitution reactions: SN1, SN2 and SNi mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions, nature of substrate, solvent, nucleophilic reagent and leaving group. 3.1.2 Aryl halides: Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (SNAr) addition-elimination mechanism and benzyne mechanism. **3.2 Alcohols, phenols and epoxides: [6L]** 3.2.1 Alcohols: Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols	10

	3.2.2 Phenols: Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. 3.2.3 Epoxides: Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring-opening reactions by nucleophiles (a) In acidic conditions: hydrolysis. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides	
Case Study Scenario		
M1	Given data for NaCl: • Sublimation energy = 108 kJ/mol • Ionization energy = 496 kJ/mol • Bond dissociation energy of Cl_2 = 242 kJ/mol • Electron affinity of Cl = –349 kJ/mol • Enthalpy of formation = –411 kJ/mol Calculate lattice energy.	
M2	A chemical plant produces ethylene oxide and studies its reaction with different reagents. Ethylene oxide reacts with aqueous acid (H^+/H_2O) to form a product. What is the product formed in it?	

References Books:

Physical Chemistry

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).

Inorganic Chemistry

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.

Organic Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt any three out of five (05M) Module I	15
Q2	Attempt any three out of five (05M) Module II	15
Q3	Attempt any three out of five (05M) Module III	15
Q4	Case study/application-based question- One question of five marks	05
	Total	50

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	To verify Ostwald's dilution law for weak acid conductometrically.	2	CO1,CO2, CO3,CO4 ,CO5
2	To determine dissociation constant of weak acid conductometrically.	2	CO1,CO2, CO3,CO4 ,CO5
3	To determine the critical solution temperature (CST) of phenol – Water System.	2	CO1,CO2, CO3,CO4 ,CO5
4	Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.	2	CO1,CO2, CO3,CO4 ,CO5
5	To investigate the reaction between K2S2O8 and KI with equal initial concentrations of the reactants	2	CO1,CO2, CO3,CO4 ,CO5
6	To determine solubility of sparingly soluble salts (any two) conductometrically.	2	CO1,CO2, CO3,CO4 ,CO5
7	Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]	2	CO1,CO2, CO3,CO4 ,CO5
8	Crystallisation of potassium iodate and to estimate its purity before and after the separation.	2	CO1,CO2, CO3,CO4 ,CO5

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Skills in Chemistry**				
Course Code	**HUSCY205P**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	-	3	3
Type	**SEC**	**No of Teaching Hours**	-	90	90
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	100	-	-	100	

Learning Objectives	
1	To introduce students to the fundamental techniques of formulating everyday cosmetic and personal care products.
2	To develop hands-on laboratory skills in the preparation of various cosmetic formulations.
3	To impart knowledge on quality assessment techniques such as solubility testing,moisture analysis, viscosity, pH measurement, and foaming ability.
4	To enable learners to analyze the physicochemical properties of cosmetic products using instrumental and classical methods.
5	To provide experience in interpreting cosmetic product labels, ingredient functionalities, and regulatory compliance.
6	To foster comparative and critical thinking skills by analyzing and benchmarking various commercial cosmetic brands.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Formulate various cosmetic products using standard laboratory protocols.
CO2	Perform chemical and physical analyses of cosmetic products.
CO3	Compare foaming abilities of shampoo brands using experimental methods.
CO4	Determine active ingredient concentrations and interpret efficacy.
CO5	Conduct surveys on product labels and ingredient lists.
CO6	Evaluate and compare product performance across brands.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Preparation	30	CO1, CO2, CO3, CO4, CO5, CO6
2	Analysis	30	CO1, CO2, CO3, CO4, CO5, CO6
3	Surveys	30	CO1, CO2, CO3, CO4, CO5, CO6

Syllabus

Module No.	Content	No. of Lectures
1	Preparations (Any 6) 1.1. To prepare the Talcum Powder. 1.2. To prepare the Bath Soap. 1.3. To prepare the Shampoo. 1.4. To prepare the Nail Polish. 1.5. To prepare the Nail Polish Remover. 1.6. To prepare Hand Wash. 1.7. To prepare Hand Sanitizer. 1.8. To prepare Hand Cream. 1.9. To prepare Body Lotion 1.10. To prepare after Shave Lotion.	30
2	Analysis 2.1. To determine the amount of matter insoluble in boiling water of the given material. 2.2. To determine the moisture, volatility and to test the solubility of the color in the given material. 2.3. To study the comparative foaming ability of the various Shampoo brands using Cylinder Shake Method. 2.4. To measure the pH of the sample of a cosmetic products using pH meter. 2.5. To determine the relative viscosity of a given liquid product using Ostwald Viscometer. 2.6. To determine the concentration of Thioglycolic acid in a given Depilatories.	30
3	Surveys 3.1. To carry out the survey of given cosmetic product's label. 3.2. To carry out the study of ingredients in given cosmetic products. 3.3. To determine and compare the melting points of the Lipstick of various brands using the slip melting point method.	30

Reference Books:

1. Garud, A.; Sharma, P. K.; Garud, N. (2012), Text Book of Cosmetics, Pragati Prakashan.
2. Gupta, P. K.; Gupta, S. K. (2011), Pharmaceutics and Cosmetics, Pragati Prakashan
3. Butler, H. (2000), Poucher's Perfumes, Cosmetics and Soap, Springer
4. Kumari, R. (2018), Chemistry of Cosmetics, Prestige Publisher.
5. Formulation Guide for cosmetics; The Nisshin Oillio Group, Ltd.

Note:

1. The candidate is expected to submit a journal certified by the Head of the Department / institution at the time of the practical examination.
2. A candidate will not be allowed to appear for the practical examination unless he / she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily.

   The list of the experiments performed by the candidate should be attached with such a certificate.
3. Use of non-programmable calculator is allowed both at the theory and the practical examination.

Semester End Practical Evaluation **Time: 5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	80
Q.2	Journal & viva	20

BOS	**Natural and Physical Sciences**				
Course	**Electrodynamic**				
Course Code	**HUSPH201**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To understand the fundamental laws of electrostatics such as Coulomb's law and Gauss's law, and to analyze electric fields and electric potentials produced by different charge distributions using line, surface, and volume integrals.
2	To develop mathematical skills in vector calculus by applying divergence and curl of the electric field, and to relate these concepts to physical quantities like electric flux, electrostatic energy, work, and potential energy.
3	To understand the principles of electrodynamics, including electromotive force and electromagnetic induction, and to analyze the limitations of pre-Maxwell electrodynamics leading to Maxwell's correction in Ampère's law.
4	To comprehend Maxwell's equations in free space and to understand their role in predicting the existence and basic properties of electromagnetic waves.
5	To understand magnetic fields, magnetic forces, and current distributions in magnetostatics.
6	To apply Biot-Savart law, Ampere's law, and vector calculus in magnetostatics problems.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Apply Coulomb's law and Gauss's law to calculate electric field and electric potential for symmetric charge distributions and interpret the physical significance of divergence and curl of the electric field.
CO2	Evaluate electrostatic work, energy, and potential using line, surface, and volume integrals, and explain the relationship between electric field, electric potential, and energy in electrostatic systems.
CO3	Explain and apply the concepts of electromotive force and electromagnetic induction, and critically discuss Maxwell's correction to Ampère's law and its significance in unifying electric and magnetic fields.
CO4	Derive and interpret Maxwell's equations in free space and use them to explain the origin, propagation, and fundamental characteristics of electromagnetic waves.
CO5	Calculate magnetic fields and forces for different steady current configurations using Biot–Savart law and Ampère's law, and explain the physical significance of surface and volume current densities.
CO6	Apply divergence and curl operations to magnetic fields and use the concept of magnetic vector potential to analyze magnetostatic systems and interpret Maxwell's equations in the magnetostatic limit.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
1	Electrostatics	10	CO1, CO2
2	Electrodynamics	10	CO3, CO4,
3	Magnetostatics	10	CO5, CO6

