



**Department of Chemistry, School of Basic Sciences, CSJM
University, Kanpur**

Minutes of Meeting of Board of Studies

An online meeting of Board of Studies of Chemistry Department, School of Basic Sciences, was held on 7th July' 2023 at 12:15 pm to modify the syllabus of M.Sc. Chemistry/ M.Sc. Industrial Chemistry, two year (Four Semester) programme. The following members (as approved by the Vice Chancellor, CSJM University) attended the meeting.

1. Prof. Deepak Srivastava, Department of Plastic Technology, HBTU- External Member
2. Dr. Debashis Adhikari, Associate Professor, Dept. of Chemical Sciences, IISER Mohali, Mohali-140306-External Member.
3. Prof. Sudhir Kumar Srivastava, Dean, Science faculty, Department of Chemistry, DAV College, Kanpur- Internal Member
4. Prof. Meet Kamal Dwivedi, Dept. of Chemistry Christ Church P.G. College, Kanpur-208001- Internal Member
5. Dr. B.P. Singh, Department of Chemistry, CSJM University, Kanpur- Internal Member
6. Dr. Rashmi Dubey, Department of Chemistry, CSJM University, Kanpur- Internal Member
7. Dr. Dhananjay Dey, Coordinator, Dept. of Chemistry, CSJM University, Kanpur- internal Member.
8. Prof. R. K. Dwivedi, Director, School of Basic Sciences, CSJM University, Kanpur- Convenor.

Special Invitees:

- 1) Dr. Ratna Shukla, Dept. of Chemistry, CSJM University, Kanpur.
- 2) Dr. P.S. Niranjana, Dept. of Chemistry, CSJM University, Kanpur.
- 3) Dr. Meraj Jafri, Dept. of Chemistry, CSJM University, Kanpur.

Purushkta

Ratna Shukla *P.S. Niranjana* *Meraj Jafri* *10.07.2023*

The syllabus was discussed in detail. Following modifications have been done to our existing M.Sc. NEP implemented syllabus:

1. One unit related to the Indian Knowledge system is included in the Paper first –Inorganic Chemistry- I of the first semester as recommended by the BOS Members.

2. The following courses have been shifted from the second semester to the fourth semester:

Environmental Chemistry

3. The following course has been shifted from semester fourth to third: Advanced organic chemistry

4. Paper name of open elective for other department i.e. “Industrial Applications in Chemistry” has been changed as “Applications of Chemistry” and first unit has been replaced by Medicinal Chemistry.

5. Last semester courses classes can be in online mode and the courses can be taken through MOOC/NPTEL

6. In the last semester the Research Project credit has been increased from 8 to 16.

Students will be doing four-month internship/field work followed by the dissertation, presentation and viva

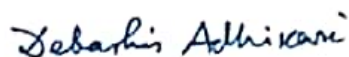
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Department of Chemistry, School of Basic Sciences, CSJM University, Kanpur

Minutes of Meeting of Board of Studies



Prof. Deepak Srivastava,
Dept. of Plastic Technology
HBTU.



Dr. Debashis Adhikari
Associate Professor
Dept. of Chemical Sciences
IISER Mohali



Prof. Sudhir Kumar Srivastava
Dean, Science Faculty
DAV College



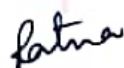
Prof. Meet Kamal
Dept. of Chemistry
Christ Church P.G. College



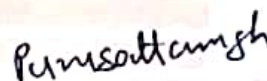
Dr. B.P. Singh
Dept. of Chemistry
CSJM University



Dr. Rashmi Dubey
Dept. of Chemistry
CSJM University.



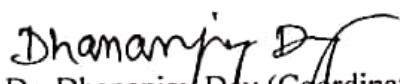
Dr. Ratna Shukla
Dept. of Chemistry
CSJM University.



Dr. P.S. Niranjana
Dept. of Chemistry
CSJM University.



Dr. Meraj Jafri
Dept. of Chemistry
CSJM University.



