Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE51	Title of the Course	Environmental Chemistry and analysis
Total Credits of the Course	1	Hours per Week	3 L + 1S = 4 h

Course Objectives:	1. To teach students the environmental chemistry and principles of chemical analysis useful in this branch 2. To update students with growing techniques of environment monitoring 3. To provide better understanding between the human activities and their environmental impacts

Course Content		
Unit	Description	Weightage* (%)
1.	**Environmental segments:** Introduction to the environment ● scope of the environmental study and useful terms, **Earth's atmosphere:** its composition and structure ● tropospheric and stratospheric chemistry ● fog, precipitation, particles, ions, radicals, aerosols **Hydrosphere:** resources and distribution of global water ● aquatic systems ● sea water model ● microbiological processes ● gases in water etc. **Terrestrial environment:** Concentric layers of the earth ● soil formation, composition, properties and textures ● nitrogen cycle and NPK **Biosphere:** ecosystem and natural cycles	25 (10 L)
2.	**Environmental Pollution**: pollutants and their classification ● **Air pollution**: CFCs, SMOK, FOG, SMOG, PAN, PAH, green house effect, acid rain, ozone depletion, EL Nino event ● **Water pollution:** toxic elements and pesticides in water ● their impact on enzymatic and biochemical processes ● **Soil pollution:** wastes and pollutants in soil and their classification ● fertilizers, pesticides, plastics and metals	25 (10 L)
3	**Environmental chemical analysis** ● techniques in water and gas monitoring ● sampling of air ● total solids ● alkalinity and acidity ● chlorides and sulphate ● hardness ● D.O., BOD, COD, nitrate and nitrite ● pollutants in water, fuel gas, gaseous pollutants in air ● Karl-Fisher reagent and its use ● **Instrumental techniques:** AAS, XRF, GC etc.	25 (10 L)
4	**Waste management and green chemistry ● Waste management:** classification of wastes, overview of waste management methodologies and techniques available and new approaches ● **Green chemistry:** its need, tools for green synthesis, twelve principles of green chemistry, and elementary ideas about green process, green reagent, solvent, catalyst, atom economy	25 (10 L)

Teaching-Learning Methodology	Class room teaching with board work and computer aids, Assignments of teaching contents to students, training for better communications of subject knowledge,

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	The outcome of this course is background of environmental aspects and analytical methods to evaluate the environmental pollutant and related issues. It also provides the knowledge to control the environmental pollution and green chemistry aspects. Students gain knowledge of various environmental segments, their interaction among each other and how they are contaminated due to man-made activities on the earth. After completing M.Sc. chemistry program, students will be able to:
2.	Learn about the air, land, and water pollutions.
3.	Aware about environment and educate others that how our planet is getting spoiled and what are the remedies to stop this pollution.
4	Generate knowledge to monitor environmental processes.
5	Tackle their work at research in environmental sciences and chemical industries.

Suggested References:	
Sr. No.	References
1.	*Environmental Chemistry* by J.W.Moore & E.A.Moore, Academic Press.Inc.New York,1976

2.	*Environmental Chemistry* by A.K.De,4th edition, New Age International Publishers
3	*Principles of Environmental Science : Inquiry and Applications* by William P.Cunningham & Mary A.Cunningham,1st edition,2002,Tata McGraw Hill Publishing Company Ltd., New Delhi
4.	*Environmental Chemistry* by S.K. Banerji, 2nd Edition, 1999, Prantice Hall of India Pvt. Ltd., New Delhi.
5.	Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH
6.	Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley
7	*A text book on Experiments and Calculations-Engineering Chemistry*, 1st Edition, 1984, S.Chand &Co. Ltd., New Delhi.

On-line resources to be used if available as reference material
On-line Resources:
e-books, reviews on general topic

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Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE60	Title of the Course	Applied Organic Chemistry
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To enrich the knowledge of process and research chemistry in pharmaceutical, agrochemical, and dye industries. 2. To understand the organic chemistry of environmental pollutants and green chemistry. 3. To familiarize students with the role of organic chemistry in forensic science. 4. To impart knowledge of catalysis of organic reaction using various types of catalysts.