Syllabus

Module No.	Content	No. of Lectures
1	**Electrostatics** 1.Electric field 2.Coulomb's lawLine integrals (electric potential), Surface integrals (Gauss law),Volume integral(Electrostatics energy) 3.Gauss's law 4.Divergence and curl of electric field 5.Electric potential 6.Work and energy in electrostatics	10
2	**Electrodynamics** 1.Electromotive force 2.Electromagnetic induction 3.Electrodynamics before Maxwell and Maxwell's correction in Ampere's law 4.Maxwell's equations in free space 5.Introduction to electromagnetic waves	10
3	**Magnetostatics** 1.Magnetic field 2.Magnetic force (Lorentz force) 3.Surface current density, volume current density 4.Biot-Savart law 5.Divergence and curl of magnetic field 6.Ampere's law 7.Magnetic vector potential	10
Case Study Scenario		
M1	A long straight copper conductor of radius 2 mm carries a steady current of 10 A, uniformly distributed over its cross-section.With reference to the given situation, answer the following. a) Write the expression for volume current density of the conductor. b) Using Ampère's law, calculate the magnetic field at a distance 5 mm from the axis of the conductor. c) State the value of divergence of the magnetic field and explain its significance.	
M2	A rectangular loop of dimensions 5 cm × 4 cm carries a current of 2 A and is placed in a uniform magnetic field of magnitude 0.5 T. The plane of the loop is perpendicular to the magnetic field.With reference to the given situation, answer the following; a) Write the expression for the Lorentz force acting on a current-carrying conductor. b) Calculate the force acting on the longer side of the loop. c) Explain why the loop experiences a torque.	

Reference Books:

1. Introduction to Electrodynamics : David J. Griffiths (4th Ed) Prentice Hall of India.
2. Introduction to Electrodynamics: A. Z. Capria and P. V. Panat. Narosa Publishing House.
3. Engineering Electrodynamics : William Hayt Jr. & John H. Buck (TMH).
4. Electricity and Magnetism :Navina Wadhwani (PHI – 2010).

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Determination of angle of diffraction using grating (Ist order only)	4	CO1, CO2 CO3,CO4 CO5
2	To determine capacitance in AC circuits using R and C	4	CO1, CO2 CO3, CO4 CO5
3	Slit width by diffraction pattern	4	CO1, CO2 CO3, CO4 CO5
4	Transistor configurations : CB/CE/CC (study of input-output characteristics)	4	CO1, CO2 CO3,CO4 CO5
5	To study load regulation of a Bridge Rectifier	5	CO1, CO2 CO3,CO4 CO5
6	To study Zener Diode as Regulator	5	CO1, CO2 CO3,CO4 CO5
7	Use of electronic balance: Find the density of a solid cylinder (Skill)	4	CO1, CO2 CO3,CO4 CO5

Note:

1. Minimum number of four experiments and one skill experiment to be performed and reported in the journal.
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.
4. For practical examinations, the learner will be examined in one experiment from the list of experiments. Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal with a certificate that the learners has completed the practical course respective semester as per the minimum requirements. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Introduction to Electronics**				
Course Code	**HUSPH202**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	To make students understand the concept of faithful amplification and analyze the need for proper transistor biasing in amplifier circuits.
2	To introduce students to the concept of different methods of transistor biasing and their role in stabilizing amplifier operation.
3	To make students aware of the principle of oscillations, the effect of positive feedback, and analyze RC oscillators such as Phase Shift and Wien Bridge oscillators.
4	Analyze general amplifier characteristics and operational amplifier parameters including gain, bandwidth, slew rate, and frequency response.
5	Design and analyze basic OPAMP applications such as inverting, non-inverting, summing, integrator, and differentiator circuits.
6	To familiarize the students with the operation of flip-flops,registers, and counters and analyze their use in basic digital systems.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Explain faithful amplification and analyze transistor biasing techniques such as base resistor, emitter bias, and voltage divider bias circuits.
CO2	Describe the conditions for oscillations and analyze the working of Phase Shift and Wien Bridge oscillators.
CO3	Explain amplifier characteristics including current, voltage, and power gain, frequency response, decibel gain, and bandwidth.
CO4	Analyze OPAMP parameters and design basic OPAMP circuits such as inverting, non-inverting, voltage follower, summing amplifier, integrator, and differentiator.
CO5	Explain the operation of RS, D, and JK flip-flops including gated, edge-triggered, and master-slave configurations using generalized logic diagrams.
CO6	Analyze the working of registers and counters, including SISO, SIPO, PISO, PIPO registers, asynchronous and synchronous counters, and Mod-5 and Mod-10 decade counters.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
1	Analog Electronics and Oscillators	10	CO1, CO2
2	General amplifier characteristics and Operational Amplifiers	10	CO3, CO4,
3	Digital Electronics: Flip Flops, Registers and Counters	10	CO5, CO6

Syllabus

Module No.	Content	No. of Lectures
1	**Analog Electronics and Oscillators** 1.Faithful amplification 2.Transistor Biasing 3.Methods of Transistor Biasing- Base Resistor Method, Emitter Bias Circuit, Voltage Divider Bias Method. 4.Introduction, effect of positive feedback, Requirements for oscillations 5.Phase shift oscillator (1,2,3- Reference 1 and 4,5 Reference 2)	10
2	**General amplifier characteristics and Operational Amplifiers** 1.Concept of amplification, Current gain, voltage gain, power gain 2.Frequency response, Decibel gain and Band width 3.Amplifiers: Introduction, Schematic symbol of OPAMP, 4.Slew rate, Frequency Response of an OPAMP 5.Virtual ground concept 6.Inverting Amplifier, Non-Inverting Amplifier, 7.Voltage Follower, Summing Amplifier, 8.OPAMP Integrator and Differentiator (Reference 1)	10
3	**Flip Flops, Registers and Counters** 1.RS Flip-Flops (only NOR gate latch, NAND gate latch) 2.Gated Flip Flops 3.Edge-Triggered RS Flip-Flop, Edge- Triggered D Flip-Flop 4.EdgeTriggered J-K Flip-Flop, JK Master- Slave Flip-Flops. 5.Types of registers : SISO , SIPO, PISO , PIPO [in this chapter the teacher should make all IC specific diagrams into general diagrams ie. Ignore pin numbers and IC numbers] (Reference 3)	10
Case Study Scenario		
M1	In a small control system, signals from three sensors must be added together to produce a single output for monitoring. An OP-AMP based inverting summing amplifier is used. Calculate the output voltage for the following case. Sensor voltages: V1=0.5 V V2=1.0 V3=1.5 V Input resistors: R1=R2=R3=10 kΩ Feedback resistor: Rf=10 kΩ	
M2	A small signal CE transistor amplifier is designed for laboratory experiments. To ensure stable operation and faithful amplification, a voltage divider bias circuit is used. The operating point of the transistor must be determined. **Given** Supply voltage, VCC=12 V, Voltage divider resistors: R1=40 kΩ, R2=10 kΩ Emitter resistor, RE=1 kΩ, Transistor current gain, β=100, Base–emitter voltage, VBE=0.7 V	

