VIII Semester

GREEN CHEMISTRY			
Course Code	**21BSC81**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

CLO 1	Discuss about the role of principles of green chemistry.
CLO 2	Explain the importance of green synthesis.
CLO 3	Interpret the knowledge of prevention of hazardous chemicals in reactions.
CLO 4	Evaluate the efficiency of green catalysts.
CLO 5	Interpret the use of biocatalysts.

Pedagogy (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to convince abstract concepts.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1 Introduction to Green Chemistry

Basic introduction and explaining goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry, Principles of Green Chemistry with their explanations and examples and special emphasis on Designing a Green Synthesis using these principles.

Pedagogy	**Chalk and talk/power point presentation**: Basic introduction and explaining goals of Green Chemistry. **Videos/Learning material**: Principles of Green Chemistry with their explanations and examples. **Self-study:** Phase transfer catalysts.

Module-2 Green Solvents in Organic Synthesis

Green Solvents, Supercritical fluids (SCFs), Super Critical Water (SCW), Supercritical Carbon Dioxide (SC-CO2); Pyrolysis of t-butylbenzene, Pinacol-pinacolone rearrangement, Beckmann rearrangement, Diels-Alder reactions, Reduction of aromatic nitro compounds. Reaction in Supercritical Carbon Dioxide; Kolbe – Schmitt reaction, Friedel–Crafts reaction.

Pedagogy	**Chalk and talk/power point presentation**: Green Solvents, Supercritical fluids (SCFs), Super Critical Water (SCW) **Videos/Learning material**: Pyrolysis of t-butylbenzene, Pinacol-pinacolone

	rearrangement, Beckmann rearrangement, Diels-Alder reactions. **Self-study**: Epoxidation reaction.

Module-3 Solvent free reactions (Solid State Synthesis)

Solid state reaction at room temperature: Aldol condensation, Reformatsky reaction, Synthesis of quinoxaline derivatives.
Microwave assisted solid state reactions using solid support: Synthesis of heterocyclic compounds; Synthesis of benzimidazole, Synthesis of oxazoles/thiazoles, Synthesis of oxadiazoles, Synthesis of N-arylated pyrrole derivatives, Synthesis of quinolones, Synthesis of furans.

Pedagogy	**Chalk and talk/power point presentation**: Solid state reaction at room temperature: Aldol condensation, Reformatsky reaction, Synthesis of quinoxaline derivatives. **Videos/Learning material**: Microwave assisted solid state reactions using solid support: Synthesis of heterocyclic compounds; Synthesis of benzimidazole, Synthesis of oxazoles, Synthesis of oxadiazoles. **Self-study**: Synthesis of thiazoles

Module-4 Catalysis and Green Chemistry

Catalyst and Catalysis; Homogeneous catalysis, Heterogeneous catalysis, Catalysis in Green chemistry, Biocatalysis, Reactions using biocatalyst, Biocatalytic conversion of penicillin to 6-aminopenicillanic acid.
Photocatalysis, Titanium dioxide (TiO2) as a green photocatalyst for destroying organic pollutants, Some important photocatalytic applications of TiO2 - Photocatalytic disinfection or sterilization.
Polymer supported catalysis - Reaction using polymer supported catalyst, Substitution reaction.

Pedagogy	**Chalk and talk/power point presentation**: Catalyst and Catalysis; Homogeneous catalysis, Heterogeneous catalysis, Catalysis in Green chemistry, Some important photocatalytic applications of TiO2 - Photocatalytic disinfection or sterilization **Videos/Learning material**: Biocatalysis, Reactions using biocatalyst, Biocatalytic conversion of penicillin to 6-aminopenicillanic acid. Photocatalysis, Titanium dioxide (TiO2) as a green photocatalyst for destroying organic pollutants **Self-study:.** Polymer supported catalysis - Esterification reaction

Module-5 Future trends in Green Chemistry

Introduction; Oxidation-reduction reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solvent less reactions; Non-covalent derivatization; Biomass conversion, co crystal controlled solid state synthesis (C2S3).