Course Content

Unit	Description	Weightage* (%)
1.	**Organic Chemistry in Industry** Introduction, Process Chemistry *versus* Research Chemistry, Pharmaceutical Industry: Drug Discovery, Drug development-Preclinical and clinical testing, Medicine, Future Problems and Opportunities. Agrochemical Industry: Herbicides, Fungicides and Insecticides. Dyes Industry: Textile and Food dyes.	25
2.	**Organic Chemistry and Environment** Introduction, Pesticides, Focus on POPs and VOCs, Endocrine Disruptors, Chlorofluorocarbons, and their Replacements, Polycyclic Aromatic Hydrocarbons, Plastics, Green Chemistry, and the future.	25
3.	**Organic Chemistry in Forensic Science** Introduction, Drugs of Abuse: Categories, Presumptive Tests, Instrumental Methods and Designer Drugs, Poisoning, Testing of Blood, Dyes, Inks and Paper, Trace Evidence, Fingerprints Visualization.	25
4.	**Organic Reactions Catalysis** Introduction, Catalysis by Acids and Bases, Lewis Acid Catalysis, Phase-Transfer Catalysis, Reactions Catalyzed by Metal Surfaces and Transition Metal Complexes, Enzyme and Organocatalysis.	25

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology will be blend of lectures / PPT presentation / seminar / tutorials / assignments etc.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand process and research chemistry in pharmaceutical, agrochemical, and dye industries.
2.	Understand the organic chemistry of environmental pollutants and green chemistry.
3.	Understand role of organic chemistry in forensic science.
4.	Understand catalysis of organic reaction by transition metal catalyst, phase transfer catalyst, catalysis by acid, base enzyme, and metal surface.

Suggested References:	
Sr. No.	References
1.	Organic Chemistry: A Mechanism Approach; Penny Chaloner, CRC Press, Tailor and Francis; Florida.
2.	Pharmaceutical Process development: Current Chemical and Engineering Challenges, J. Blacker and M. T. Williams, RSC Cambridge, UK.
3.	Fine Chemicals: The Industry and Its Business, P. Pollak, 2nd Edition, Wiley.

4.	The Evolution of Drug Discovery: From Traditional Medicines to Modern Drugs, E. Ravina, Wiley.
5.	Name Reactions, Jie Jack Lie, Fourth edition, Springer, NewYork.
6.	Catalysis of Organic Reactions, John R. Sowa, Jr., CRC Press, Tailor and Francis, Florida.

On-line resources to be used if available as reference material
On-line Resources: https://swayam.gov.in/

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Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE52	Title of the Course	Analysis of Pharmaceuticals drugs
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. This course provides the skill for the background of analysis and of various pharmaceutical products and their biological testing 2. To aware with Drug development and testing pathway and their norms

Course Content		
Unit	Description	Weightage* (%)
1.	Role of FDA in Pharmaceutical Industries: Definitions of Drug & Cosmetics, Substandard Drugs, Role of FDA, Introduction to New Drug, Development of New Drugs- Selection of Area, Phase I, Phase II, Phase III Application to FDA for formulation and marketing for new drug. Stability studies and Self life fixation. Biological Tests & Assay: Introduction to biological assay, Biological assay of Heparin sodium, Determination of Amylase activity, Determination of Photolytic Activity, Test for Insulin in solution, Biological Assay of Tetanus Antitoxin, Test for Undue Toxicity.	25%
2.	Microbiological Tests and Assays: Microbiological test for antibiotics Standard preparation and units of activity, Test organisms and Inoculums, Cylinder-plate assay receptacles, Turbidimetric assay receptacles, Assay Designs, Cylinder plate or Cup-plate method, Two level fractional assay, Test for Sterility. Physical Test, Determinations, Limit tests and Sterilization : Disintegration Test for Tablets and Capsules, Dissolution Test for Tablets and Capsules, moisture / water content by Karl-Fischer titration, limit tests for arsenic, heavy metals, iron, lead, sulphate, chloride, Ash, sulphated ash, Methods for Sterilization Steam Sterilization, Dry heat sterilization, Sterilization by Filtration, Gas Sterilization, Sterilization by Ionizing radiation, Sterilization by heating with Bactericides, Water for Pharmaceutical use.	25%
3.	Analysis of vegetable Drugs: Vegetable drugs: Sampling, foreign organic matter, ash value, acid soluble ash, acid insoluble ash, sulphated ash, Extraction of alkaloids. Sources of Impurities in Pharmaceutical raw materials & finished products, Shelf life of pharmaceutical product: Raw materials, Method of manufacture, Atmospheric contaminations,	25%

