VII Semester

ANALYTICAL CHEMISTRY			
Course Code	21BSC71	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

CLO 1	Understand about SI units.
CLO 2	Learn use of analytical equipment.
CLO 3	Understanding the types of Errors in chemical analysis.
CLO 4	Handle statistical test of data
CLO 5	Know about gravimetric methods as well safe handling of chemicals and waste

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 Sampling and Storage

Sampling: Definition, types of sample, sampling plan, sampling of raw materials, intermediates and finished products, storage of samples.
Selection of methods: Sources of methods, factors to consider when selecting a method, method validation and quality by design.

Pedagogy	**Chalk and talk/power point presentation:** Sampling: Definition, types of sample, sampling plan, sampling of raw materials, intermediates and finished products, storage of samples. **Learning material:** Selection of methods: Sources of methods, factors to consider when selecting a method, method validation and quality by design. **Self-study:** Preparation of solutions: Standard solutions, primary standard, secondary standards.

Module-2 Quality parameters

Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results.
Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction.

Pedagogy	**Chalk and talk/power point presentation**: Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. **Videos/Learning material**: Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction.

	Self-study: Non-aqueous titrations and its applications.

Module-3 Spectroscopy

Infrared spectroscopy: Principles, instrumentation and applications of Infrared spectroscopy.
Raman spectroscopy: Principles, instrumentation and applications of Raman spectroscopy.
UV Visible spectroscopy: Principles, instrumentation and applications of UV Visible spectroscopy.

Pedagogy	**Chalk and talk/power point presentation**: General information about spectroscopy, Infrared spectroscopy: Principles, instrumentation and applications of Infrared spectroscopy. Raman spectroscopy: Principles, instrumentation and applications of Raman spectroscopy. UV Visible spectroscopy: Principles, instrumentation and applications of UV Visible spectroscopy. **Videos/Learning material**: Introduction to new methods of detecting and quantifying analytes by spectroscopy **Self-study:** New applications of separation techniques in industry.

Module-4 Analytical Separations-I

Chromatography: Introduction, Chromatographic classifications based on Sorption process: adsorption, partition, ion-exchange and size exclusion.
Thin layer chromatography (TLC): Principles, procedure and applications of TLC.
Ion-exchange chromatography (IEC): Principles, procedure and applications of IEC.

Pedagogy	**Chalk and talk/power point presentation**: Separation techniques. Chromatography: Introduction, Chromatographic classifications based on Sorption process: adsorption, partition, ion-exchange and size exclusion. Thin layer chromatography (TLC): Principles, procedure and applications of TLC. Ion-exchange chromatography (IEC): Principles, procedure and applications of IEC. **Videos/Learning material:** Chromatographic techniques and its industrial applications. **Self-study:** Recent update on chromatography.

Module-5 Analytical Separations-II

Size-exclusion chromatography (SEC): Principles, procedure and applications of SEC.
Gas chromatography (GC): Principles, instrumentation and applications of GC.
High performance liquid chromatography (HPLC): Principles, instrumentation and applications of HPLC.

Pedagogy	**Chalk and talk/power point presentation**: Separation techniques. Size-exclusion chromatography (SEC): Principles, procedure and applications of SEC. Gas chromatography (GC): Principles, instrumentation and applications of GC. **Videos/Learning material:** Chromatographic techniques and its industrial applications. **Self-study:** High performance liquid chromatography (HPLC): Principles, instrumentation and applications of HPLC.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Understand about SI units
CO 2	Learn about quantification by titration.
CO 3	Study about spectroscopy techniques.
CO 4	Have an insight into quantitative method of analysis
CO 5	An insight into chromatographic separations.

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 . Douglas A, Skoog and Donald M.. West: Fundamentals of Analytical Chemistry
2. Adion A.Gordus: Schaum's Outline of Analytical Chemistry, Tata Mc Graw-Hill
3. Daniel C Harris: Exploring Chemical Analysis.
4. Daniel C Harris: Quantitative Chemical Analysis.
5. Vogel's text book of quantitative chemical analysis, 6th edition
6. Vogel's text book of quantitative chemical analysis, 7th edition
7. Instrumental method of analysis,H.H.Willard, L.L.Merritt and J.A.Dean,7th edition
8. Spectroscopy, B.P.Straughan and S.Walker, John Wiley and Sins Inc.New York, Vol.1 and 2.1976.
9. Vibration Spectroscopy Theory and Applications. D.N.Satyanarayana, New Age International, New Delhi (2004).
10. Fundamental of Molecular Spectroscopy, C.N.Banwell and E.M.Mc Cash.4th edition, Tata Mc Graw-Hill.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=Ym3HyZGsOg4&list=PLLy_2iUCG87CZ8WsOQA3WWb1IqAuAlAuB
2. https://www.youtube.com/watch?v=-j1rjB_-DhI

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

VII Semester

ELECTROCHEMISTRY			
Course Code	**21BSC72**	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

CLO 1	To understand the basic concepts of Electrochemistry.
CLO 2	To develop an understanding of the operating principles and mechanisms of energy storage, sensors and energy conversion devices.
CLO 3	To impart fundamental knowledge of corrosion and its control.
CLO 4	To obtain and apply the knowledge of surface chemistry.
CLO 5	To create an understanding of advanced materials having engineering applications.

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 Electrochemistry

Electrochemistry:

Introduction, Structure of electrified interface: Helmholtz theory, Guoy-Chapman theory, Electrochemical cells, Conventions to represent Galvanic cells. Electrochemical series, Cell potential. Importance of Nernst equation, derivation and numerical problems. Types of electrodes: metal-metal ion, metal-metal salt ion, gas, amalgam, redox & ion selective. Reference electrodes: Introduction; construction, working and applications of calomel electrode, Ag-AgCl electrode. Types of Ion selective electrodes, Construction of glass electrode, derivation of E_G, determination of pH using combined glass electrode. Numericals on pH measurement.