Pedagogy	**Chalk and talk/power point presentation**: Introduction; Oxidation-reduction reagents and catalysts **Videos/Learning material**: Biomimetic, multifunctional reagents **Self-study**: Biomass conversion, co crystal controlled solid state synthesis (C2S3)

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

CO 1	Describe about the principles of green chemistry with example.
CO 2	Explain the importance of green solvents.
CO 3	Brief significance of biocatalysis and Photocatalysis.
CO 4	Enumerate use of combinatorial green chemistry

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

1. First test at the end of 5thweek of the semester
2. Second test at the end of the 10thweek of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

4.First assignment at the end of 4th week of the semester

5. Second assignment at the end of 9th week of the semester Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

6. At the end of the 13thweek of the semester The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

1. The question paper will have ten questions. **Each question is set for 20 marks**.

2. There will be **2 questions from each module**. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Ahluwalia, V.K., Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K, Green Chemistry- Theory and Practical, Oxford University Press (1998). 3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
4. Cann, M.C.and Connely, M.E. Real-World cases in Green Chemistry, ACS (2000).
5. Ryan, M.A. and Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, (2002).
6. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, Second Edition, 2010

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=ESGFdKITnDg

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- https://www.vlab.co.in/broad-area-chemical-sciences
- https://demonstrations.wolfram.com/topics.php
- https://interestingengineering.com/science

VIII SEMESTER	NUCLEAR & RADIATION CHEMISTRY		
Course Code	21BSC82	CIE Marks	50
Teaching Hours/Week(L:T:P:S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

CLO 1	To provide a comprehensive overview of Nuclear Chemistryand Radiation Chemistry.
CLO 2	To provide the students with necessary background for understanding of Nuclear Reactors
CLO 3	To develop an understanding of the basis of Measurement of Nuclear Radiation
CLO 4	To give an insight into complete systems where nanotechnology can be used to improve our everyday life

Pedagogy (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to convince abstract concepts.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1 Nuclear Chemistry

Fundamental Particles of nucleus (nucleons), Concept of nuclides and its representation, Isotopes, Isobars and isotones (with specific examples), Force operating between nucleons (n-n, p-p, & n-p), Qualitative idea of stability of nucleus (n/p ratio).

Pedagogy	**Chalk and talk/power point presentation:** Fundamental Particles of nucleus (nucleons), Concept of nuclides and its representation, **Videos/Learning material:** Isotopes, Isobars and isotones (with specific examples), Force operating between nucleons (n-n, p-p, & n-p) **Self-study:** Qualitative idea of stability of nucleus (n/p ratio).

Module-2 Radiochemistry

Natural and artificial radioactivity, interaction of radiation with matter, Radioactive disintegration series, Radioactive displacement law, Radioactivity decay rates and numericals, Half-life and average life, Nuclear binding energy, mass defect and calculation of defect and binding energy, numericals on half life period, Nuclear reaction, Spallation, Nuclear fission and fusion.

Pedagogy	**Chalk and talk/power point presentation:** Natural and artificial radioactivity, interaction of radiation with matter, Radioactive disintegration series, Radioactive displacement law, Radioactivity decay rates and numerical. **Videos/Learning material:** Half-life and average life, Nuclear binding energy, mass defect and calculation of defect and binding energy, numericals on half life period, Nuclear reaction, Spallation.