	Cross Contamination, Microbial contamination, Container contamination, Packaging errors, Chemical instability, Temperature effect and Physical changes, shelf life of pharmaceutical product and determination of shelf life.	
4.	Standardization and quality control of different raw materials and dosage form: Analysis of raw materials with respect to identification, other or related substances, loss on drying, and Assay as per IP, i) adrenaline ii) Cephalexin, iii) isoniazid and iv) paracetamol. Problems based on assay of these materials. Brief introduction to different dosage forms with the IP requirements Analytical methods for the following- Tablets, different types of tablets, uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, (Rifampicin) Powders (Sodium benzoate), Solutions (saline NaCl) Suspensions (barium sulphate –limit test for impurity) Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), ophthalmic preparations (sulphacteamine), Aerosols (salbutamol)	25%

Teaching-Learning Methodology	The conventional teaching methodology along with animation and PowerPoint presentation are also use to effective teaching

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	After completing M.Sc. chemistry program, students will be able to:
2.	To know the microbiological test for antibiotics.
3.	• Perform the Cup-plate method. • Perform the Karl-Fischer titration for the determination of moisture / water

	content. • Perform the limit tests for arsenic, heavy metals, iron, lead, sulphate, chloride, Ash, and sulphated ash.
4	To Know the about Steam Sterilization, Dry heat sterilization, Sterilization by Filtration, Gas Sterilization, Sterilization by Ionizing radiation, Sterilization by heating with Bactericides.
5	Analyze the vegetable Drugs.
6	Understand the atmospheric contaminations, cross contamination, microbial contamination and container contamination.
7	Perform the standardization and quality control of different raw materials.

Suggested References:	
Sr. No.	References
1.	Practical biochemistry, Principles and Techniques, 5th Edition, by Keith Wilson and John Walker, Cambridge University Press.
2.	Quantitative Analysis of Drugs in Pharmaceutical formulations, 3rd Edition, by P. D. Sethi, C.B.S. Publishers & Distributors, New Delhi.
3	Indian Pharmacopeia Volume I and II.
4	Practical Pharmaceutical chemistry, 3rd Edition, volume 1, By A.H. Beckett and J. B. Stenlake.
5	Remington's Pharmaceutical sciences.
6	Ansel's Pharmaceutical Analysis

On-line resources to be used if available as reference material
On-line Resources

Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE53	Title of the Course	Selected Topics in Advanced Inorganic Chemistry-II
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. The students explain the structure of polyhedral molecules, the equation of balance and topological theory, surfactant chemistry and its applications, mathematical functions and their interrelationship, and the factors affecting the stability constants of metal complexes. 2. Adapt lab safety precautions.

Course Content		
Unit	Description	Weightage* (%)
1.	Molecular Polyhedra Boron hydrides and related structures, Three centre bonds: basic assumptions, Three center orbital in known structures, Equation of balance, Topological theory and its applications	25%
2.	Application of surfactants in inorganic chemistry Surfactants, CMC, micelles, reverse micelles, use of surfactants in synthesis of mesoporous materials and nano-particles, microemulsions and their use in synthesis of nano-particles, purification of minerals (froth flotation), surface modification	25%
3.	Complex Equilibria Types of Complex Equilibria in Solution and Equilibrium Constants: Basic principles, Mathematical functions and their interrelationship. Statistical considerations. Factors affecting the stability constants of Metal complexes. Mixed- ligand complexes. Experimental Methods for the Determination of Stability Constants Ion exchange methods, Polarographic methods. Solubility methods and Least square method for computing stability constant	25%
4.	Safety in Chemistry Laboratories Good Laboratory Practices: Elements of Good Laboratory Practices; Standard Operating Procedures; Quality Assurance, Handling of Hazardous Materials, Toxic Materials (Various types of toxins and their effects on humans), Explosives and Inflammable Materials, Types of fire extinguishers, Bioactive materials, Recycling and Waste Disposal, Management in Chemical Laboratories. Legal provisions regarding Chemical Laboratories, Environment Protection Act, 1986.	25%

Teaching-	Class room teaching, seminars, quizzes, and assignments

Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Explain the structure of polyhedral inorganic molecules.
2.	Explain the equation of balance and topological theory.
3.	Explain surfactant chemistry and its applications.
4.	Explain mathematical functions and their interrelationship.
5.	Identify the factors affecting the stability constants of metal complexes.
6.	Adapt lab safety precautions to handle hazardous, toxic, explosives and inflammable materials, to know fire extinguishers, to recycle the waste disposal, and to manage chemical laboratories and legal provisions, etc.

Suggested References:	
Sr. No.	References
1.	Structure and Bonding, Vols. 1& 6, Springer-Verlag.
2.	Micelles: Theoretical and Applied Aspects by Y. Moroi
3.	Inorganic Chemistry by Phillips and Williams, Oxford.
4.	Non-stoichiometric Compounds by L. Mandelcorn, Academic Press.
5.	Inorganic Chemistry by K.F. Purcell and J.C. Kotz, Half-Saunders International Editions.