Reference Books:

1. Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolour revised edition).
2. Electronic devices and circuits – An introduction Allan Mottershead (PHI Pvt. Ltd.– EEE – 1986)
3. Digital Principles and Applications - Leach, Malvino, Saha_ 6th edition.
4. Electronic Principles (SIE) -7th edition by Albert Malvino and Daviid J Bates.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Opamp: Inverting amplifier with different gains	4	CO1,CO2, CO3, CO4, CO5, CO6
2	Opamp: Non-inverting amplifier with different gains	4	CO1,CO2, CO3, CO4, CO5, CO6
3	Opamp Integrator and Opamp Differentiator	4	CO1,CO2, CO3, CO4, CO5, CO6
4	CE amplifier: Determination of bandwidth	4	CO1,CO2, CO3, CO4, CO5, CO6
5	Opamp: Summing and Difference amplifier	4	CO1,CO2, CO3, CO4, CO5, CO6
6	Phase shift oscillator	5	CO1,CO2, CO3, CO4, CO5, CO6
7	Use of Oscilloscope: Measurement of voltage and frequency of AC signal (Skill)	5	CO1,CO2, CO3, CO4, CO5, CO6

Note:

1. Minimum number of four experiments and one skill experiment to be performed and reported in the journal.
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.
4. For practical examinations, the learner will be examined in one experiment from the list of experiments. Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal with a certificate that the learners has completed the practical course respective semester as per the minimum requirements. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Optics**				
Course Code	**HUSPH203**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	1
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	Explain the nomenclature used in lenses, lens equations for single convex lenses, and sign convention. lens maker's equation, Newton's lens equation and principal foci positions.
2	Describe Lateral, Longitudinal and Angular magnification, Equivalent focal length and power of two thin lenses, Concept of cardinal points and their significance
3	Explain qualitatively Spherical aberration & reduction, chromatic aberration & reduction.
4	Study of Fresnel and Fraunhofer type of diffraction and Fraunhofer diffraction pattern due to a single slit and double slit
5	Learn Michelson's Interferometer and its Applications
6	Describe Polarization and types of Polarization
7	The students learn to apply their knowledge to solve problems that are covered in the all syllabus.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Understand the nomenclature used in lenses, lens equations for single convex lenses, and sign convention. lens maker's equation, Newton's lens equation and principal foci positions.
CO2	Understand Lateral, Longitudinal and Angular magnification, Equivalent focal length and power of two thin lenses, Concept of cardinal points and their significance
CO3	Comprehend qualitatively Spherical aberration & reduction, chromatic aberration & reduction.
CO4	Understand Fresnel and Fraunhofer type of diffraction and Fraunhofer diffraction pattern due to a single slit
CO5	Understand Michelson's Interferometer and its Applications
CO6	Understand Polarization and types of Polarization
CO7	Solve problems related to the topics that are covered in the syllabus

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Lenses	10	CO1, CO2
2	Diffraction & Types	10	CO4
3.	Application of lenses	10	CO3, CO5, CO6

Syllabus

Module No.	Content	No. of Lectures
1	**Lenses** 1. Lenses and Lens Maker's Equation: Introduction to lenses, Terminology and sign conventions, Introduction to Thin lenses and Lens equation for single convex lens, Lens maker's equation: Positions of the Principal Foci and Newton's Lens equation. (SBA: 4.1, 4.2, 4.3, 4.7, 4.8, 4.9, 4.10, 4.10.1, 4.11) 2. Magnification by a lens and power of lens: Lateral, Longitudinal and Angular magnification, Deviation by a thin lens and its power, Equivalent focal length of two thin lenses, Focal length of the equivalent lens & power of two thin lenses (SBA: 4.12, 4.12.1, 4.12.2, 4.12.3, 4.15, 4.16, 4.17, 4.17.1, 4.17.2, 4.17.3, 4.17.4, 5.2)	10
2	**Diffraction & Types** 1. Fresnel diffraction: Introduction, Huygens-Fresnel's theory, Fresnel's assumptions, Distinction between interference and diffraction, Fresnel and Fraunhofer types of diffraction, (SBA: 17.1, 17.2, 17.3, 17.6, 17.7) 2. Fraunhofer diffraction: Introduction, Fraunhofer diffraction at a single slit, intensity distribution in diffraction pattern due to a single slit. (SBA: 18.1, 18.2, 18.2.1, 18.4, 18.4.2)	10
3	**Application of lenses** 1.Introduction to Aberration in lenses: Spherical aberration & reduction, chromatic aberration & reduction (Qualitative). SBA: 9.2, 9.5, 9.5.1, 9.10 Suitable numerical with appropriate difficulty level. 2. Michelson's Interferometer: Principle, construction, working, Applications of Michelson Interferometer: a) Measurement of wavelength b) Determination of the difference in the wavelength of two waves c) Determination of the refractive index of gases. (SBA: 15.7, 15.7.1 to 15.7.3, 15.8, 15.8.1, 15.8.2, 15.8.4) 3. Polarization: Introduction, Polarization, Types of Polarization (SBA: 20.1, 20.2, 20.5,20.5.1, 20.5.2, 20.5.3)	10
Case Study Scenario		
M1	While performing the Michelson interferometer experiment, a student moves the mirror slowly and observes 500 fringes passing the reference point. The mirror displacement is measured as 0.16 mm. Question: Determine the wavelength of the light used in the experiment.	
M2	In a single-slit Fraunhofer diffraction experiment, a student uses a laser of wavelength 650 nm. The slit width is 0.2 mm, and the screen is placed 1.5 m away. Question: Calculate the width of the central maximum observed on the screen.	

Reference Books:

1. Dr. N. Subrahmanyam, Brijlal, and Dr. M. N. Avadhanulu, A Textbook of Optics, 25th Revised Edition (2012) S. Chand.
2. (AG) Ajoy Ghatak, Optics 6E Mc Graw Hill Education.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Spectrometer: To determine refractive index of prism material	4	CO1, CO2 CO4,CO3, CO5,CO6, CO7.
2	Optical lever: determination of μ	4	CO1, CO2 CO4,CO3, CO5,CO6, CO7
3	R.P. of telescope/ R.P. of grating	4	CO1, CO2 CO4,CO3, CO5,CO6, CO7
4	Brewster's law: determination of μ	5	CO1, CO2 CO4,CO3, CO5,CO6, CO7
5	Determination of R.I. of liquid by laser	5	CO1, CO2 CO4,CO3, CO5,CO6, CO7
6	Interference: Newton's rings experiment measures the wavelength of light.	4	CO1, CO2 CO4,CO3, CO5,CO6, CO7
7	Study and use of Spectrometer (Skill)	4	CO1, CO2 CO4,CO3, CO5,CO6, CO7