	Self-study: Nuclear fission and fusion.
Module-3 Nuclear Reactor	
Fission energy, The Natural uranium reactor, the four factor formula- The reproduction factor K, the classification of reactor. Reactor power, Critical size of thermal reactor, excess reactivity & control, the Breeder reactor, The Indians nuclear energy programme, Reprocessing of spent fuel: Recovery of Uranium & Plutonium, Nuclear waste management. Isotopes for nuclear reactors: Isotope separation, separation of selected isotopes, Plutonium.	
Pedagogy	**Chalk and talk/power point presentation:** Fission energy, The Natural uranium reactor, the four factor formula- The reproduction factor K, the classification of reactor. Reactor power, Critical size of thermal reactor, excess reactivity & control, the Breeder reactor **Videos/Learning material:** The Indians nuclear energy programme, Reprocessing of spent fuel: Recovery of Uranium & Plutonium, Nuclear waste management. **Self-study:** Isotopes for nuclear reactors: Isotope separation, separation of selected isotopes, Plutonium.
Module-4 Measurement of Nuclear Radiation	
Activity and Counting Rate, basic principle and instrumentation of Gas-Filled Detectors , Ionization Chambers, Proportional Counters, Geiger–Müller Counters, Scintillation Detectors, Semiconductor Detectors, Choice of Detectors, Spectrometry.	
Pedagogy	**Chalk and talk/power point presentation:** Activity and Counting Rate, basic principle and instrumentation of Gas-Filled Detectors , Ionization Chambers, Proportional Counters, Semiconductor, Spectrometry. **Videos/Learning material:** Geiger–Müller Counters, Scintillation Detectors **Self-study:** Detectors, Choice of Detectors
Module-5 Applications of radioactivity	
Typical reaction involved in preparation of radioisotopes: 3H, 14C, 22Na, 32P, 35S, and 137IGeneral principles of using radioisotopes. - Physical constants – Diffusion coefficients, surface area, solubility. - Analytical applications- neutron activation analysis, dilution analysis, radiometric titration. - Industrial applications – radiation guaging, friction and wear out, gamma radiography.	
Pedagogy	**Chalk and talk/power point presentation:** Typical reaction involved in preparation of radioisotopes: 3H, 14C, 22Na, 32P, 35S, and 137IGeneral principles of using radioisotopes. - Physical constants – Diffusion coefficients, surface area, solubility. - **Videos/Learning material:** Analytical applications- neutron activation analysis, dilution analysis, radiometric titration. radiation guaging, friction and wear out, gamma radiography. **Self-study:** Industrial applications

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

CO1	Demonstrate the concepts of nuclear and radiation chemistry.
CO2	Explain working of nuclear reactor
CO3	Identify the suitable instruments to be used in Measurement and detection of nuclear radiation
CO4	Illustrate the applications of radio isotopes

Assessment Details (both CIE and SEE)
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Two assignments each of 10 Marks
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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)
1. The question paper will have ten questions. **Each question is set for 20 marks**.
2. There will be **2 questions from each module**. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module.

SuggestedLearningResources:
Books:

1. H.J. Arnikar, Elements of Nuclear chemistry –fourth edition New Age International Pvt. Ltd 1995.
2. Attila Ve´rtes, Sa´ndor Nagy, Zolta´nKlencsa´r, Rezso˝ G. Lovas,Frank Ro¨sch (Eds.)Handbook of Nuclear Chemistry , Second Edition, Springer, New York
3. Nuclear and Radiochemistry Fundamentals and Applications Jens-Volker Kratz Volume 1,4th Edition, 2022 WILEY-VCH GmbH, Boschstr. 12, 69469 Weinheim, Germany
4. Frank Rösch, Nuclear- and Radiochemistry,Volume 1,2014 Walter de Gruyter GmbH, Berlin/
5. H.J. M. Brown, Chemical applications of radioisotopes –,1969, Buffer & Jammer Ltd.

WeblinksandVideoLectures(e-Resources):

1. Radiation Chemistry: https://youtu.be/dTLzFcN34ho
2. Nuclear Chemistry 1: https://youtu.be/c35aY-ao65E?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
3. Nuclear Chemistry 2: https://youtu.be/A-ozhJcbR5w?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
4. Nuclear Chemistry 3: https://youtu.be/OdCML9lmfMc?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
5. Nuclear Chemistry 4:https://youtu.be/PNlZJlM1gVM?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
6. Nuclear Chemistry 5: https://youtu.be/A0qU-vSWOJY?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
7. Nuclear Chemistry 6: https://youtu.be/Z2jeAwlfiQc?list=PL6GAQur3T7PejKzwwuA76FCbXJLC9YN5U
8. Nuclear Chemistry 7: https://youtu.be/CwkkdHKy64k
9. GM Counter: https://youtu.be/481f181bSg8
10. Gas filled detectors: https://youtu.be/_suH1OSXUCA?list=PLAPKGqvQGg6o7j74QmE_Ai9K4XnEwUL54
11. Scintillation Counter: https://youtu.be/6rKvSLYfwGQ?list=PLAPKGqvQGg6o7j74QmE_Ai9K4XnEwUL54
12. Semiconductor detectors: https://youtu.be/sZT9VJ9HkCc?list=PLAPKGqvQGg6o7j74QmE_Ai9K4XnEwUL54
13. Nuclear Reactors: https://youtu.be/hnWRaGr94sQ
14. Nuclear Reactors: https://youtu.be/utMRKrpPPwo