6.	Boron Hydrides by William N. Lipscomb, Benjamin.Inc.
7.	Chemistry of The Metal Chelate Compounds by A.E. Martell and M. Calvin, Prentice- Hall Inc., Englewood Cliffs, New Jersey.
8.	Chelates in Analytical Chemistry, Vol. 1 by H.A. Flaschka and A. J. Barnard, Marcel Dekker Inc., N.Y.
9.	Co-ordination Chemistry Reviews, Vo1.7(l) by A.B.P. Lever, Elsevier Publishing Company, Amsterdam.
10.	New Pathways in Inorganic Chemistry by E.A.V. Ebsworth, University Press, Cambridge.
11.	Chemistry of Complex Equilibria by M.T. Beck, Van Nostrand Reinhold Company, London.
12.	Determination of Stability Constants by F.J.C. Rossotti and H. Rossotti.
13.	Progress in Inorganic Chemistry, Vol. 1 by F.A.Cotton, IntersciencePub.Inc., New York.
14.	Vogel's Textbook of Quantitative Chemical Analysis, 5th edition by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS Publication, 1996, Chapter 2, 3, 11.
15.	Modern Analytical Chemistry, 1st Edition by D. Harvey, The McGraw-Hill Pub, 2000.
16.	Instrumental Methods of Analysis,4th edition by G.W. Ewing, McGraw Hill Ltd., 1970.
17.	Inorganic Medicinal and Pharmaceutical Chemistry by Lea and Fibiger, John H. Block, E.B. Roche, T.P. Soine and Charles O.Wilson, 1974.
18.	Physical Methods in Inorganic Chemistry by R. S. Drago, John-Wiley Pub.,1975.

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE54	Title of the Course	Inorganic Polymers and Inorganic Materials
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. The students synthesize different types of inorganic polymers and inorganic materials. 2. The students apply various characterization techniques to characterize inorganic polymers and inorganic materials. 3. The students explain and analyse the data obtained from various characterization techniques. 4. The students outline and predict the applications of inorganic polymers and inorganic materials and their applications as energy materials, as optical and electronic materials, adsorbents, catalysts, etc.

Course Content		
Unit	Description	Weightage* (%)
1.	**Inorganic Polymers** Introduction, classification of inorganic polymers, general properties of inorganic polymers, characterization of inorganic polymers, crystalline and amorphous polymers, solubility parameter, glass- transition temperature, modulus-temperature curves, Important inorganic polymers: phosphorus-based polymers, sulphur-based polymers, boron-based polymers, silicon-based polymers, Pre-ceramic Inorganic Polymers.	25%
2.	**Co-ordination Polymers** Introduction to Co-ordination Polymers, classification of coordination polymers, organometallic polymers, metal organic frameworks (MOFs): general method of preparation of MOFs and their applications, Polygermanes and polystannanes: synthesis, properties and applications, Ferrocene-Based Polymers: synthesis, properties and applications.	25%
3.	**Aluminosilicates** Introduction, Classifications, Clays, Talc, Zeolites and related silica based materials, Phosphate-based Zeolites, Synthesis and Characterization of Aluminosilicates, Modification of Zeolites, Applications of aluminosilicates in heterogeneous catalysis.	25%
4.	**Metal Clusters** Introduction, Cluster Compounds of the Main Group Elements: Alkali metals, Boron hydrides, Carboranes, and Metallocarboranes, Cage Compounds of Non-Metal Elements, Transition Metal Clusters, Metal	25%

	carbonyl and halide clusters.	

Teaching-Learning Methodology	Class room teaching, seminars, quizzes, and assignments

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Proceed for the synthesis of different types of inorganic polymers and inorganic materials.
2.	Apply different methods of characterization to characterize inorganic polymers and materials
3.	Assess various applications of inorganic polymers and inorganic materials.
4.	Explain the applications of material chemistry and nanotechnology.

Suggested References:	
Sr. No.	References
1.	Inorganic Polymers, 2nd Edition byJ.E. Mark, H.R. Allcock, R. West, Oxford University Press, Inc., New York.
2.	Inorganic and Organometallic Polymers by R.D. Archer, Wiley-VCH, Inc.
3.	Inorganic Polymers by D.N. Hunter.
4.	Modern Aspects of Inorganic Chemistry by H.Emeleus and A.G.Sharpe, Universal Books Stall, New Delhi Routledge& Kegan paul, London.