Note:
1. Minimum number of four experiments and one skill experiment to be performed and reported in the journal.
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.
4. For practical examinations, the learner will be examined in one experiment from the list of experiments. Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal with a certificate that the learners has completed the practical course of respective semester as per the minimum requirements. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Fundamentals of Light Phenomena**				
Course Code	**HUSPH204**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	1
Type	**Minor**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Learning Objectives	
1	Explain the nomenclature used in lenses, lens equations for single convex lenses, and sign convention. lens maker's equation, Newton's lens equation and principal foci positions.
2	Describe Lateral, Longitudinal and Angular magnification, Equivalent focal length and power of two thin lenses, Concept of cardinal points and their significance
3	Explain qualitatively Spherical aberration & reduction, chromatic aberration & reduction.
4	Study of Fresnel and Fraunhofer type of diffraction and Fraunhofer diffraction pattern due to a single slit and double slit
5	Learn Michelson's Interferometer and its Applications
6	Describe Polarization and types of Polarization
7	The students learn to apply their knowledge to solve problems that are covered in the all syllabus.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Understand the nomenclature used in lenses, lens equations for single convex lenses, and sign convention. lens maker's equation, Newton's lens equation and principal foci positions.
CO2	Understand Lateral, Longitudinal and Angular magnification, Equivalent focal length and power of two thin lenses, Concept of cardinal points and their significance
CO3	Comprehend qualitatively Spherical aberration & reduction, chromatic aberration & reduction.
CO4	Understand Fresnel and Fraunhofer type of diffraction and Fraunhofer diffraction pattern due to a single slit
CO5	Understand Michelson's Interferometer and its Applications
CO6	Understand Polarization and types of Polarization
CO7	Solve problems related to the topics that are covered in the syllabus

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Lenses	10	CO1, CO2
2	Diffraction & Types	10	CO4
3.	Application of lenses	10	CO3, CO5, CO6

Syllabus

Module No.	Content	No. of Lectures
1	**Lenses** 1. Lenses and Lens Maker's Equation: Introduction to lenses, Terminology and sign conventions, Introduction to Thin lenses and Lens equation for single convex lens, Lens maker's equation: Positions of the Principal Foci and Newton's Lens equation. (SBA: 4.1, 4.2, 4.3, 4.7, 4.8, 4.9, 4.10, 4.10.1, 4.11) 2. Magnification by a lens and power of lens: Lateral, Longitudinal and Angular magnification, Deviation by a thin lens and its power, Equivalent focal length of two thin lenses, Focal length of the equivalent lens & power of two thin lenses (SBA: 4.12, 4.12.1, 4.12.2, 4.12.3, 4.15, 4.16, 4.17, 4.17.1, 4.17.2, 4.17.3, 4.17.4, 5.2)	10
2	**Diffraction & Types** 1. Fresnel diffraction: Introduction, Huygens-Fresnel's theory, Fresnel's assumptions, Distinction between interference and diffraction, Fresnel and Fraunhofer types of diffraction, (SBA: 17.1, 17.2, 17.3, 17.6, 17.7) 2. Fraunhofer diffraction: Introduction, Fraunhofer diffraction at a single slit, intensity distribution in diffraction pattern due to a single slit. (SBA: 18.1, 18.2, 18.2.1, 18.4, 18.4.2)	10
3	**Application of lenses** 1.Introduction to Aberration in lenses: Spherical aberration & reduction, chromatic aberration & reduction (Qualitative). SBA: 9.2, 9.5, 9.5.1, 9.10 Suitable numerical with appropriate difficulty level. 2. Michelson's Interferometer: Principle, construction, working, Applications of Michelson Interferometer: a) Measurement of wavelength b) Determination of the difference in the wavelength of two waves c) Determination of the refractive index of gases. (SBA: 15.7, 15.7.1 to 15.7.3, 15.8, 15.8.1, 15.8.2, 15.8.4) 3. Polarization: Introduction, Polarization, Types of Polarization (SBA: 20.1, 20.2, 20.5,20.5.1, 20.5.2, 20.5.3)	10
Case Study Scenario		
M1	While performing the Michelson interferometer experiment, a student moves the mirror slowly and observes 500 fringes passing the reference point. The mirror displacement is measured as 0.16 mm. Question: Determine the wavelength of the light used in the experiment.	
M2	In a single-slit Fraunhofer diffraction experiment, a student uses a laser of wavelength 650 nm. The slit width is 0.2 mm, and the screen is placed 1.5 m away. Question: Calculate the width of the central maximum observed on the screen.	

Reference Books:

1. Dr. N. Subrahmanyam, Brijlal, and Dr. M. N. Avadhanulu, A Textbook of Optics, 25th Revised Edition (2012) S. Chand.
2. (AG) Ajoy Ghatak, Optics 6E Mc Graw Hill Education.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Spectrometer: To determine refractive index of prism material	4	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
2	Optical lever: determination of μ	4	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
3	R.P. of telescope/ R.P. of grating	4	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
4	Brewster's law: determination of μ	4	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
5	Determination of R.I. of liquid by laser	5	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
6	Interference: Newton's rings experiment measures the wavelength of light.	5	CO1, CO2 CO3, CO4 CO5, CO6,CO7.
7	Study and use of Spectrometer (Skill)	4	CO1, CO2 CO3, CO4 CO5, CO6,CO7.

Note:
1. Minimum number of four experiments and one skill experiment to be performed and reported in the journal.
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.
4. For practical examinations, the learner will be examined in one experiment from the list of experiments. Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal with a certificate that the learners has completed the practical course of respective semester as per the minimum requirements. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.

Semester End Practical Evaluation **Time: 2.5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	40
Q.2	Journal	05
Q.3	Viva	05

BOS	**Natural and Physical Sciences**				
Course	**Battery and Inverter – Testing and Maintenance**				
Course Code	**HUSPH205P**	**Level**	**5**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	-	3	3
Type	**SEC**	**No of Teaching Hours**	-	90	90

Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**
	100	-	-	100

Learning Objectives	
1	Understand and analyze battery characteristics.
2	Apply fundamental electrical laws to practical circuits
3	Demonstrate inverter operation and block level design.
4	Analyze inverter output waveform and transformer operation.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Understanding of the various types of batteries, their construction, and materials used in their design.
CO2	Equip students with the knowledge of testing methods to evaluate battery performance and lifespan.
CO3	Understand the fundamentals of inverters, including their design, working principles, and applications.
CO4	Design inverters for different applications with an understanding of power conversion principles and component selection

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Battery Testing and Maintenance	45	CO1, CO2
2	Inverter Testing and Maintenance	45	CO3, CO4,

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
Battery Testing and Maintenance			
1	Study of specifications of Battery provided by the manufacturer.	30	CO1, CO2
2	Voltage, Capacity and Internal resistance Measurement of a Battery.		
3	Verification of Ohm's Law Using a Battery and Resistors.		
4	Series and Parallel Connection of Batteries & their effect on Voltage and Current.		
5	Measurement of Battery Terminal Voltage Under Load, No-Load Conditions and Testing Battery Performance under Load		
6	Determining the Charging and Discharging Time of a Battery.		
7	Battery Self-Discharge Experiment.		
8	Battery Inspection and Maintenance (Visual Inspection & Heavy Load Test.		
9	Effect of Temperature on Battery Voltage.		
Inverter Testing and Maintenance			
1	Study of specifications of Inverter provided by the manufacturer.	30	CO3, CO4,
2	Drawing the Block Diagram of an Inverter and Explaining Each Block		
3	Demonstrate and explain the working of Inverter and its different parts and its functions (PWM card, charging card, driver card etc.)		
4	Generating an Oscillator Signal Using a 555 Timer IC (Astable mode)		
5	Making a Simple DC-AC Inverter Circuit.		
6	Simulating an Inverter Output Using a Square Wave Generator.		
7	Analysis of Inverter Output Waveform Using an Oscilloscope.		
8	Testing Transformer Primary & Secondary Voltages and Build a Simple Bridge Rectifier and Testing DC Output		

Note:

1. Minimum number of fourteen experiments to be performed and reported in the journal.
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.
4. For practical examinations, the learner will be examined in one experiment from the list of experiments. Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal with a certificate that the learners has completed the practical course respective semester as per the minimum requirements. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.