SkillDevelopmentActivitiesSuggested

- Assignments
- Quizes
- Seminars

VIII Semester

ELECTROCHEMISTRY LAB			
Course Code	**21BSCL83**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:2	/SEE Marks	50
Credits	02	Exam Hours	3 Hours

CLO 1	Understanding the applications of redox reactionsin the determination of strength of salts
CLO 2	Explain the transport number of ions in solution.

Sl.NO	Experiments
1	Determination of dissociation constant of a monobasic acid potentiometrically.
2	Verification of Onsagar's equation; Determine the equivalent conductance of a strong electrolyte at several dilutions.
3	To determine the relative strength of two acids by conductance measurements.
4	To determine the solubility of a sparingly soluble salts in water by conductance measurements.
5	Conductometric determination of degree of hydrolysis and hydrolysis constant of (i) CH_3COONa (ii) NH_4Cl
6	Conductometric titration of very weak acid like phenol.
7	To determine transport number of Cu^{2+} and SO_4^{2-} by Hittorf's method.
8	Potentiometric titration of antipyretic drug (Paracetamol) in different solvent media like Acetic acid and Dimethylformamide.
9	Assay of active pharmaceutical ingredient; analysis of purity of sulphanilamide in sulpha drugs potentiometrically using standard potassium bromide.
10	Assay of active agents in surfactants; analysis of Lidocaine hydrochloride in ointment potentiometrically by using standard sodium hydroxide solution.

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:
CO1 Determine the dissociation constant, drug concentration potentiometrically.
CO2 Determine therelative strength of two acids, degree of hydrolysis and hydrolysis constant of salts conductometrically.
CO3 Determine the pharmaceutical ingredients potentiometrically.

Assessment Details (both CIE and SEE)
Continuous Internal Evaluation (CIE): The CIE marks awarded in case of Practical shall be based on the weekly evaluation of laboratory journals/ reports after the conduction of every experiment and one practical test.

Semester End Evaluation (SEE): The practical examinations to be conducted as per the time table of University in a batch wise with strength of students not more than 10-15 per batch.

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Books:

1. Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Pearson Education India, 2003.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education, 2009.
3. Yadav, J. B; Advanced Practical Physical Chemistry, Goel Publishing House, Meerut, 2002. 21st Ed.,
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
5. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Suggested Learning Resources:

1. https://www.youtube.com/watch?v=BBKwtjCT8Ug
2. https://www.youtube.com/results?search_query=conductometric+titration+of+strong+acid+vs+strong+base

VIII Semester

POLYMER CHEMISTRY AND COMPOSITE MATERIALS			
Course Code	21BSC841	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

CLO 1: Understand the basics and significance of polymers, polymerization methods

CLO 2: Explain the mechanism of polymerization, polymer processing and synthetic polymers

CLO 3: Describe the polymer properties and elastomers

CLO 4: Explain conducting polymers, biodegradable polymers and plastics management.

CLO 5: Explain the manufacturing and uses of composites

Pedagogy (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to convince abstract concepts.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1 Polymers and methods of polymerization

Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers - Classification based on the origin (natural, semi synthetic and synthetic), thermal behaviour (thermoplastics and thermosetting plastics), synthesis (addition andcondensation), structure (linear, branched chain and cross linked) and intermolecular forces (elastomers, fibres, plastics and elastomers) – Tacticity. Methods of polymerization- Bulk polymerization, solution polymerization, Suspension polymerization and Emulsion polymerization.