Pedagogy	**Chalk and talk/power point presentation:** Introduction, Importance of Nernst equation, derivation and numerical problems. Types of electrodes: metal-metal ion, metal-metal salt ion, gas, amalgam, redox & ion selective. Reference electrodes: Introduction; construction, working and applications of calomel electrode, Ag-AgCl electrode. Types of Ion selective electrodes, Construction of glass electrode, derivation of E_G, determination of pH using combined glass electrode. Numericals on pH measurement. **Videos/Learning material:** Structure of electrified interface: Helmholtz theory, Guoy-Chapman theory, Electrochemical cells, Conventions to represent Galvanic cells. Electrochemical series, Cell potential. **Self-study:** Construction, working and applications of Ag-AgCl electrode.

Module-2 Energy Conversion and Storage Devices

Energy Conversion and Storage Devices

Battery Technology: Introduction to battery, Classification of cells, Construction, working and applications of Zn-air, Li-ion, Lithium-Sulphur, Li-phosphate and Na-ion Battery.

Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Classification of fuel cells based on electrolyte; construction & working of Proton Exchange Membrane (PEM) fuel cell.

Pedagogy	**Chalk and talk/power point presentation**: Introduction to battery, Classification of cells, Construction, working and applications of Zn-air, Li-ion battery. **Fuel Cells:** Introduction, difference between conventional cell and fuel cell, limitations & advantages. Classification of fuel cells based on electrolyte; construction & working of Proton Exchange Membrane (PEM) fuel cell. **Videos/Learning material**: Construction, working and applications of Lithium-Sulphur and Li-phosphate battery. **Self-study:** Construction, working and applications of Na-ion Battery.

Module-3 Electrochemistry of Corrosion

Electrochemistry of Corrosion

Corrosion: Introduction to corrosion concept, galvanic series, Electrochemical theory of corrosion. Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, polarization of anodic & cathodic regions, nature of metal, nature of corrosion product, Electrode potential, nature of medium – pH, conductivity and temperature.

Types of corrosion- Differential metal, Differential aeration (Pitting and water line) and Stress corrosion- Caustic embrittlement in boilers and Hydrogen Embrittlement.

Corrosion testing methods: Salt spray Test and numerical on rate of corrosion based on weight loss method.

Corrosion control: Anodizing of Aluminium, Galvanization, Tinning, Cathodic protection-sacrificial anodic method and Impressed current method.

Pedagogy	**Chalk and talk/power point presentation**: **Corrosion:** Introduction to corrosion concept, galvanic series, Electrochemical theory of corrosion. Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, polarization of anodic & cathodic regions, nature of metal, nature of corrosion product, Electrode potential, nature of medium – pH, conductivity and temperature. **Types of corrosion**- Differential metal, Differential aeration (Pitting and water line) and Stress corrosion- Caustic embrittlement in boilers and Hydrogen Embrittlement. **Corrosion testing methods**: Salt spray Test and numerical on rate of corrosion based on weight loss method. .**Videos/Learning material: Corrosion control:** Anodizing of Aluminium, Galvanization, Cathodic protection-sacrificial anodic method **Self-study:** Tinning, Cathodic Protection-Impressed current method. Pourbaix diagrams, Tafel equation and slopes

Module-4 Surface Engineering

Surface Engineering: Introduction, Principles – Polarization, Decomposition potential and over voltage, Surface preparation/pre-treatment and post-treatment processes.

Electroplating process: Electroplating process, Factors affecting plating: Current density, Metal salt and ion concentration, Additives-complexing agents, brighteners, levellers, wetting agents, stress relievers, Throwing power of plating bath. Numerical on Throwing power of plating bath and electro-deposition. Electroplating of Chromium and Nickel, Duplex and Triplex coatings, Applications.

Electroless plating of copper & manufacture of double sided Printed Circuit Board (PCB) with copper.

Pedagogy	**Chalk and talk/power point presentation: Surface Engineering: Electroplating process**: Electroplating process, Factors affecting plating: Current density, Metal salt and ion concentration, Additives-complexing agents, brighteners, levellers, wetting agents, stress relievers, Throwing power of plating bath. Numerical on Throwing power of plating bath and electro-deposition. Electroplating of Chromium and Nickel, Applications. **Electroless plating** of copper & manufacture of double sided Printed Circuit Board (PCB) with copper. **Videos/Learning material**: Introduction, Principles – Polarization, Decomposition potential and over voltage, Surface preparation/pre-treatment and post-treatment processes. **Self-study:** Duplex and Triplex coatings.

Module-5 Sensors

Sensors: Introduction to Chemical and Biosensors, definition of sensor element, sensor and sensor system. Transduction principle. Chemical sensors: Classification electrochemical and electromagnetic sensors. Electrochemical Sensors- Amperometric, Conductometric, Potentiometric sensors. Electromagnetic Sensors – Optical and mass sensors.

Organic Light Emitting Diodes: Introduction to Organic Light Emitting Diodes, Components of OLEDs, Organic molecules used in OLEDs, Working Principle. Types of OLEDs - Passive-matrix, Active-matrix, Transparent, Top-emitting, Foldable and White OLEDs), Advantages, disadvantages and Applications.