Semester End Practical Evaluation **Time: 5 Hours**

Question No.	Questions	Total Marks
Q.1	Experiment	80
Q.2	Journal	10
Q.3	Viva	10

BOS	**Mathematics, Statistics and Computer Application**				
Course	**Real Analysis**				
Course Code	**HUSMT201**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60

Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**
	150	50	50	50

Learning Objectives	
1	Understand the basic concepts of infinite series, including convergence, divergence, and geometric series.
2	Identify and apply various tests of convergence such as Comparison Test, Ratio Test, Root Test, Limit Comparison Test, and Leibnitz Test.
3	Understand the concept of absolute and conditional convergence and analyze different types of series.
4	Understand the concept of Riemann integral, partitions, upper and lower sums, and integrability conditions.
5	Apply Fundamental Theorems of Calculus to evaluate definite integrals and solve related problems.
6	To apply integration techniques in solving geometrical problems such as area, length, and surface area

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Understand and explain the concepts of convergence and divergence of infinite series, Cauchy criterion, and different tests of convergence including absolute and conditional convergence.
CO2	Apply various convergence tests (Comparison, Ratio, Root, Leibnitz test, etc.) to analyze and solve problems related to infinite series and construct suitable examples or counterexamples.
CO3	Understand the concept of Riemann integral, upper and lower sums, integrability criteria, and Fundamental Theorems of Calculus.
CO4	Apply Riemann integration techniques to evaluate definite integrals and solve problems related to area between curves, length of curves, surface area of revolution, and Gamma–Beta functions.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Infinite Series & Uniform Convergence	15	CO1,CO2
2	Riemann Integration & Applications	15	CO3,CO4

Syllabus

Module No.	Content	No. of Lectures
1	**Infinite Series** **1.Infinite series in $\mathbb{R}$:** Definition of convergence and divergence. Basic examples including geometric series. Elementary results:If $\sum a_n$ converges, then $a_n \to 0$, but the converse is not true. Cauchy Criterion. Algebra of convergent series and related examples **2.Tests for convergence:** Comparison Test, Limit Comparison Test (without proof), Ratio Test (without proof), Root Test (without proof), Examples, p-series test. **3.Alternating series:** Leibnitz Test, Examples.Absolute convergence, Absolute convergence implies convergence, but not conversely, Conditional convergence	15
2	**Riemann Integration & Applications** **1.Introduction to Riemann Integration**: Idea of approximating area under a curve using inscribed and circumscribed rectangles. Partitions of an interval. Refinement of a partition. Upper and Lower Riemann sums. Definition of Riemann integral of a bounded real-valued function on a closed and bounded interval **2.Integrability criteria:** Criterion for Riemann integrability. Characterization of Riemann integral as the limit of a sum (without proof). Examples. **3.Algebra of Riemann integrable functions** If $f: [a, b] \to R$is integrable, then $\int_a^b f(x)\,dx = \int_a^c f(x)\,dx + \int_c^b f(x)\,dx$ (without proof) If $\lvert f \rvert$is integrable, then $\lvert \int_a^b f(x)\,dx \rvert \leq \int_a^b \lvert f(x) \rvert\,dx$ If $f(x) \geq 0$for all $x \in [a, b]$, then $\int_a^b f(x)\,dx \geq 0$ **4.Integrability conditions:** Riemann integrability of continuous functions. Integrability of bounded functions with finitely many discontinuities (without proof).Integrability of monotone functions **5.Fundamental Theorems of Calculus:** First Fundamental Theorem of Calculus and Second Fundamental Theorem of Calculus **6.Applications of definite integrals:** Area between two curves. Lengths of plane curves. Surface area of surfaces of revolution **7.Gamma and Beta functions:** Definitions and their Properties. Relationship between Gamma and Beta functions (without proof)	15
Case Study Scenario		
M1	A scientist is studying the decay of a radioactive substance. The quantity of substance decreases every hour such that the remaining quantity follows the pattern: $100, 50, 25, 12.5, \ldots$ This forms an infinite geometric series. 1.Write the infinite series representing the total quantity. 2.Test whether the given series is convergent or divergent.	

	3.Find the sum of the infinite series. 4.Construct another example of a convergent infinite
M2	The velocity of a particle moving along a straight line is given by: $v(x) = 6x - x^2$ where $x$is measured in seconds and velocity in m/s. The motion is observed from $x = 0$to $x = 6$. a) Write the definite integral to find the total displacement. b) Evaluate the displacement using definite integration. c) Verify whether the function is Riemann integrable on the given interval. d) Interpret the physical meaning of the result obtained.

Reference Books:

1.Sudhir Ghorpade and Balmohan Limaye, *A Course in Calculus and Real Analysis* (Second Edition), Springer.
2. R. R. Goldberg, *Methods of Real Analysis*, Oxford and IBH Publishing Co., New Delhi, 1970.
3. Thomas and Finney, *Calculus and Analytic Geometry* (Ninth Edition), Addison-Wesley, Reading, Mass., 1998.
4. T. M. Apostol, *Calculus, Vol. 2*, John Wiley.
5. Ajit Kumar and S. Kumaresan, *A Basic Course in Real Analysis*, CRC Press, 2014.
6. D. Somasundaram and B. Choudhary, *A First Course in Mathematical Analysis*, Narosa, New Delhi, 1996.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Convergent and divergent series and algebra of convergent series.	3	CO1
2	Comparison and limit comparison test.	3	CO2
3	Ratio test and root test	3	CO2
4	Alternating Series and p-series test	3	CO2
5	Absolute and conditional convergence.	3	CO1,CO2
6	Upper sum and lower sum	3	CO3
7	Riemann integral and its properties	3	CO3
8	Fundamental Theorems of Calculus.	3	CO3,CO4
9	Area between two curves, lengths of plane curves and surface area of surfaces of revolution	3	CO4
10	Beta and Gamma functions	3	CO4

Semester End Practical Evaluation **Time: 2 Hours**

Question No.	Questions	Total Marks
Q.1	Practical Questions	40
Q.2	Journal	05
Q.3	Viva & Attendance	05

BOS	**Mathematics, Statistics and Computer Application**				
Course	**Linear Algebra-I**				
Course Code	**HUSMT202**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60

Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**
	150	50	50	50

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Students will be able to understand and solve systems of homogeneous and non-homogeneous linear equations using matrix representation, elementary row and column operations, row echelon form, and Gaussian elimination, along with geometric and algebraic interpretation of solutions and applications.
CO2	Students will be able to analyze matrix properties related to solvability of linear systems, including elementary matrices and their invertibility, rank (row and column rank), rank conditions for existence and uniqueness of solutions, equivalence statements for invertible matrices, determinant criteria, and application of Cramer's Rule.
CO3	Students will be able to understand the structure of vector spaces and subspaces over $\mathbb{R}$, including examples such as $\mathbb{R}^n$, row and column spaces of matrices, polynomial spaces, matrix spaces, and spaces of real-valued functions, and perform operations like intersection, sum, and direct sum of subspaces.
CO4	Students will be able to analyze linear dependence and independence, linear span, basis, and dimension of vector spaces, verify whether a given set forms a basis, and determine the dimension and finite generation of vector spaces through appropriate examples.