Pedagogy	
	Chalk and talk/power point presentation: Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers -Classification based on the origin (natural, semi synthetic and synthetic), thermal behaviour (thermoplastics and thermosetting plastics), synthesis (addition andcondensation), structure (linear, branched chain and cross linked) and intermolecular forces (elastomers, fibres, plastics and elastomers) – Tacticity.
	Videos/Learning material: Methods of polymerization- Bulk polymerization, solution polymerization, Suspension polymerization and Emulsion polymerization.
	Self-study: Importance of polymers, Polymerization, degree of polymerization

Module-2 Mechanism of polymerization and Polymer processing

Chain and step growth polymerizations – Free radical polymerization with mechanism taking polyethylene as example, Polymer Processing: Calendaring, Blow moulding, Extrusion moulding compression and injection moulding. Preparation, properties and uses of polyethylene (LDPE and HDPE), polystyrene, PVC, Teflon, and PMMA. Adhesives-Introduction, Types (natural and synthetic), synthesis, properties and uses of epoxy resin and phenol-formaldehyde resin.

Pedagogy	**Chalk and talk/power point presentation:** Chain and step growth polymerizations – Free radical polymerization with mechanism taking polyethylene as example, Polymer Processing: Calendaring, Blow moulding, Extrusion moulding compression and injection moulding. **Videos/Learning material:** Preparation, properties and uses of polyethylene (LDPE and HDPE), polystyrene, PVC, Teflon, and PMMA. Adhesives-Introduction, Types (natural and synthetic), synthesis, properties and uses of epoxy resin and phenol-formaldehyde resin. **Self-study:** Processing aids – plasticizers – extenders – fillers – antioxidants - accelerators, colorants.

Module-3 Properties and Reactions of Polymers

Glass Transition temperature (Tg)-Meaning, factors influencing Tg, determination of Tg and its significance. Viscoelasticity of polymers (basic concept only) - Vulcanisation. Polymer Degradation: Basic idea of thermal, photochemical, oxidative and bio- degradations of polymers. Molecular weight of polymers-Number average and weight average molecular weight, index of polydispersity and its significance, numerical problems.

Elastomers-Meaning, Types (Natural rubber and synthetic rubber), advantages of synthetic rubber and disadvantages of natural rubber, Synthesis, properties and uses of Buna-S, Neoprene rubber, Butyl rubber, silicone rubber. 3 Hours

Pedagogy	**Chalk and talk/power point presentation:** Glass Transition temperature (Tg)-Meaning, factors influencing Tg, determination of Tg and its significance. Viscoelasticity of polymers (basic concept only) - Vulcanisation. Polymer Degradation: Basic idea of thermal, photochemical, oxidative and bio- degradations of polymers. Molecular weight of polymers-Number average and weight average molecular weight, index of polydispersity and its significance, numerical problems. **Videos/Learning material:** Elastomers-Meaning, Types (Natural rubber and synthetic rubber), advantages of synthetic rubber and disadvantages of natural rubber, Synthesis, properties and uses of Buna-S, Neoprene rubber, Butyl rubber, silicone rubber. **Self-study:** Structure-property relationship.

Module-4 Conducting polymers, biodegradable polymers and recycling of plastics

Conducting polymers-Introduction, requirement, examples, Synthesis of polyacetylene, properties, mechanism of conduction in polyacetylene (oxidative and reductive doping), commercial uses of polyacetylene. Polyaniline-synthesis, mechanism of conduction and uses.

Biodegradable polymers-Introduction, requirements, Synthesis, properties and applications of Polylacticacid.

Pollution due to plastics - Thermoplastic waste management: 4 R's approach (reduce, reuse, recycle (mechanical and chemical), recover), recycling classification- - primary - secondary - tertiary - quaternary recycling with examples.

Pedagogy	**Chalk and talk/power point presentation:** Conducting polymers-Introduction,

	requirement, examples, Synthesis of polyacetylene, properties, mechanism of conduction in polyacetylene (oxidative and reductive doping), commercial uses of polyacetylene. Polyaniline-synthesis, mechanism of conduction and uses. Biodegradable polymers-Introduction, requirements, Synthesis, properties and applications of Polylacticacid. **Videos/Learning material:** Pollution due to plastics - Thermoplastic waste management: 4 R's approach (reduce, reuse, recycle (mechanical and chemical), recover), recycling classification- - primary - secondary - tertiary - quaternary recycling with examples. **Self-study:** Biopolymers, Biodegradable polymers used in surgical sutures and capsule covers.