Pedagogy	**Chalk and talk/power point presentation**: Sensors: Introduction to Chemical and Biosensors, definition of sensor element, sensor and sensor system. Transduction principle. Chemical sensors: Classification electrochemical and electromagnetic sensors. Electrochemical Sensors- Amperometric, Conductometric, Potentiometric sensors. Electromagnetic Sensors – Optical and mass sensors. **Videos/Learning material**: Organic Light Emitting Diodes: Introduction to Organic Light Emitting Diodes, Components of OLEDs, Organic molecules used in OLEDs, Working Principle. **Self-study:** Types of OLEDs - Passive-matrix, Active-matrix, Transparent, Top-emitting, Foldable and White OLEDs), Advantages, disadvantages and Applications.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Develop an insight into the chemistry aspects of electrode systems and theories.
CO 2	Identify the materials best suited for construction of batteries, fuel cells, sensors and OLEDs.
CO 3	Apply the knowledge of electrochemistry for corrosion in achieving a practical solution.
CO 4	Assess the quality of plating, plating techniques and illustrate the applications.
CO 5	Illustrate the knowledge of advanced engineering materials for the technological applications.

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. Bahl, A.; Bahl, B. S.; Tuli, G. D., Essentials of Physical Chemistry, S. Chand and Company (2010).
2. Atkins, P. W.; de Paula, J.; Keeler, J., Physical Chemistry, 11th Ed., Oxford University Press India (2018).
3. J. O'M. Bockris, A. K. N. Reddy, Modern Electrochemistry, Vol. 2 A & B, 2nd Edition, Plenum Press, New York (1998).
4. C. M. A. Brett and A. M. O. Brett, Electrochemistry: Principles, Methods and Applications, Oxford University Press, Oxford, 1993.
5. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
6. Shashi Chawla, "A text Book of Engineering Chemistry" Dhanpat Rai and Co. (Pvt) Ltd., 3rd Ed. Reprint 2013.
7. Dr. H. Panda, "Handbook on Electroplating with Manufacture of Electrochemicals", ASIA PACIFIC BUSINESS PRESS Inc., 2017.
8. Robert Baboian, "Corrosion Tests and Standards Application and Interpretation", ASTM International, 2005.
9. EIRI Board of Consultants and Engineers, "Hand Book of Electroplating anodizing and Surface Finishing Technology", Engineers India Research Institute, New Delhi.
10. Mars Fontana,"CORROSION ENGINEERING", 2017, McGraw Hill Education.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/downloads/122101001/
2. https://www.youtube.com/watch?v=iLgiTAz86Hw
3. https://www.youtube.com/watch?v=RQE56ksVBB4

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

- https://www.vlab.co.in/broad-area-chemical-sciences
- https://www.youtube.com/watch?v=_avejV7J7Wk
- https://www.youtube.com/watch?v=NG1x-aiHdW4

VII Semester

ANALYTICAL CHEMISTRY LAB			
Course Code	21BSCL73	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:2	SEE Marks	50
		Total Marks	100
Credits	02	Exam Hours	03

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Have idea about different analytical techniques
CO 2	Have hands on few analytical equipments

SL.NO	Experiments
1	Preparation of buffers and measurement of pH
2	Estimation of optical activity of sugar solution by Polarimeter.
3	Spectophotometric analysis of fluoride by SPADNS method.
4	Determination of percentage of chloride in a sample by precipitation Mohr method
5	Analysis of hypochlorite by iodometric titration.
6	Thin layer chromatographic separation of amino acids,
7	Colorimetric/spectrophotometric estimation of hexavalent chromium in waste water sample.
8	Amperometric method for estimation of phosphate in water sample
9	Gas chromatographic determination of ethanol in beverages (Online mode demo)
10	Determination of aspirin, phenacetin and caffeine in a mixture by HPLC (Online mode demo)

Assessment Details (both CIE and SEE)

Continuous Internal Evaluation: The 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: The practical examinations to be conducted as per the time table of University in a batch wise strength of students not more than 10-15 per batch.

1. All laboratory experiments are to be included for practical examination, except Sl/No 11 & 12.
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 examiner
4. Change of experiments is allowed only once and 15% Marks allotted to the procedure part to be made zero

Suggested Learning Resources:

Books: 1. Douglas A.Skoog and DonaldM..West: Fundamental of Analytical Chemistry
2. GaryD.Christian: Analytical Chemistry
3. Daniel C Harris: Exploring Chemical Analysis
4. Quantitative Chemical Analysis, R.A. Day and A.L.Underwood,6th edition,1993, prentice Hall,Inc,New Delhi
5. Vogel's textbook of quantitative chemical analysis 6th edition or 7th edition
6. Analytical Chemistry principles,John H.Kennedy,2nd edition, Saunders College Publishing,California .1990

7. Practical Clinical Biochemistry by Harold Varley and Arnold Heinmann , 4th edition.

VII Semester	MOLECULAR SPECTROSCOPY		
Course Code	**21BSC741**	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:

CLO1	Understand the basic concepts of UV Spectroscopy.
CLO2	Characterize the organic compounds using IR Spectroscopy.
CLO3	Analyse the samples using Mass spectroscopy
CLO4	Interpret NMR spectra and elucidate the structure.
CLO5	Apply spectroscopic concepts to characterize the organic compounds.

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 UV Spectroscopy

Types of electronic transitions, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes).

Pedagogy	**Chalk and talk/power point presentation** :Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts. **Videos/Learning material:** Intensity of absorption; Application of Woodward Rules for calculation of λmax. **Self-study:** Distinction between cis and trans isomers.

Module-2 Infrared Spectroscopy

Principle and Instrumentation of FTIR, Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, normal modes of vibration, force constant. simple–rules of IR, an hormonicity, modes of vibration in molecules, changes in infrared spectra of donor molecules oxide, amine, dimethylacetamide, DMSO. Finger print region.

Pedagogy	**Chalk and talk/power point presentation:** Infrared spectroscopy: Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules **Videos/Learning material:** Infrared spectra of diatomic and polyatomic molecules,

	normal modes of vibration, force constant, selection rotation spectroscopy. **Self-study:** Characterization of chemical compounds using FTIR.