Learning Objectives	
1	Understand systems of linear equations (homogeneous and non-homogeneous) and interpret their solutions both algebraically and geometrically.
2	Analyze rank of a matrix and understand its invariance under elementary operations and its importance in determining consistency of linear systems.
3	Establish conditions for existence and uniqueness of solutions, understand equivalence statements related to invertibility, determinant, and rank, and apply Cramer's Rule for solving systems.
4	To introduce the fundamental concepts of vector spaces over $\mathbb{R}$, including subspaces, examples of vector spaces ($\mathbb{R}^n$, polynomial spaces, matrix spaces, function spaces), and operations such as intersection, sum, and direct sum of subspaces.
5	To develop understanding of linear combinations, span, linear dependence and independence, basis, and dimension, and to enable verification of these concepts through illustrative examples.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	System of Linear Equations and Matrices	15	CO1, CO2
2	Vector Spaces	15	CO3, CO4

Syllabus

Module No.	Content	No. of Lectures
1	**System of Linear Equations and Matrices:** 1. Systems of homogeneous and non-homogeneous linear equations, Simple examples of finding solutions of such systems, Geometric and algebraic understanding of the solutions, Matrix representation of systems of linear equations (both homogeneous and non-homogeneous). 2. Elementary row and column operations; Row reduction (of a matrix to its row echelon form); Gaussian elimination, Applications of solving systems of linear equations with examples. 3. Elementary matrices and their relationship with elementary row operations. Invertibility of elementary matrices. Consequences such as: a square matrix is invertible if and only if its row echelon form is invertible, and invertible matrices are products of elementary matrices. 4. Notion of row rank and column rank with examples. Equivalence of the row rank and the column rank (without proof). Invariance of rank upon elementary row or column operations. 5. Necessary and sufficient condition for a system of non-homogeneous linear equations to have a solution [viz., the rank of the coefficient matrix equals the rank of the augmented matrix [A|B]]. Equivalence of statements (in which A denotes an n × n matrix) such as (i) The system AX = b of non-homogeneous linear equations has a unique solution. (ii) The system AX = 0 of homogeneous linear equations has no nontrivial solution. (iii) A is invertible. (iv) det A = 0. (v) rank(A) = n. Cramer's Rule.	15
2	**Vector Space** 1. Definition of a vector space over $\mathbb{R}$. Subspaces; criterion for a nonempty subset to be a subspace of a vector space. Examples of vector spaces, including the Euclidean space $\mathbb{R}n$, Row space and the column space of a matrix as examples of vector space, space of polynomials, space of various types of matrices, space of real valued functions on a set. 2. Intersections, union and sums of subspaces. Direct sums of vector spaces. 3. Linear combination of vectors. Linear span of a subset of a vector space. Definition of a finitely generated vector space. Linear dependence and independence of subsets of a vector space. 4. Basis of a vector space. Verification of basis of vector space through examples. Dimension of a vector space. Examples. Bases of a vector space as a maximal linearly independent sets and as minimal generating sets (without proof)	15
Case Study Scenario		
M1	An engineering structure is held in equilibrium by three supporting cables. The tensions in the cables are T1,T2,T3. Based on equilibrium conditions (sum of forces in x, y, z directions = 0), the equations are: T1+2T2+T3=9, 2T1+T2+3T3=13, 3T1+2T2+4T3=19 Find the value of T1,T2.T3.	
M2	A streaming company stores user behavior data in a relational database. Each user is	

	represented by a vector containing: ● Number of movies watched ● Number of hours watched ● Number of genres explored The following user vectors are recorded:v1= (1,2,1),v2= (2,4,2), v3= (1,1,0) 1.Check whether the vector form a vector space. 2.Check whether the vectors are linearly dependent or independent.. 3.Find a basis for the vector space generated by the vectors. 4.Find the dimension of the vector space generated by the vectors.

Recommended Reference Books:

1. Elementary Linear Algebra, Howard Anton and Chris Rorres, 11th Edition, Wiley, 2013.
2. Introduction to Linear Algebra, Serge Lang, 2nd Edition, Springer, 1986.
3. Linear Algebra: A Geometric Approach, S. Kumaresan, Prentice-Hall of India, 2000.
4. Linear Algebra Done Right by Sheldon Axler, 3rd Edition, Springer, 2015.
5. Linear Algebra with Applications by Gareth Williams, 6th Edition, Jones and Bartlett Publishers, 2008. Sheldon Axler, Linear Algebra done right, Springer.
6. Matrix Theory by David W. Lewis, World Scientific Publishing Company, 1991.

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	System of homogeneous and non-homogeneous linear equations .	3	CO1
2	Elementary row (column) operations and elementary matrices	3	CO1
3	Row space, column space, row rank and column rank	3	CO1
4	Gaussian elimination method	3	CO2
5	System of linear equations (using determinants) and Cramer's rule	3	CO2
6	Vector spaces and subspaces	3	CO3
7	Intersection, union, sum and direct sum of subspaces	3	CO3
8	Linear combinations and linear span of a subset	3	CO4
9	Linear independence and dependence	3	CO4
10	Basis and dimension of vector spaces	3	CO4

Semester End Practical Evaluation **Time: 2 Hours**

Question No.	Questions	Total Marks
Q.1	Program	40
Q.2	Journal	05
Q.3	Viva & Attendance	05

BOS	**Mathematics, Statistics and Computer Application**				
Course	**Ordinary Differential Equations**				
Course Code	**HUSMT203**	**Level**	**4.5**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	150	50	50	50	

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Understand the basic concepts and solution methods of differential equations.
CO2	Solve linear differential equations and test whether an equation is exact.
CO3	Find the complementary function and integrating factor of a given differential equation
CO4	Distinguish between homogeneous and non-homogeneous differential equations with examples

Learning Objectives	
1	Understand the basic ideas and methods of differential equations and learn how to use them to model, solve, and explain real-life problems.
2	Learn important mathematical tools that help in higher studies and in different science fields.
3	Improve problem-solving ability, creativity, communication skills, and overall development for future careers.
4	Gain awareness of both global and local applications of mathematics and explore different areas of mathematical science.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
1	First Order First Degree Differential Equations	15	CO1, CO2
2	Higher Order Linear Differential Equations.	15	CO3, CO4