Dr. Dhananjay Dey (Coordinator)
Dept of Chemistry
CSJM University.



Dr. R.K. Dwivedi (Convenor)
Director, School of Basic Science
CSJM University

**Proposed Syllabus
for
M.Sc. Industrial Chemistry
(NEP)
CHOICE BASED CREDIT SYSTEM**



**Department of Chemistry
CSJM UNIVERSITY, CAMPUS
Kanpur**

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CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.Sc., SUBJECT: Industrial Chemistry

Department of Chemistry
School of Basic Sciences
CSJM University Campus, Kanpur
Semester wise – Distribution of Course
Total Marks- 2100, Total Credit- 98

1Credit = 1hour/week, L= Lecture,
T= Tutorial, P= Practical, Total classes for each paper per semester = 50

1 ST YEAR / 1 ST SEM						
COURSE CODE	TYPE	COURSE TITLE	MIN CREDITS	CIA	ESE	MAX. MARKS
B190701T	CORE I	Inorganic Chemistry	4	25	75	100
B190702T	CORE II	Organic Chemistry	4	25	75	100
B190703T	CORE III	Physical Chemistry	4	25	75	100
B190704T	CORE IV	Analytical Techniques Part A	4	25	75	100
B190705P	PRACTICAL	LAB COURSE I	4	25	75	100
	PROJECT	RESEARCH PROJECT				-
TOTAL			20			500
1 ST YEAR / II ND SEM						
B190801T	CORE V	Research Methodology	4	25	75	100
B190802T	CORE VI	Analytical Techniques Part B	4	25	75	100
B190803T	ANY TWO	1. Polymer Chemistry	4	25	75	100
B190804T	ELECTIVES	2. Soft Materials and Nano composites				
B190805T	TO BE CHOSEN	3. Environmental Chemistry	4	25	75	100
B190806P	PRACTICAL	LAB COURSE II	4	25	75	100
B190807R	PROJECT	RESEARCH PROJECT	8	25	75	100
MINOR ELECTIVE FROM OTHER FACULTY (IN 1 ST YR- 1st/II ND SEM)*			4/5/6	25	75	100
TOTAL			32			700
II ND YEAR / III RD SEM						
B190901T	CORE VII	Sugar and Pulp Chemistry	4	25	75	100
B190902T	CORE VIII	Chemistry of Life	4	25	75	100
B190903T	ANY TWO	1. Environmental Impact Assessment and Wastewater Treatment	4	25	75	100
B190904T	ELECTIVES	2. Natural Products, Cosmetics and Perfumery				
B190905T	TO BE CHOSEN	3. Pharmaceutical Chemistry	4	25	75	100
B190906T		4. Chemistry of Materials, Petrochemicals And Fertilizers				
B190907P	PRACTICAL	LAB COURSE 3	4	25	75	100
	PROJECT	RESEARCH PROJECT				-
TOTAL			20			500
II ND YEAR / IV TH SEM						
B191001T	ANY TWO	1. Food Technology and Agrochemicals				
B191002T	ELECTIVES	2. Essential Oils, Dyes and Paints	5	25	75	100
B191003T	TO BE CHOSEN	3. Waste Management	5	25	75	100
B191004T		4. Green Chemistry				
B191005T		5. Chemical Analysis In Agro, Food, Soap and Detergent Industries and Safety Measures				
B191006R	PROJECT	RESEARCH PROJECT	16	50	150	200
TOTAL			26			400
GRAND TOTAL			98			2100

A *Ratna* *Pshu*



CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.Sc., SUBJECT: Industrial Chemistry

Open elective course for other departments						
B190808T		Applications of Chemistry	4	25	75	100


NOTE:


1. • A Minor Elective from other faculty shall be chosen In 1st Year (Either Ist / IInd Semester) as per availability.
2. The last semester of the master's programme shall comprise of 4 to 6 months of training/ Internship along with two theory papers (to be chosen by students amongst a basket of elective papers).
3. For the II year/IV semester students, the theory classes will be conducted online/offline (hybrid) mode at the university or the credits may be earned via MOOC courses. Accordingly, a list of relevant courses offered in that session and the assigned credits shall be intimated to the students by the MOOC nodal officer and course coordinators.
4. Research projects can be done in the form of Internship/Survey/Fieldwork/Research projects/ Industrial training, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voce.
5. The student will be awarded 25 marks if he publishes a research paper on the topic of a Research Project or Dissertation.