5.	Inorganic Polymers by G.R.Chatwal, Himalaya Publishing House.
6.	Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkinson, John-Wiley & Sons, New York.
7.	Catalysis and Zeolites: Fundamentals and Applications by. -L. Guth, H. Kessler, J. Weitkamp, L. Puppe (Eds.), Springer-Verlag Berlin Heidelberg GmbH.
8.	Zeolites and Catalysis: Synthesis, Reactions and Applications, Edited by J. Cejka, A. Corma, and S. Zones, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.
9.	Introduction to Zeolite Science and Practice by H. van Bekkum, E.M. Flanigen, P.A. Jacobs and J.C. Jansen (Eds.), Elsevier Publications, Amsterdam.
10.	Cluster Chemistry by Guillermo Gonzalez-Moraga, Springer- Verlag Berlin Heidelberg GmbH.
11.	Metal clusters in chemistry by P. Braunstein, L.A. Oro, P.R. Raithby, Wiley-VCH Verlag GmbH, Weinheim.

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar, Gujarat
(Reaccredited with 'A' Grade by NAAC (CGPA 3.25)
Syllabus with effect from the Academic Year 2022-23

Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE55	Title of the Course	Selected Topics in Polymers-III
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	• Understanding of important monomers for polymerization, chemical processing of aromatic hydrocarbons. • To study the production of ethenoid plastics and resins, cellulosic, silicone resins etc.. • Detailed study on effect of Polymer Structure on Properties like molecular weight, mechanical properties, chemical resistance, solubility, intermolecular forces in monomers and polymers, and mechanical behavior of polymers, • To understand the theory for testing of plastics.

Course Content		
Unit	Description	Weightage* (%)
1.	**Preparation of Monomers**: Introduction: Monomers capable of chain polymerization, Saturated hydrocarbons from natural gas, Acetylene, Ethylene, Aromatic Hydrocabons, Chemical processes used in industrial organic synthesis, Processing of hydrocabon gases, Chemical processing of ethylene hydrocarbons, Chemical processing of aromatic hydrocabons, Methanol, Phenol, Formaldehyde, Styrene, 1,3-butadiene.	25
2.	**Production of Polymers**: Ethenoid plastics and Resins, Cellulose plastics and resins, Silicone resins and plastics. **Polymer Blends and Alloys**: Blending methods and characterization of Polymers Blends, Characterization of Polymer Blend and Alloys, Microscopy and Solubility, Types of Polymer Blends	25
3.	**Effect of Polymer Structure on Properties**: Molecular Weight, Strength, Plastic Deformation, Physical state of Polymer, Elastic Property, Chemical Resistance, Solubility, Intermolecular forces in Monomers and Polymers, Mechanical behavior of polymers	25
4.	**Polymer Degradation:** Polymer Degradation, Types of Degradation, Thermal Degradation, Polymer Degradation Involving Substituent Groups, Oxidative Degradation of Polymers, Hydrolytic Degradation, Mechanical Degradation, Deterioration of Polymers	25

Teaching-Learning Methodology	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Actual demonstration of mechanical testing of plastics specimens. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material from the Department/University/Digital Library Service.

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the students will be able to	
1.	Understand the basic concept of chemical reactions and polymerization reactions
2.	Know in details about mechanical & thermal properties of plastics material & different types of test method like tensile, flexural, creep, VST, HDT etc.
3.	Aware of the physical and mechanical testing of polymers will provide basic understanding about the product and quality control.

Suggested References:	
Sr. No.	References
1.	Plastics Materials J. A. Brydson (7th Edition), Elsevier
2.	Text Book of Polymer Science by F. W. Bill Meyer
3.	Industrial polymer handbook: Products, Processes, Applications, (V1,2,&3) Edited by E. S. Wilks, Wiley VCH Verlag GmbH, Weinheim.
4.	Rubber Technology by Morris Morton, Van Nostrand Publ.
5.	Handbook of Plastics Testing and Failure Analysis (3 rd Edition) , Vishu Shah, Wiley Publ.
6.	Polymer Blends and Alloys by M. J. Folkes and P. S. Hope, Springer, Dordrecht

On-line resources to be used if available as reference material
On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.

Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE56	Title of the Course	Selected Topics in Polymers- II
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	• Understanding of various paints like oil paints, emulsion paints, cements paints, epoxy paints etc.. • To study the synthesis/ formulation of various polymers used in paints and its properties. • Detailed study on engineering plastics and various adhesives.