Syllabus

Module No.	Content	No. of Lectures
1	**First Order First Degree Differential Equations** Review of Definition of a differential equation, order, degree, ordinary differential equation, linear and non-linear ODE. Solution of homogeneous and non-homogeneous differential equations of first order and first degree. Notion of partial derivatives. Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for $Mdx + Ndy = 0$ to be exact. Non-exact equations: Rules for finding integrating factors (without proof) for non exact equations, such as: i) $\frac{1}{Mx+Ny}$ is an I.F. if $Mx+Ny\neq 0$ and $Mdx+Ndy=0$ is homogeneous. ii) $\frac{1}{Mx-Ny}$ is an I.F. if $Mx-Ny\neq 0$ and $Mdx+Ndy=0$ is of the form $f_1(xy)\, y\, dx+f_2(x\, y)\, xdy=0$. iii) $e^{\int f(x)dx}$ (resp $e^{\int g(y)dy}$) is an I.F. if $N\neq 0$ (resp $M\neq 0$) and $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ $\left(\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)\right)$ is a function of x (resp y) alone, say $f(x)$ (resp $g(y)$). iv) Linear and reducible linear equations of first order, finding solutions of first order differential equations	15
2	**Higher Order Linear Differential Equations** a)The general n-th order linear differential equation, linear independence, existence and uniqueness theorem (Statement only), Wronskian, classification of D.E.: homogeneous and non-homogeneous, general solution of homogeneous and non-homogeneous LDE, the differential operator and its properties. b)Higher order homogeneous linear differential equations with constant coefficients, the auxiliary equations, roots of the auxiliary equations: real and distinct, real and repeated, complex and complex repeated. c)Non-homogeneous equations: The inverse differential operator and particular integral, evaluation of $\frac{1}{f(D)}$ for the functions like $e^{ax}, \sin ax, \cos ax, x^m$, $x^m \sin ax, x^m \cos ax, e^{ax}V$ and xV where V is any function of x. d)The method of undetermined coefficients. The method of variation of parameters.	15
Case Study Scenario		
M1	A cup of coffee is poured at 90°C in a room with ambient temperature 25°C. After 5 minutes, the coffee cools to 70°C. Model the cooling process and predict the temperature after 10 minutes.	
M2	When you pluck a guitar string, it vibrates up and down repeatedly and slowly comes to rest. Model how the displacement of the string changes with time.This motion involves acceleration, velocity, and position — so it leads to a second-order linear differential equation.	

Reference Books:

1. George F. Simmons, Differential Equations with Applications and Historical Notes, Taylor's and Francis, Third Edition, 2017.
2. E.D. Rainville and P.E. Bedient; Elementary Differential Equations; Macmillan.
3. E.A. Coddington and R. Carlson: Linear Ordinary Differential Equations, SIAM.
4. M.D. Raisinghania; Ordinary and Partial Differential Equations; S. Chand

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Systems of homogeneous and non-homogeneous linear equations.	3	CO1,CO2
2	General solution of Exact equations	3	CO1,CO2
3	Solution of Non-exact equations	3	CO1,CO2
4	Solution of Linear equations	3	CO1,CO2
5	Solution of Non-linear equations	3	CO1,CO2
6	Wronskian and linear independence of solutions.	3	CO3, CO4
7	Higher order homogeneous linear differential equations with constant coefficients.	3	CO3, CO4
8	Evaluation of particular integral for $X = e^{ax}$, sinax, cosax.	3	CO3, CO4
9	Evaluation of a particular integral for $X = e^{ax}V$ and $X = xV$ where V is any function of x.	3	CO3, CO4
10	Method of undetermined coefficients and variation of parameters.	3	CO3, CO4

Semester End Practical Evaluation **Time: 2 Hours**

Question No.	Questions	Total Marks
Q.1	Practical Questions	40
Q.2	Journal	05
Q.3	Viva & Attendance	05

BOS	**Mathematics, Statistics and Computer Application**				
Course	**Essential Mathematics in Real life-I**				
Course Code	**HUSMT204**	**Level**	**5.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Minor**	**No of Teaching Hours**	30	30	60
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**		**Practical**
	150	50	50		50

Learning Objectives	
1	Provide a strong foundation in matrix algebra, including matrix operations, transpose, symmetric and skew-symmetric matrices, determinants, minors, cofactors, adjoint, inverse, and properties of determinants.
2	Develop problem-solving skills in solving linear systems using inverse methods and computing determinants of special matrices such as the Vandermonde matrix.
3	Introduce practical applications of matrices in cryptography, chemical equation balancing, and forest growth modeling to connect mathematical theory with real-world problems.
4	To develop students' ability to collect, classify, tabulate, and present data effectively using appropriate statistical tables and graphical methods.
5	To equip students with the knowledge and skills to calculate and interpret various statistical measures of central tendency, dispersion, skewness, and kurtosis for meaningful data analysis.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Students will be able to understand and perform matrix operations and determinant calculations.
CO2	Students will be able to apply matrices and determinants to solve real-life problems.
CO3	Students will be able to collect, organize, and present statistical data using appropriate tabular and graphical methods and compute measures of central tendency such as mean, median, quartiles, and mode.
CO4	Students will be able to analyze and interpret data using measures of dispersion and shape of distribution, including range, quartile coefficient, mean deviation, standard deviation, variance, coefficient of variation, skewness, and kurtosis for meaningful statistical conclusions.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Matrices and Applications	15	CO1, CO2
2	Statistics – Data Analysis and Interpretation	15	CO3, CO4

Syllabus

<table>
<tr><th>Module No.</th><th>Content</th><th>No. of Lectures</th></tr>
<tr><td>1</td><td>Matrices and Applications:
Fundamentals of Matrices:Matrix definition and types of matrices,Matrix operations: addition and subtraction ,Matrix operations: multiplication ,Transpose of a matrix ,Symmetric and skew-symmetric matrices.
Determinants and Related Concepts:Determinants of order 2 and 3 , Properties of determinants ,Vandermonde matrix and computation of its determinant,Minor and cofactor,Adjoint and inverse of a matrix.
System of Linear Equations and Applications:Solution of linear equations using inverse method,Cryptography (basic matrix coding), Balancing chemical equations.
Applications in Forest Management:Forest Management I: Introduction to growth matrix , Forest Management II: Statements and notations for optimal sustainable yield.</td><td>15</td></tr>
<tr><td>2</td><td>Statistics – Data Analysis and Interpretation
Data Collection and Presentation:Types of data,Frequency distribution, Histogram, Bar chart and Multiple bar chart,Pie chart.

Measures of Central Tendency: Mean, Median , Quartiles, Mode.

Measures of Dispersion:Range and Coefficient of Range, Quartile Coefficient,Mean Deviation,Standard Deviation, Variance and Coefficient of Variation.

Shape of Distribution:Skewness and Kurtosis</td><td>15</td></tr>
<tr><td colspan="3">Case Study Scenario</td></tr>
<tr><td>M1</td><td colspan="2">The printer mixes three base colors (Red, Blue, Yellow) to produce the required shades.The relationship is modeled as:

$$\begin{bmatrix}1 & 2 & 1\\ 2 & -1 & 1\\ 3 & 0 & 2\end{bmatrix}\begin{bmatrix}R\\ B\\ Y\end{bmatrix}=\begin{bmatrix}8\\ 3\\ 13\end{bmatrix}$$

1.Write AX=B
2.Find inverse of matrix A and find X</td></tr>
<tr><td>M2</td><td colspan="2">The following table shows the weekly expenditure of 120 families. Calculate the mean weekly expenditure.