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Department of Chemistry, School of Basic Sciences, CSJM University, Kanpur

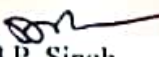
BOS Meeting

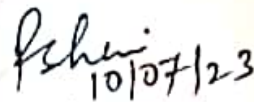

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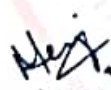

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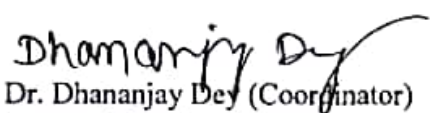

Dr. B.P. Singh
Dept. of Chemistry
CSJM University



10/07/23
Dr. Rashmi Dubey
Dept. of Chemistry
CSJM University.


Dr. Ratna Shukla
Dept. of Chemistry
CSJM University.


Dr. P.S. Nirajan
Dept. of Chemistry
CSJM University.


10.07.2023
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Dept. of Chemistry
CSJM University.


Dr. Dhananjay Dey (Coordinator)
Dept of Chemistry
CSJM University.


Dr. R.K. Dwivedi (Convenor)
Director, School of Basic Science
CSJM University

M.Sc. Industrial Chemistry
Syllabus
Semester I

Paper I: B190701T
Inorganic Chemistry

Credits: 4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Acquire the knowledge and have the ability to describe the bonding, MO theory, and molecular term symbols of inorganic molecules & ions.
CO2	Understand the metal-ligand bonding, crystal field theory, spectrochemical series, and Jahn teller effect.
CO3	Understand the fundamentals of electronic spectroscopy, Orgel and Tanabe-Sugano diagrams for transition metal complexes
CO4	To learn about the formation and stability of metal complexes and their determination
CO5	Understand the chemistry of inert & labile complexes and the substitution reaction of inorganic complexes. Mechanistic aspects of different types of reaction of metal complexes in solution.
CO6	Learn the ancient history of indian chemistry, use of chemistry in medicine and Metallurgy.

Course details:

Unit 1: Indian Knowledge System

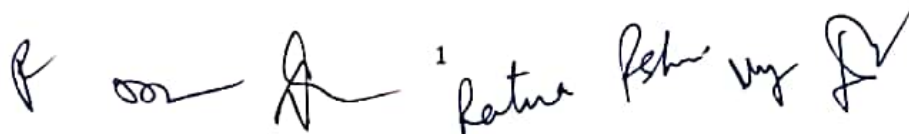
The ancient history of Indian chemistry, Various treatises on Chemistry, the use of chemistry in medicines, Metallurgy, Use of chemistry for occult practices.

Unit 2: Chemical Bonding

Walsh diagram; Evidence of MO pictures from spectra and reactivity; Molecular term symbols (ground & excited state). $p\pi - d\pi$ bonding, $3C-2e$ bonding, μ -bond, δ -bond.

Unit 3: Metal ligand bonding & electronic spectra

Crystal field theory, Splitting of d orbitals .Crystal field stabilization energies in weak field and strong field environments, spectrochemical series and Jahn-Teller effects on energy levels spin-orbit coupling, quenching of orbital contribution,. Spectroscopic


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ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes ($d^1 - d^9$ states), calculations of Dq , B and β parameters, charge transfer spectra

Unit 4: Metal Ligand Equilibrium

Equilibria Stability of mononuclear, polynuclear mixed ligand complexes in solution, Stepwise and overall formation constants, trends in stepwise constants factors affecting the stability of metal complexes – chelate effect, determination of stability constants.