Module - 3 Magnetic Resonance spectroscopy

Principle and Instrumentation of NMR Magnetic properties of nuclei such as 1H &C13, $DMSOd_6$,TMS, Chemical shift, Shielding & deshielding effect, factors governing. Prediction of NMR spectra of alcohols, aldehydes and ketones. NMR of few inorganic molecules. NMR Spectra of paramagnetic complexes, contact shift, double resonance technique.

Pedagogy	**Chalk and talk/power point presentation:** NMR in structural determination of organic and inorganic molecules **Videos/Learning material:** Magnetic properties of nuclei & NMR Instrumentation **Self-study:** NMR Instrumentation.

Module-4 Mass Spectrometry

Ionization and mass analysis. Instrumentation. Methods of ionization: EI, CI, DI, SI methods. +·Fragmentation: Principles, odd electron (OE) and even electron (EE+) ions, molecular ion and base peak, nitrogen rule, metastable ions. Fragmentation of organic compounds: (i) normal and branched alkanes. (ii) alkenes. (iii) benzene and its derivatives (iv) alcohols

Pedagogy	**Chalk and talk/power point presentation:** Ionization and mass analysis. Instrumentation. Methods of ionization: EI, CI, DI, SI methods. +·Fragmentation **Videos/Learning material:** Principles, odd electron (OE)and even electron (EE+) ions, molecular ion and base peak, nitrogen rule, metastable ions. **Self-study:** Fragmentation of inorganic and organic compounds - acids, amine compounds

Module-5 Raman, Electron Spin Resonance (ESR) and Mossbauer spectroscopy

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electron Spin Resonance (ESR) spectroscopy: Principle of ESR & hyperfine structure.

Mossbauer spectroscopy: Principles, Isomer shifts. Quadrupole and Nuclear Zeeman splittings. Applications in structure determination

Pedagogy	**Chalk and talk/power point presentation:** Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra. **Videos/Learning material:** Molecular electronic absorption spectroscopy (UV electronic spectra of diatomic molecules, electronic transitions, selection rules.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Understand the basic concepts of UV Spectroscopy.
CO 2	Characterize the organic compounds using IR Spectroscopy.
CO 3	Analyse the samples using Mass spectroscopy
CO 4	Interpret NMR spectra and elucidate the structure.
CO 5	Apply spectroscopic concepts to characterize the organic compounds.

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. Fundamentals of Molecular Spectroscopy - C. N. Banwell.

2. Introduction to Spectroscopy – D.L.Pavia, G.M.Lampman and G.S.Kriz, Thomson Learning, Singapore (2001)

3. Infrared Spectroscopy - C.N.R. Rao.

4. Electron Absorption Spectroscopy and Selected Techniques - D. N. Satyanarayana, University Press India Ltd. Hyderabad.

5. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006)

Web links and Video Lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/104106077/L01.html
2. https://www.digimat.in/nptel/courses/video/104101099/L24.html

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

- https://www.youtube.com/watch?v=oIQ8WEYsGW0
- https://www.youtube.com/watch?v=vt3WO2rf9Qs
- https://www.youtube.com/watch?v=dkARLSQWHH8&t=45s

VII Semester

PHOTOCHEMISTRY			
Course Code	**21BSC742**	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	Understand the basic of photochemistry.
CLO 2	Enumerate basic properties of excited states.
CLO 3	Learn various photochemical reactions of alkenes and carbonyl compounds.
CLO 4	Various photochemical reactions and interaction with aromatic compounds.
CLO 5	Learn classification and features of pericyclic reactions.

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 Basics of Photochemistry

Photochemistry: Light Absorption, excitation, photochemical laws, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers. Flash photolysis,Energy dissipation by radiative and non-radiative processes, Franck-Condon principle, Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones- Norrish type-I and Norrish type-II reactions, enones, PaternoBuchi reaction, di-pi- rearrangements, photooxidations, photoreductions.

Pedagogy	**Chalk and talk/power point presentation:** Light Absorption, excitation, photochemical laws, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers. **Videos/Learning material:** Franck-Condon principle, photooxidations, photoreductions.

Module-2 Photochemical Reactions

Photochemical Reactions: Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Properties of Excited States: Structure, dipole moment, acid-base strengths, reactivity. Photochemical kinetics-calculation of rates of radiative processes. Bimolecular deactivation quenching. **Effect of light intensity on the rate of photochemical reactions:** Types of photochemical reactions - photo-dissociation and gas-phase photolysis.	
Pedagogy	**Chalk and talk/power point presentation:** Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry **Videos/Learning material:** Types of photochemical reactions -photo-dissociation and gas-phase photolysis.
Module - 3 Photochemistry of Alkenes and Carbonyl compounds	
Photochemistry of Alkenes: Intramolecular reactions of olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5-dienes. **Photochemistry of Carbonyl compounds**: Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic and unsaturated compounds, Cyclohexadienones. Intermolecular cycloaddition reactions- dimerisations and oxetane formation, Paterno buchi Reaction.	
Pedagogy	**Chalk and talk/power point presentation:** Intramolecular reactions of olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5-dienes. **Videos/Learning material:** Cyclohexadienones. Intermolecular cycloaddition reactions- dimerisations and oxetane formation, Paterno buchi Reaction**.**
Module-4 Photochemistry of Aromatic Compounds	
Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions. **Miscellaneous Photochemical Reactions:** Photo-Fries reactions of anilides. Photo Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo degradation of polymers, Photochemistry of vision.	
Pedagogy	**Chalk and talk/power point presentation:** Photo-Fries reactions of anilides. Photo Fries rearrangement. **Videos/Learning material:** Photo degradation of polymers, Photochemistry of vision.
Module-5 Pericyclic reactions	
Pericyclic reactions: Classification and features, molecular orbital hexatriene–butadiene, 1,3,5–symmetry, frontier orbitals of ethylene, 1,3–butadiene, 1,3,5–hexatriene and allyl systems. **Electrocyclic processes:** Introduction, Woodward –Hoffmann rules for 4n– and (4n+2) π systems, stereochemistry under thermal and photochemical conditions. **Cycloaddition reactions:** Introduction, supra facial and antra facial addition, [2+2] and [4+2] cycloaddition reaction (Diels Alder reaction) FMO–analysis under thermal and photochemical conditions.	
Pedagogy	**Chalk and talk/power point presentation:** Classification and features, molecular orbital hexatriene–butadiene, 1,3,5–symmetry, frontier orbitals of ethylene, 1,3–butadiene **Videos/Learning material:** FMO–analysis under thermal and photochemical conditions.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Explain the basic concepts of photochemistry.
CO 2	Describe basic properties of excited states.
CO 3	Brief photochemical reactions of alkenes and carbonyl compounds.
CO 4	Explain photochemical reactions and interaction with aromatic compounds.
CO 5	Classify and describe features of pericyclic reactions.