Module-5 Composite materials

Introduction, definition, classification-particulate, fibre (short & long), laminates, nanocomposites & biocomposites-Types of matrices. Role of fibre and matrix in improving composite properties.Manufacturing methods: Hand and spray lay - up, injection moulding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Synthesis, properties and uses of carbon fibre and Kevlar.

Industrial Composites

Polymer nanocomposites, Metal matrix composites, ceramic metal matrix composites, ceramic matrix composites & carbon composites (basic idea only)

Pedagogy	**Chalk and talk/power point presentation:** Introduction, definition, classification-particulate, fibre (short & long), laminates, nanocomposites & biocomposites-Types of matrices. Role of fibre and matrix in improving composite properties.Manufacturing methods: Hand and spray lay - up, injection moulding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Synthesis, properties and uses of carbon fibre and Kevlar. **Videos/Learning material: Industrial Composites** Polymer nanocomposites, Metal matrix composites, ceramic metal matrix composites, ceramic matrix composites & carbon composites (basic idea only) **Self-study:** Polymer nano composites, Manufacturing methods: Hand and spray lay - up, injection moulding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

1. First test at the end of 5thweek of the semester
2. Second test at the end of the 10thweek of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

4.First assignment at the end of 4th week of the semester

5. Second assignment at the end of 9th week of the semester Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

6. At the end of the 13thweek of the semester The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

VIII Semester

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

1. The question paper will have ten questions. **Each question is set for 20 marks**.
2. There will be **2 questions from each module**. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module.

Suggested learning Resources:

Books

1. Billmeyer F.W., Text book of polymer science, Jr. John Wiley and Sons, 1994.
2. Gowariker V.R., Viswanathan N.V. & Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., NewDelhi.
3. Sharma, B.K., Polymer Chemistry, Goel Publishing House, Meerut, 1989.
4. Arora M.G., Singh M. and Yadav M.S., Polymer Chemistry, 2nd Revised edition, AnmolPublications Private Ltd., New Delhi, 1989.
5. Maurice Morton, Rubber Technology- van Nostrand, Reinhold, New York.
6. J.A. Bryolson, Plastic materials.
7. R.P. Singh, C. K. Das & S. K. Mustafi, Polymer Blends &Alloys –an Overview, Asian Books Pvt. Ltd. 2002 (Ist Edn).
8. Joel R Fried, Polymer Science & Technology, (2nd Edn), Prentice-Hall of India, New Delhi.

Web links and Video Lectures (e-Resources)

1. https://onlinecourses.nptel.ac.in/noc20_me29
2. https://www.sciencedoze.com/2022/03/conducting-polymers-definition-examples.html
3. https://www.youtube.com/watch?v=9J9OViSUol4

Activity Based Learning (suggested Activities in Class)/Practical based learning

1. https://www.youtube.com/watch?v=t-pVi3IMdOk&t=4s
2. https://www.youtube.com/watch?v=xxCUsSFVv9U
3. https://www.youtube.com/watch?v=cZxYte9xvTU

VIII SEMESTER	ADVANCED MATERIAL CHEMISTRY		
Course Code	21BSC842	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

CLO 1	Understand the Composites, Liquid Crystals and nanomaterials
CLO 2	Develop an understanding of the relationship between structure and property of materials
CLO 3	Learn about advanced material synthesis and material characterization.
CLO 4	Explain the significance of materials for technology, basic needs and health.
CLO 5	Explain the alternative energy sources for sustainable development.

Pedagogy (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to convince abstract concepts.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1 Composite Materials

Types of metal matrices and reinforcements and their properties, bonding mechanisms, structure-property relationships, classification based on Matrix Material: Organic Matrix Composites (Polymer matrix composites (PMC) / Carbon Matrix Composites or Carbon-Carbon Composites, Advantages of Composites materials. Reinforcements and Matrices for various types of composites. Fibres / Reinforcement Materials, Role and Selection of reinforcement materials, Types of fibres, Mechanical properties of fibres.