<table>
<tr><td>Expenditure (₹)</td><td>10-30</td><td>30-50</td><td>50-70</td><td>70-90</td></tr>
<tr><td>No. of families</td><td>15</td><td>25</td><td>35</td><td>25</td></tr>
</table>
</td></tr>
</table>

Recommended Reference Books:

1. Hermann Weyl, Symmetry, Princeton University Press, 1952.
2. Elementary Linear Algebra Application Version, H. Anton, C. Rorres, Wiley, Tenth Edition.
3. Goon AM, Gupta MK, Das Gupta B: Fundamentals of Statistics, Vol-I, the World Press Pt. Ltd, Kolkata
4. Shah R.J: Descriptive Statistics: Seth Publication, Eight Edition
5. Spiegel M.R: Theory and Problems of Statistics, Schaum's Publishing Series, Tata McGraw-Hill, First Edition

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	Matrix operations: multiplication ,Transpose of a matrix ,Symmetric and skew-symmetric matrices.	3	CO1
2	Computation of Determinants of order 2 and 3,Vandermonde matrix and Minor and cofactor,Adjoint and inverse of a matrix.	3	CO1
3	Solution of linear equations using inverse method	3	CO1
4	Cryptography (basic matrix coding), Balancing chemical equations.	3	CO2
5	Applications in Forest Management	3	CO2
6	Histogram, Bar chart and Multiple bar chart,Pie chart.	3	CO3
7	Measures of Central Tendency:Mean, Median , Quartiles, Mode.	3	CO3
8	Range and Coefficient of Range, Coefficient of Quartile Deviation	3	CO4
9	Mean Deviation,Standard Deviation	3	CO3, CO4
10	Variance and Coefficient of Variation.	3	CO4

Semester End Practical Evaluation **Time: 2 Hours**

Question No.	Questions	Total Marks
Q.1	Practical Questions	40
Q.2	Journal	05
Q.3	Viva & Attendance	05

BOS	**Mathematics, Statistics and Computer Application(AIML)**				
Course	**Introduction to Python Programming**				
Course Code	**HUSMT205P**	**Level**	**4.5**		
		Type	**Theory**	**Practical**	**Total**
Semester	**III**	**Credits**	2	1	3
Type	**Major**	**No of Teaching Hours**	30	30	60

Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**
	150	50	50	50

Learning Objectives	
1	To make students understand the basics of Python programming and its role in AIML.
2	To develop logic and problem-solving skills using Python.
3	To learn to implement Python data structures, functions, and file operations.
4	To apply Python for real-world data manipulation and visualization.
5	To gain exposure to basic AI/ML workflows and automation using Python.

Course Outcomes	
After successful completion of this course, students would be able to: -	
CO1	Explain fundamental Python concepts, syntax, and programming constructs relevant to AI/ML applications.
CO2	Develop Python programs to solve computational problems using logical reasoning and structured approaches.
CO3	Implement and manipulate core data structures (lists, tuples, dictionaries, sets), functions, and file handling operations in Python.
CO4	Perform data preprocessing, analysis, and visualization using Python libraries for real-world datasets,tools and libraries to build basic AI/ML workflows and simple automation tasks.

Modules at Glance

Module No.	**Content**	**No. of Hours**	**CO Mapping**
1	Foundations of Python Programming and Core Constructs	15	CO1, CO2, CO3
2	Python Libraries, File Handling, and AI/ML Applications	15	CO3, CO4,

Syllabus

Module No.	Content	No. of Lectures
1	**Introduction to Python Programming** History, Features, and Applications of Python ,Installation, IDEs (Anaconda, Jupyter, VS Code) ,Python Syntax, Variables, Data Types,Input/Output, Type Casting, Simple Programs and Debugging **Control Structures and Functions** Conditional Statements (if, elif, else),Loops (for, while, nested),Break, Continue, Pass statements, Functions: Definition, Parameters, Return Values,Recursion, Lambda, and Scope **Data Structures in Python** Strings, Lists, Tuples, Sets, Dictionaries, Operations and Methods,Comprehensions (List, Dict, Set),Iteration and Manipulation	15
2	**File Handling and Modules** File Operations: Text, Binary, CSV, Exception Handling (try, except, finally),Modules, Packages, and Importing Built-in Modules (math, random, os, datetime) **Python for AIML Application** Introduction to Libraries: NumPy, Pandas, Matplotlib ,DataFrames, Series, Basic Statistics,Data Cleaning & Manipulation,Data Visualization: Line, Bar, Pie, Scatter Plots,Simple Linear Regression using Scikit-learn,Flask.	15
Case Study Scenario		
M1	A smart city project requires a console-based parking management prototype developed using core Python concepts without external libraries. The system must store parking slot IDs, track availability, and allow users to reserve or release slots. It should accept user input, validate entries, and prevent invalid bookings while displaying updated slot status. The solution must use variables, conditionals, loops, functions, and data structures such as lists or dictionaries. Exception handling should be implemented to ensure robustness against incorrect inputs.Develop a Python function that checks whether a slot is available before booking.	
M2	A retail company wants to analyze historical sales data (date, category, units sold, revenue) to identify trends and predict future revenue using Python. The solution must read data from a CSV file, clean missing or inconsistent entries, and compute metrics such as total sales, average revenue, and best-selling category. It should visualize patterns using charts and apply simple linear regression for sales prediction. The implementation must use Pandas, NumPy, Matplotlib, Scikit-learn, and file handling concepts**Questions:** Outline steps for preprocessing the dataset; write code logic for computing summary statistics; explain how visualization aids decision-making;	

Reference Books:

1.Severance, C. R. (2016). Python for Everybody: Exploring Data in Python 3. CreateSpace.
2.Lutz, M. (2013). Learning Python (5th ed.). O'Reilly Media.
3.Downey, A. B. (2015). Think Python: How to Think Like a Computer Scientist (2nd ed.). O'Reilly Media.
4.Python Official Docs: https://docs.python.org
5.W3Schools / TutorialsPoint Python Tutorials
6.Kaggle Datasets and Colab Notebooks for Practice

Semester End Evaluation (50 Marks) **Time : 2 Hours**

Paper Pattern

Question No.	Questions	Total Marks : 50
Q1	Attempt 3 out of 5	15
Q2	Attempt 3 out of 5	15
Q3	Attempt 3 out of 5	15
Q4	Case Study	05

Practical Syllabus

Sr. No	List of Practical	No. of. Lectures	CO Mapping
1	**Environment Setup and Basic Programs** Write a program to perform basic arithmetic operations such as addition, subtraction, multiplication, and division. Write a program to take user input and display formatted output using variables and string operations.	3	CO1, CO2
2	**Programs Using Conditionals, Loops, and Functions** Write a program to check whether a given number is even or odd using conditional statements. Write a program to find the factorial of a number using loops.	3	CO3, CO4
3	**Data Structures Implementation** Write a program to demonstrate list operations such as append, insert, delete, and sorting. Write a program to implement a student record system using dictionaries.	3	CO3, CO4
4	**File Operations and Exception Handling** Write a program to read the contents of a text file and display them on the screen. Write a program to write and append data to a file.	3	CO4, CO3
5	**Data Analysis and Visualization** Write a program to create and manipulate NumPy arrays. Write a program to load a dataset into a Pandas DataFrame and perform basic data analysis (mean, median, mode, etc.).	3	CO3
6	**Introduction to Web GUI**: Design a simple web interface using **Flask** to accept user input (Number/Name) and display it back on a webpage.	3	CO2, CO4, CO3,

Semester End Practical Evaluation **Time: 2 Hours**

Question No.	Questions	Total Marks
Q1	Program	30
Q2	Journal	10
Q3	Viva & Attendance	10