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. Fundamentals of Photochemistry by K. K. Rohatagi-Mukherjee
2. Molecular Photochemistry by N. J. Turro,
3. Principles of Photochemistry by J.A. Baltrop & J.D. Coyle
4. Principles of Fluorescence Spectroscopy by J. R. Lakowicz
5. Molecular reactions and photochemistry, Charles H. Depuy, Orville L. Chopman

Web links and Video Lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/104106077/L01.html
2. https://nptel.ac.in/courses/104105038
3. https://archive.nptel.ac.in/courses/104/106/104106077/

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

- https://www.youtube.com/watch?v=oIQ8WEYsGW0
- https://archive.nptel.ac.in/courses/104/106/104106077/
- https://archive.nptel.ac.in/courses/104/106/104106077/

VII Semester	CHEMISTRY OF NANOMATERIALS		
Course Code	21BSC751	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	1:2:2	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	3	ExamHours	3

Course Learning objectives:

CLO 1	To provide a comprehensive overview of synthesis and characterization of nanoparticles, nanocomposites and hierarchical materials with nanoscale features.
CLO 2	To provide the students with necessary background for understanding various nanomaterials characterization techniques.
CLO 3	To develop an understanding of the basis of the choice of material for device applications.
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.

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 Introduction to Nanomaterials

Nanotechnology, Frontier of future-an overview, Length Scales, Variation of physical properties from bulk to thin films to nanomaterials, Confinement of electron in 0D, 1D, 2D and 3D systems, Surface to Volume Ratio, Synthesis of Nanomaterials: Bottom-Up approach: Chemical Routes for Synthesis of nanomaterials-Sol-gel, Precipitation, Solution Combustion synthesis, Hydrothermal, SILAR, Chemical Bath Deposition. Top-Down approach- Ball milling technique, Sputtering, Laser Ablation.

Pedagogy	**Chalk and talk/power point presentation:** Nanotechnology, Frontier of future-an overview, Length Scales, Variation of physical properties from bulk to thin films to nanomaterials, Confinement of electron in 0D, 1D, 2D and 3D systems, Surface to Volume Ratio. **Videos/Learning material:** Synthesis of Nanomaterials: Bottom-Up approach: Chemical Routes for Synthesis of nanomaterials-Sol-gel, Precipitation, Solution Combustion synthesis, Hydrothermal, SILAR, Chemical Bath Deposition. Top-Down approach- Ball milling technique, Sputtering, Laser Ablation. **Self-study:** Confinement of electron in 0D, 1D, 2D and 3D systems

Module-2 Characterization of Nanomaterials

Basic principles and instrumentations of Electron Microscopy –Transmission Electron Microscope, Scanning Electron Microscope, Scanning Probes- Scanning Tunneling microscope, Atomic Force Microscope –different imaging modes, comparison of SEM and TEM, AFM and STM, AFM and SEM. Basic principles of working of X-ray diffraction, derivation of Debye-Scherrer equation, numericals on Debye Scherrer equation, Optical Spectroscopy- Instrumentation and application of IR, UV/VIS (Band gap measurement)	
Pedagogy	**Chalk and talk/power point presentation:** Basic principles and instrumentations of Electron Microscopy –Transmission Electron Microscope, Scanning Electron Microscope, Basic principles of working of X-ray diffraction, numericals on Debye Scherrer equation, Optical Spectroscopy- Instrumentation and application of IR, UV/VIS (Band gap measurement) **Videos/Learning material:** Scanning Probes- Scanning Tunneling microscope, Atomic Force Microscope –different imaging modes, comparison of SEM and TEM, AFM and STM, AFM and SEM. **Self-study:** Derivation of Debye-Scherrer equation
Module-3 Carbon based Nanostructures	
Introduction, synthesis, Properties (electrical, Electronic and Mechanical), and Applications of Graphene (Synthesis by exfoliation and electrochemical method), SWCNT, MWCNT, Fullerenes (Synthesis by CVD method and purification procedures) and other Carbon Materials: Carbon nanocomposites, nanofibres, nanodiscs, nanodiamonds.	
Pedagogy	**Chalk and talk/power point presentation:** Introduction, synthesis, Properties (electrical, Electronic and Mechanical), and Applications of Graphene (Synthesis by exfoliation and electrochemical method), SWCNT, MWCNT, Fullerenes (Synthesis by CVD method and purification procedures). **Videos/Learning material:** Carbon Materials: Carbon nanocomposites, nanofibres, nanodiscs, nanodiamonds. **Self-study:** Applications of Graphene.
Module-4 Nanotechnology for Water Treatment	
Overview of water treatment technologies; Role of nanotechnology in water treatment and purification; Nanoparticle-based adsorption and membrane filtration processes; Nanoparticle-based sensors for water quality monitoring; Nanotechnology-based approaches for desalination and water reuse; Nanoparticle-based disinfection and sterilization of water; Treatment of emerging contaminants using nanotechnology; Economic and environmental aspects of nanotechnology-based water treatment systems.	
Pedagogy	**Chalk and talk/power point presentation:** Overview of water treatment technologies; Role of nanotechnology in water treatment and purification; Nanoparticle-based adsorption and membrane filtration processes; Nanoparticle-based sensors for water quality monitoring; **Videos/Learning material:** Nanotechnology-based approaches for desalination and water reuse; Nanoparticle-based disinfection and sterilization of water; Economic and environmental aspects of nanotechnology-based water treatment systems.