Course Content

Unit	Description	Weightage* (%)
1.	Fundamental of paints, Introduction, Principle of paint formulation, Properties of coating, Paint mixer, Characteristic, properties of Pigments Formulation of Paints and Varnishes.	25
2.	Paints resins: .Natural and Synthetic- Rosin & Resin esters, Phenolic, Rubber & latexes, Coumarone-indene, Terpene, Terpene-phenolic, Alkyd, phthalic alkyd, vinyl etc.	25
3.	Synthetic Adhesives: Traditional, Pressure Sensitive and Hot melt Adhesives, Block and Graft copolymers and Ion Exchange polymers.	25
4.	Engineering Plastics: Introduction to high temperature and fire resistant polymers- Polyacetals, Poly butylene-terphthalate, Polyphenylene oxide, Polyphenylenesulfide, Polyether ketone, Polyether ether ether ketone (PEEK), Engineering polyesters, Fluoro polymers and Ionomers	25

Teaching-Learning Methodology	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Demonstration of some engineering plastics articles and its applications. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material from the Department/University/Digital Library Service.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the students will be able to	
1.	Understand the General Introduction of Paint industry, definition of Paints, varnishes and lacquers their constitutions and functions. General classification of surface coating, mechanism of film formation.
2.	Have mechanism of adhesion process, surface preparation for adhesion.
3.	Understand the various types of adhesive types and applications.
	Aware of preparation, properties & application of various Engineering plastics

Suggested References:	
Sr. No.	References
1.	Paint manufacture by J. R. Kapuria
2.	High Temperature Resistance Polymers by -A. H. Frazer, Intersci. Pubs.
3.	Specialty polymers by-R. W. Dyson, 1998, 2nd Edition.
4.	Macromolecules, Vol. II by - H.GElias, Plennum Press, New York
5.	Hand-book of Adhesives and Sealants by - Edward M. PetriteM.C.Graw-Hill Pub

On-line resources to be used if available as reference material
On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.

Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	**PS04ECHE57**	Title of the Course	**Surface Chemistry and Catalysis**
Total Credits of the Course	**04**	Hours per Week	**04**

Course Objectives:	This course is intended as an introduction to surface chemistry and catalysis. An overview of methods for the characterization of surfaces along with mechanism of catalysis are also covered. We will cover theories of molecular adsorption/desorption and surface complexation, kinetics, surface analysis, etc. The applications of surface chemistry in various fields like heterogeneous catalysis, nanoscience and materials chemistry will also be discussed.

Course Content

Unit	Description	Weightage* (%)
I	**Adsorption :**Adsorption definition, Physical and Chemical adsorption – adsorption isotherms : Evaluations, chemisorption on metals and metal oxides, Thermodynamics of adsorption, Langmuir adsorption isotherm, Langmuir constant and Gibbs energy of adsorption, BET adsorption isotherm, adsorption on heterogeneous surface, The potential theory of Polanyi. **Surface Forces :** Van der Waals Forces and macroscopic solids, Microscopic approach, macroscopic calculation – Lifshitz theory, Surface energy and Hamaker constant, Derjaguin approximation, electrostatic double layer, DLVO theory and application.	25
II	**Micelles, Dispersed Systems and Application :** Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC) and methods of determination, factors affecting the CMC of surfactants, counter ion binding of micelles, thermodynamics of micellization – phase separation and mass action models, solubilisation, emulsions, micro-emulsion : Mechanism of formation and their stability, reverse micelles, Micellar catalysis, Photochemistry in micellar systems.	25
III	**Catalysis – I : Fundamentals :** Catalysis, Concept of activity, selectivity, poisoning, promotion and deactivation. Types of catalysis : homogeneous, heterogeneous, Heterogeneous catalysis and catalytic kinetics : concepts of Langmuir – Hinshelwood Preparation and characterization of Catalysts : General methods for preparation of catalysts : precipitation, sol-gel, hydrothermal, impregnation, hydrolysis, vapour deposition. Activation of catalysts : calcinations, reduction. Catalyst Characterization : surface area, pore size distribution, particle size determination etc.	25
IV	**Catalysis – II : Nanomaterials and Catalysis**: General definition, Nano-chemistry basics, distinction between molecules, nanoparticles and bulk materials. Physico-chemical considerations of nanomaterials, Size-dependent	25

	properties. **Catalysis in Green Chemistry and environmental applications :** Purification of exhaust gases from different sources, auto-exhaust catalysts (petrol vehicles, diesel vehicles), VOC removal, Ozone decomposition, photocatalysis in effluent treatment **Photo-catalysis :** Photoprocesses at metals, oxides and semiconductors : concepts and mechanism. Photocatalysis application in organic pollutant degradation present in water and air.	