Pedagogy	**Chalk and talk method and power point presentation**- metal matrices and reinforcements, structure-property relationships, preforms **Videos**: Bonding mechanisms, structure-property relationships **Self-Study:** Concept of Composite materials, Classification of Composites, Various types of composites, Classification

Module-2 Liquid Crystals

Liquid Crystals:Liquid crystals (LC's) - Introduction, classification-structure of nematic, smectic and cholesteric phases and properties. Chemical constitution and liquid crystalline behaviour, Molecular structure and liquid crystals and application in Liquid Crystal Displays (LCD's).

Pedagogy	**Chalk and talk method and power point presentation**-Classification, properties,

	chemical constitution and liquid crystalline behaviour. **Videos:** Molecular structure, LCD **Self-Study:**Processing aids – plasticizers – extenders – fillers – antioxidants - accelerators, colorants.
Module-3 Metals & its alloys	
Introduction, classification of metals as ferrous & non ferrous, ores of iron and its extraction using Blast furnace, properties and applications of iron & its alloys, aluminium & its alloys, copper & its alloys, extraction of magnesium from sea water & magnesium alloys, Nickel and its alloys.	
Pedagogy	**Chalk and talk method and power point presentation**-size dependent properties, carbon materials **Videos:** Synthesis and applications. **Self-Study:** Extraction of metals
Module-4 Smart materials	
Piezoelectric materials, Electro strictive materials, Magnetostrictive materials, Magnetoelectric materials, Magnetorheological fluids, Electrorheological fluids, Shape memory materials.	
Pedagogy	**Chalk and talk method and power point presentation-** Electro strictive materials, Magnetostrictive materials, Magnetoelectric materials, Magnetorheological fluids, Electrorheological fluids **Videos:** Shape memory materials. **Self-Study:** Piezoelectric materials
Module-5 Materials for engineering applications	
Polymer resins for Water treatment, Advanced Membrane materials for water and air purification (Micro, Ultra, Nano and Reverse osmosis membrane materials), Biomaterials- Cellulose, chitosan, collagen for biomedical applications. Epoxy resins: Synthesis,properties and its applications.	
Pedagogy	**Chalk and talk method and power point presentation-** Polymer resins for Water treatment, Advanced Membrane materials for water and air purification (Micro, Ultra, Nano and Reverse osmosis membrane materials), Biomaterials- Cellulose, chitosan, collagen for biomedical applications. **Videos:** Epoxy resins: Synthesis,properties and its applications. **Self-Study:**Working of batteries, commercial cells, working of various fuel cells.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

1. First test at the end of 5thweek of the semester
2. Second test at the end of the 10thweek of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

4.First assignment at the end of 4th week of the semester

5. Second assignment at the end of 9th week of the semester Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

6. At the end of the 13thweek of the semester The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have

a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

1. The question paper will have ten questions. **Each question is set for 20 marks**.
2. There will be **2 questions from each module**. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module.

Suggested learning Resources:

Books

1. Clyne T. W. and Withers P. J. – 'An Introduction to Metal Matrix Composites' – Cambridge University Press – 2003.
2. Applied Chemistry, Sunita Rattan, Kataria
3. Engineering Chemistry, Baskar, Wiley.
4. Nanotechnology A Chemical Approach to Nanomaterials, G.A. Ozin & A.C. Arsenault, RSC Publishing, 2005.
5. Linden's Handbook of Batteries, Kirby W. Beard, Fifth Edition, McGraw Hill, 2019.
6. Smart material systems and MEMS;Design and Development methodologies, V.K.Varadhan, K.J Vinoy, S.Gopalakrishnan, John Wiley and sons publications England, 2006
7. Polymer science By Bill meyer.

Web links and Video Lectures (e-Resources)

1. https://www.youtube.com/watch?v=Vu6ik-bcKf4
2. https://www.youtube.com/watch?v=YJITp7dwrPk
3. https://archive.nptel.ac.in/courses/113/105/113105081/

Activity Based Learning (suggested Activities in Class)/Practical based learning

1. https://www.youtube.com/watch?v=B_9uR34t3Hw
2. https://www.youtube.com/watch?v=-rKAcjXafYc