	Self-study: Treatment of emerging contaminants using nanotechnology;

Module-5 Applications of Nanotechnology

Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry - Packaging, Food processing - Food safety and bio-security – Contaminant detection – Smart packaging.
Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application – **Polymer nanofibers**- Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers - **Bionics**– Swim-suits with shark-skin-effect,Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes).

Pedagogy	**Chalk and talk/power point presentation:** Nanotechnology in Agriculture - Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry - Packaging, Food processing - Food safety and bio-security – Contaminant detection – Smart packaging. **Videos/Learning material:** Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application – **Polymer nanofibers**- Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers - **Bionics**– Swim-suits with shark-skin-effect,Soil repellence. **Self-study:** Lotus effect - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes).

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

CO1	Demonstrate the synthesis of nanoparticles by various techniques.
CO2	Explain working of basic instruments used in characterization of nanoparticles.
CO3	Identify the nanotechnology based water treatment methods.
CO4	Illustrate the application of nanomaterials in fertilizer, food technology, textiles and cosmetics.

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:**

Based on Project report submission and Viva-voce (30M and 20 Marks).

Suggested Learning Resources:

Books:

1. Carbon Nanotubes: properties and applications-Mchael J. O'Connell, Taylor & Francis, 2006.
2. Nanotubes and Nanowires-CNR Rao and A Govindaraj RSC publishing.
3. Handbook of Carbon, YuryGagotsi, Taylor & Francis, 2006.
4. Nano Materials – A.K. Bandyopadhyay/ New Age Publishers
5. Nanocrystals: Synthesis, Properties and Applications – C.N.R. Rao, P. John Thomas and G. U. Kulkarni, Springer Series in Materials Science
6. Nano Essentials- T. Pradeep/TMH
7. Peter J. F. Harris, Carbon nanotube science: synthesis, properties, and applications. Cambridge University Press, 2011
8. M.A. Shah, K.A. Shah, "Nanotechnology: The Science of Small", Wiley India, ISBN 13: 9788126538683
9. Mark A. Ratner and Daniel Ratner,Nanotechnology: A Gentle Introduction to the Next Big Idea, Pearson (2003). 10 NT – 12–13 – SRM – E&T
10. Bharat Bhushan,Springer Handbook of Nanotechnology, Barnes & Noble (2004).
11. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).
12. Lynn J. Frewer, WillehmNorde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, (2011).
13. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).
14. W.N. Chang, Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, (2009).

Web links and Video Lectures (e-Resources):

1. Fullerenes and Carbon nanotubes: https://www.youtube.com/watch?v=9EKqNBvz4cA
2. Carbon Materials and Manufacturinghttps://www.youtube.com/watch?v=AzyYyjPEqOk&t=1s
3. Carbon Nanostructures https://www.youtube.com/watch?app=desktop&v=kCTED1wlQBU
4. https://nptel.ac.in/courses/118104008
5. https://www.digimat.in/nptel/courses/video/118104008/L16.html
6. https://archive.nptel.ac.in/courses/113/106/113106099/
7. https://nptel.ac.in/courses/112107283
8. https://onlinecourses.nptel.ac.in/noc22_me131/preview
9. Nanotechnology in Agriculture - Prof Mainak Das, IIT Kanpur: https://www.youtube.com/watch?v=hdDBvC7kop8
10. Nanofibers: https://www.youtube.com/watch?v=i-EmUjv-fL4

Skill Development Activities Suggested

- Assignments
- Quizes
- Seminars

VII SEMESTER

CHEMISTRY OF COSMETICS AND PERFUMES			
Course Code	21BSC752	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

CLO 1 Learn basic of cosmetics, classification, cosmetic formulation, ingredients and their roles in cosmetic products.

CLO 2 Explain the importance of essential oils in cosmetic industries.

CLO 3 Describe the general methods of obtaining volatile oils from plants and the composition of volatile oils.

CLO 4 Explain the use of safe, economic and body-friendly cosmetics.

CLO 5 Explain the new innovative formulations.

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 Cosmetics Chemistry

Introduction of Cosmetics, Cosmetics- Definition, History, Classification, Ingredients, Nomenclature, Regulations. Excipients & its applications in cosmetics; Oily Materials, Surface Active Agents, Humectants, Antioxidants, Safety of Cosmetics. Structure nomenclature.

Pedagogy	**Chalk and talk/power point presentation:** Introduction of Cosmetics, Cosmetics- Definition, History, Classification, Ingredients, Nomenclature, Regulations. **Videos/Learning material:** Excipients & its applications in cosmetics; Oily Materials, Surface Active Agents, Humectants, Antioxidants, Safety of Cosmetics. Structure nomenclature. **Self-study:** Role of natural products in cosmetics, fixatives.

Module-2 Face Preparation

Structure of skin, Face powder, Compact powder, Talcum powder. Skin Preparation: Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream.

Pedagogy	**Chalk and talk/power point presentation:** Face powder, Compact powder, Talcum powder. Skin Preparation: Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream.