Teaching-Learning Methodology	Chalk and board method along with ICT tools Model demonstration as per the demand of the topic

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	To understand the function of catalytic systems for synthesis of chemicals in general and polymer in particular.
2.	To get information on various types of industrial catalysis and process involved behind it.
3.	To understand the basic concepts on catalytical chemistry with background of other subjects like solid state chemistry, metal complexes and organic chemistry.
4.	Understanding of mechanism of catalysis empower students for their applications in novel areas like energy storage and generation devices.

Suggested References:	
Sr. No.	**References**
1.	Surface Chemistry of Surfactants and Polymers, Bengt Kronberg, Krister Homberg, Bjorn Lindman, Wiley, 1st Edition
2.	Colloid and Interface Science, Pallab Ghosh, PHI Learning Private Limited.

3.	Physics and Chemistry of Interface, Hans-Jurgen Butt, Karlheunz Graf, MiCael Kappl, Wiley VCH, 2nd Edition.
4.	Surfactants and Interfacial Phenomena, Milton J. Rosen, Wiley-Interscience, 3rd Edition.
5.	Micelles : Theoretical and Applied Aspects, Yoshikiyo Moroi, Springer Int. Ed.
6.	Physical Chemistry of Surface, A. W. Admson, Wiley Inter-science Publication, 5th Edition.
7.	Surfactant Science and Technology, Drew Myers, VCH Publishers, 2nd Edition
8.	Principles of Colloids and Surface Chemistry, P. C. Hiemenz, Marcel and Dekker, New York

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	**PS04ECHE58**	Title of the Course	**Introduction to Different Materials**
Total Credits of the Course	**04**	Hours per Week	**04**

Course Objectives:	The course provides information on different types of materials along with their fundamental differences and applications. It delivers information on preparation, characterization and their properties which are useful in novel devices.

Course Content

Unit	Description	Weightage* (%)
I	**Nanomaterials :** Fundamental of nanomaterial, various methods of synthesis, Characterization of nanomaterials-AFM, STM, TEM. Types of nanomaterials, e.g. nanotubes, nanorods, solid spheres, core-shell nanoparticles, Mesoporous materials, Some important properties of nanomaterials: optical properties of metal and semiconductor nanoparticles, Properties : magnetic, optical, electronic, photonic, catalytical properties, Nanocomposites; Carbon nanotubes; Graphene; Molecular nanomaterials. Various promising applications of nanomaterials, Environmental effects of nanotechnology.	25
II	**Organic Semiconductors :** *Structure :* Introduction, History, Transitions between molecular states, *Spectroscopic methods:* Photoluminescence spectra, Lifetimes and quantum yields, Excited state absorption spectra, Fluorescence excitation spectroscopy. *Charges and Excited States in Organic Semiconductors :*Introduction, Excited molecules from the gas phase to the amorphous film, Excited molecules in crystalline phases – Frenkel exciton, Excited states in π-conjugated polymers, Comparison between inorganic and organic semiconductors. Advanced materials, devices and applications or products.	25
III	**Liquid Crystalline Materials :** Introduction, Thermotropic & Lyotropic liquid crystals, structure and property relationship, Smectic, nematic & cholesteric liquid crystals, globular and discotic liquid crystals, liquid crystalline polymers. Applications of liquid crystals in chemistry, electronics, medicine and non-destructive testing. Basic chemistry in Ionic liquid, Liquid crystal and Organic ionic plastic crystal, Applications	25
IV	**Thin films :** Preparation techniques - evaporation/sputtering, chemical processes, MOCVD, sol-gel, Langmuir-Blodgett technique; Properties and applications of thin and ultrathin films. **Porous Materials :** Introduction, various types of porous materials, preparation methods, MoF, COF, mesoporous materials and their applications.	25

Teaching-Learning Methodology	Chalk and board method along with ICT tools Model demonstration as per the demand of the topic

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Student will understand the detailed the various classes and distinct features of materials along with basic concepts related to structure and properties of materials.
2.	Design and preparation of new materials based on a fundamental understanding of their attributes.
3.	Grow the knowledge of advanced materials for contemporary and futuristic advanced applications

Suggested References:	
Sr. No.	**References**
1.	Nanoscale Materials in Chemistry, K. J. Klabunde, Wiley Interscience, Newyork, 1st Edition, 2001.
2.	Nanotechnology and Nanoelectronics, W. R. Fahrner, Springer publication house, 1st Indian Edition. 2006.
3.	Nanomaterials: Synthesis, Properties and Application, A. S. Edelstein, R. C. Cammarata, IOP publication. 1996.
5.	Nanochemistry – A Chemical Approach to nanomaterials, G. A. Ozin, A. C. Arsenault, L. Cademartiri, RSC Publication House, 2nd Edition, 2006.
6.	Electronic Processes in Organic Semiconductors: An Introduction, Anna Köhler and Heinz Bässler, Wiley-VCH Verlag GmbH & Co. KGaA. 2015.