	Videos/Learning material: Structure of skin **Self-Study:** Preparation of talcum powder and face cream.
Module-3 Hair preparation	
Structure of hair, classification of hair, Hair dye- classification – temporary, semipermanent, demi permanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners. Colored preparation: Nail preparation-Structure of nail, Nail lacquers, Nail polish remover, Lipsticks.	
Pedagogy	**Chalk and talk/power point presentation:** Structure of hair, classification of hair, Hair dye- classification – temporary, semipermanent, demi permanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners. Colored preparation: Nail preparation-Structure of nail, Nail lacquers, Nail polish remover, Lipsticks. **Videos/Learning material:** Structure of hair and nail. **Self-Study:**Preparation of shampoo and nail polish and remover.
Module-4 Herbal Cosmetics	
History, definition, developmental and role of natural products in cosmetics. Herbs, Hair, dye, shampoo. description and morphology of organized and un-organized herbs. Different systems of classification of natural excipients, their merits and demerits.	
Pedagogy	**Chalk and talk/power point presentation:** History, definition, developmental and role of natural products in cosmetics. Herbs, Hair, dye, shampoo. description and morphology of organized and un-organized herbs. **Videos/Learning material:** Different systems of classification of natural excipients, their merits and demerits. **Self-Study:** Extraction of essential oils, Methods for animal testing for safety evaluation of cosmetics.
Module-5 Personal hygiene products	
Classification of perfumes. Perfume ingredients listed as allergens. Deodorants, Antiperspirants and deodorants and artificial flavours, oral hygiene products, flavours and essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	
Pedagogy	**Chalk and talk/power point presentation:** Classification of perfumes. Perfume ingredients listed as allergens. Deodorants, Antiperspirants and deodorants and artificial flavours, oral hygiene products, flavours and essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone. **Videos/Learning material:** Classification of perfumes. Perfume ingredients listed as allergens. **Self-Study:** Safe use of perfumes, study of safety use ofperfumes on naked skin including various dermatological tests.
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)**	

VII SEMESTER

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week 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 13th week 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:

Based on Project report submission and Viva-voce (30M and 20 Marks).

Suggested Learning Resources:

Books

1. Harry's Cosmetology Edited by J.B. Wilkinson and R. J. Moore, Longman Scientific & Technical Publishers.
2. Cosmetics Science and Technology, Edited by M.S. Balsam, E. Sagarin, S.D. Gerhon,S.J.Strianse and M.M.Rieger, Volumes 1,2and 3, Wiley-Interscience, Wiley India Pvt. Ltd., 2008.
3. Poucher's Perfumes, Cosmetics & Soaps, 10th Ed, Editor- Hilda Butler, Klewer Academic Publishers, Netherlands, 2000.
4. Cosmetic Technology, Ed. By S.Nanda, A. Nanda and R. Khar, Birla Publications Pvt. Ltd., New Delhi, 2007.
5. Handbook of Cosmetic Science and Technology, edited by M. Paye, A.O.Barel, H. I. Maibach, Informa Healthcare USA,Inc. 2007.
6. Encyclopedia of Pharmaceutical Technology, Vol. 6, Eds. James Swarbrick, James C. Boylan, Marcel Dekker Inc., 1992.
7. Kemp S.E., Hollowood T, Hort J., "Sensory evaluation-A practical handbook," John Wiley & Sons, 2009.
8. Sensory Evaluation Techniques, Fourth Edition, Morten C. Meilgaard, B. Thomas Carr, Gail Vance Civille, CRC Press.
9. ISO 13299:2016(en) Sensory analysis — Methodology — General guidance for establishing a sensory profile.
10.BIS Guidelines for different cosmetic products.
11. Formulation and function of cosmetics by Jellinek Stephan, Wiley Interscience.
12. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
13. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
14. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

Web links and Video Lectures (e-Resources)

1. https://www.youtube.com/watch?v=vFdyJKfFwwg&t=9s
2. https://www.youtube.com/watch?v=8ZkopHWpZ2s

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

1. https://www.youtube.com/watch?v=8cyjlnDo5ok&t=239s

VII Semester

GEOGRAPHY			
Course Code	21BSO761	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	02	Exam Hours	03

CLO 1	To introduce students to basic concepts of geography and several up-to-date issues which are widely discussed in the field of geography.
CLO 2	To provide an overview of the major branches of physical geography and their interconnections
CLO 3	Ability to interpret the distribution and processes of physical and human phenomena.
CLO 4	Provide an understanding of the definitions and concepts related to natural hazards and disaster risk reduction.
CLO 5	To identify economic patterns across space and time in order to provide insight into how and why economic systems and practices develop.

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 Geography

Introduction, Defining Geography, Nature and Scope of Geography, Branches of Geography, Spatial Distribution of Phenomenon, Importance of Physical Geography and Human Geography.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-2 Physical Geography

Weathering, factors affecting weathering; Concept of cycle of erosion; works of running water, wind and glaciers; Karst and coastal regions; Drainage patterns, lakes and islands. Elements of weather and climate; Composition and structure of the atmosphere; Insolation, heat budget, vertical, horizontal and seasonal distribution of temperature.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-3 Environmental Geography	
Principle of ecology; Human ecological adaptations; Influence of man on ecology and environment; Global and regional ecological changes and imbalances; Ecosystem their management and conservation; Environmental degradation, management, and conservation; Biodiversity and sustainable development; Environmental policy; Environmental hazards and remedial measures; Environmental education and legislation.	
Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**
Module-4 Perspectives in Human Geography	
Areal differentiation; regional synthesis; Dichotomy and dualism; Environmentalism; Quantitative revolution and locational analysis; Radical, behavioural, human, and welfare approaches; Languages, religions, and secularisation; Cultural regions of the world; Human development index.	
Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**
Module-5 Economic Geography	
World economic development: measurement and problems; World resources and their distribution; Energy crisis; the limits to growth; World agriculture: a typology of agricultural regions; Agricultural inputs and productivity; Food and nutrition problems; Food security; famine: causes, effects, and remedies; World industries: location patterns and problems; Patterns of world trade.	
Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Explain the meaning, definitions, nature, and scope of physical geography and identify and describe the branches of physical geography.
CO 2	Examine the origin, shape, and size of the earth, and the effects of the movement of the earth, coordinates -latitude, longitude, and time.
CO 3	Discuss the major environmental issues facing the earth system, including global warming, greenhouse effect, ozone depletion, floods, droughts, weather variations, changing ecosystems, snow/glaciers melting, and impact of pollution.
CO 4	Define and explain key concepts related to natural hazards and disaster risk Reduction.
CO 5	Understand the process of recovery and reconstruction following a disaster.

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 5th week of the semester
2. Second test at the end of the 10th week 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 13th week 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:

- A.M. Patwardhan ., (2012),' The Dynamic Earth System', Prentice Hall India Learning Private Limited; Third edition
- B.S. Negi., (1993), 'Physical Geography', S.J. Publication, Meerut.
- D.S. Lal., (1998), 'Climatology' Chaitnya publishing house, Allahabad.
- K. Siddhartha., (2001), 'Atmosphere, Weather and Climate', Kisalaya publication, New Delhi.
- R.N. Tikka., (2002), 'Physical Geography' Kedarnath Ramnath & Co, Meerut.
- Robinson, H. et al (1995): Elements of Cartography, 6th Edition, John Wiley & Sons, New York.
- Strahler, A.N., (2005), 'Physical Geography', Wiley Publications., 3rd Ed.
- W. Kenneth Hamblin & Eric H. Christiansen., (2003), 'Earth's Dynamic Systems' Pearson; 10th edition.
- Monkhouse, F.J.R. & Wilkinson H.R.(2000):Maps and Diagrams, Methuen &Co. London.
- Mishra, R.P. (1973): Fundamentals of Cartography, Prasaranga, University of Mysore
- Rampal, K.K.(1993): Mapping and Compilation, Concept Publishing Co.New Delhi.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=qLnQlLcwoxM
2. https://www.youtube.com/watch?v=625W7bwB5GY

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

https://wiki.millersville.edu/display/ittac/Geography+Virtual+Lab+Instructions

VII Semester

Mass Communication and Journalism			
Course Code	**21BSO762**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	02	Exam Hours	03

CLO 1	To introduce students to basic concepts of mass communication and journalism and several up-to-date issues which are widely discussed in the field of mass communication and journalism.
CLO 2	Explain the concepts and process of communication.
CLO 3	Understand the theories and models of communication.
CLO 4	Elucidate News report and Feature writing
CLO 5	Understand the writing for the web.

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 Communication: Concepts and Process

Nature and process of human communication, functions of communication, verbal and non- verbal communication, intra-personal, inter-personal, small group, public and mass communication. Nature and process of mass communication, media of mass communication, characteristics and typology of audiences. Social Functions of Mass Communication, Scope of Mass Communication.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-2 Communication Theories

Authoritarian; Libertarian; Socialistic; social-responsibility; Normative theories; Development media theory; Democratic participation media theory.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-3 Communication Models

Overview of the importance of communication models, Understanding the role of following models in the study of communication: Lasswell, Shannon and Weaver, Osgood, Dance, Schramm, Gerbner, Newcomb, Wesley and Maclean model.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-4 Writing for Print

Basics of writing a news report: Structuring a news report- 5 W's and H, Intro/ Lead, Inverted Pyramid and other news structures, Dateline. Feature writing, book reviews. Opinion and editorial writing.

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Module-5 Writing for the Web

Basics of writing for online media- structure and content
Writing stories for internet, editing and rewriting

Pedagogy	**Chalk and talk/power point presentation:** **Videos/Learning material:** **Self-study:**

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1	Discuss the basics concepts of mass communication and journalism.
CO 2	Understand the communication theories and models.
CO 3	Understand the basics of writing a news report and Feature writing.
CO 4	To be able to write for online media.
CO 5	To be able to write stories for internet and carry out editing and rewriting.

Assessment Details (both CIE and SEE)

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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. McQuail, D., McQuail's Mass Communication Theory, Vistar Publications New Delhi, 2009
2. Baran, J.S. and Dennis K. Davis, Mass Communication Theory: Foundations, Ferment, and Future, Thomson Wadsworth, Noida, 2007
3. Becker, S. L., Discovering Mass Communications, Scott, Foresman, Glenview, 1987
4. Berger, A. A., Essentials of Mass Communication, Sage, New Delhi, 1995
5. McLuhan, M., Understanding Media, Mentor, London, 1980
6. Wright, C. R., Mass Communication and Sociological perspectives, Random House, New York, 1986
7. Kumar, K. J., Mass communication in India, 1995
8. D.R. Williamson, Feature Writing for Newspaper Fiske, J., An introduction to Communication, Routledge, 1990
9. Fiske, J., An introduction to Communication, Routledge, 1990
10. Introduction to Online Journalism: Publishing News and Information by Ronald De Walk.
11. J. J. Astor, Art of Modern Journalism
12. Journalism in the 21st Century: Online Information, Electronic Databases and the News by Tom Koth (Adamantine Press Ltd.)
13. K. M. Srivastava, News Reporting & Editing
14. M. V. Charnley, Reporting
15. M.V. Kamath, Professional Journalism

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=QcnI7o2n2MI
2. https://www.youtube.com/watch?v=QdL6RTaB5qk
3. https://www.youtube.com/watch?v=aSVxsXMdTlw

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

- https://communication.depaul.edu/about/initiatives/center-for-communication-engagement/Pages/varc-lab.aspx