7.	Organic Electronics: Materials, Manufacturing and Applications, Hagen Klauk, Wiley-VCH Verlag GmbH & Co. KGaA, 2006.
8.	Materials Science and Engineering: An Introduction, William D. Callister Jr., David G. Rethwisch, Wiley10th Edition
9.	Liquid Crystals, S. Chandrasekhar, 1992, Cambridge University Press.
10.	Sol-Gel Science : The physics and Chemistry of Sol-Gel Processing, C. J. Brinker, G. W. Scherer, Academic Press, 1990.
11.	Handbook on Thin Film Deposition Processes and Techniques, K. Seshan, Noyes Publications, New York, USA. 2nd Ed. 2002.
12.	Journals like Chemistry of Materials, Journal of Materials Chemistry, Advanced Materials etc..

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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Master of Science, Chemistry
M. Sc. Chemistry, Semester – IV

Course Code	PS04ECHE59	Title of the Course	Topics in Organic Chemistry
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To understand transition metal catalyst-based C-C/C-N coupling reactions and their mechanism. 2. To understand the role of S, Si, and P elements in designing different pathways to synthesize organic compounds with the specific stereochemical outcome. 3. To practice solving problems in organic chemistry based on stereochemistry, spectroscopy, photochemistry, pericyclic chemistry, name reactions, and reagents.

Course Content		
Unit	Description	Weightage* (%)
1.	**Organometallic Chemistry** Transition metals in Organic reactions; 18-electron rule; Bonding and reactions in transition metal complexes: oxidative addition, reductive elimination, insertion reaction; Role of palladium in homogenous catalysis; Heck reaction; Cross-coupling of organometallics and halides: Stille coupling, Suzuki coupling, Sonogashira reaction, Hiyama coupling, Kumada coupling, Allylic electrophile activation by Pd(0); Pd catalyzed amination of the aromatic ring; Nucleophilic attack to Pd(II)-alkene organometallic complexes, Metathesis reactions.	25%
2.	**Name Reactions and Reagents** Sharpless asymmetric hydroxylation, Staudinger reaction, Corey-Fuchs reaction, Ritter reaction, Nef reaction, Mcmurry reaction, Luche reduction, Wacker oxidation, TEMPO, Noyori asymmetric hydrogenation, Mitsunobu reaction, Von Richter reaction, Apple reaction, Goldberg reaction.	25%

3.	**Sulfur, Silicon and Phosphorous in Organic Chemistry** Sulfur and organosulfur compounds; Sulfur stabilized anions; Sulfonium salts; Sulfonium ylids, Reactivity comparison of silicon and carbon; Allyl silanes as nucleophiles; Role of S. Si and P in alkene synthesis; Stereoselective synthesis of alkene; Julia olefination; Peterson reaction, Witting reaction.	25%
4.	**Organic Chemistry – Problem-Solving in Context to Competitive Examinations** Solving problems based on the reaction mechanism, reagents, spectroscopy, and stereochemistry with special emphasis on current research.	25%
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Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprises classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/workshops, presentation by students, assigning work based upon subject requirements, etc.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand transition metal catalyst-based C-C, C-N coupling reactions.
2.	Metathesis reaction.

3.	Applications of different reagents and name reactions in organic synthesis.
4.	Role of S, Si, and P in organic synthesis.
5.	Solutions of organic problems based on stereochemistry, spectroscopy, photochemistry, pericyclic chemistry, name reactions, and reagents.

Suggested References:	
Sr. No.	References
1.	Organic Chemistry by J. Clayden, N. Greeves and S. Warren, 2nd edition, Oxford University Press, UK.
2.	Modern Methods of Organic Synthesis; W. Carruthers and I. Coldham, 4th edition, Cambridge University Press, UK.
3.	Name Reaction for Functional Group Transformation, E. J. Corey and Jie Jack Lie, John Wiley and Sons, New Jersey.
4.	Name Reactions, Jie Jack Lie, 4th edition, Springer, New York.
5.	Selected Organic Synthesis, Ian Fleming, John Wiley & Sons, New Jersey.

Online resources to be used if available as reference material
Online Resources

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