Unit 5: Reaction Mechanism

Inert and labile complexes-Explanation of lability on the basis of CFSE. Substitution reactions (dissociative, associative, I_d & I_a mechanisms) in square planar, tetrahedral and octahedral geometries with special reference to d^n ion complexes.

Recommended Text Books

1. B. Seal ,Ancient Indian Sciences , Motilal Banarsidas, India, 2016.
2. Melissa Stewart, Science in Ancient India, Franklin Watts, 1999.
3. D. F. Shriver, P. W. Atkins and C. H. Langford, *Inorganic Chemistry*, Oxford University Press, New York ,1990.
4. B. Douglas, D. McDaniel and J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd Edn, John Wiley and Sons, Inc., New York ,2001.
5. J. E. Huheey, E. A. Keiter and R. L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Edn, Harper Collins College Publishers, New York, 1993.
6. M. Driess and H. Noth (Eds.), *Molecular Clusters of the Main Group Elements*, Wiley-VCH, Weinheim, 2004.
7. O. Kahn, *Molecular Magnetism*, VCH, New York, 1993.
8. P. Braunstein, L. A. Oro and P. R. Raithby (Eds.), *Metal Clusters in Chemistry*, Wiley-VCH, Weinheim, 1999.
9. M. H. Chisholm (Ed.), *Early Transition Metal Clusters with π -Donor Ligands*, VCH, New York, 1995.
10. J. D. Lee, *Concise Inorganic Chemistry*, Chapman and Hall, London, 1991.

Recommended Reference Books:

1. Catherine Housecroft, , A.G. Sharp, *Inorganic Chemistry*, 5th ed, ,Pearson ,2018.
2. T. P. Fehlner, J. -F. Halet and J. -Y. Saillard, *Molecular Clusters — A Bridge to Solid State Chemistry*, Cambridge University Press, Cambridge, 2007.
3. R.L. Johnston, *Atomic and Molecular Clusters*, CRC Press, 2002.

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Semester I

Paper II: B190702T

Organic Chemistry

Credits:4

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Learn the concept of aromaticity & different types of reactive intermediates.
CO2	Learn modern synthetic methods for the preparation of heterocyclic compounds and their structural elucidation.
CO3	Learn the concept of thermal & photochemical reactions.
CO4	Learn the different types of organometallic compounds and their uses in organic synthesis
CO5	Learn the different types of rearrangement reactions in organic synthesis.

Course details:

Unit 1: Reactive intermediates & Aromaticity

General methods of generation, detection, stability, reactivity and structure of the intermediates, Classical and non-classical carbocations and carbanions; radicals, radical cations, radical anions, carbenes, arynes and nitrenes, Aromaticity: Concept of aromaticity, benzenoid and non-benzenoid aromatic compounds.

Unit 2: Pericyclic Reactions

Cycloaddition, Electrocyclic, Sigmatropic and Cheletropic reactions.

Unit 3: Heterocyclic synthesis

Introduction, synthesis and properties of Thiophene, Furan, Pyridine, Pyrrole, Quinoline and Indole.

Unit 4: Reagents in Organic synthesis

Grignard reagent, NaBH_4 , LiAlH_4 , Gilman's reagents, Lithium dimethyl cuprate, DDQ, oxidising agents: SeO_2 .

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Unit 5: Rearrangement and Reactions

Pinacol/Pinacolone Rearrangement, Wagner-Meerwein Rearrangement, Wolff Rearrangement, Hofmann Rearrangement, Curtius Reaction, Lossen Rearrangement, Schmidt Reaction, Beckmann Rearrangement, Favorskii Rearrangement and Claisen Rearrangements, Aldol Reaction, Perkin Reaction, Stobbe Reaction, Reimer-Tiemann Reactions.

Recommended Text Books:

1. Carey, F.A. & Sundberg, R.J. *Advanced Organic Chemistry, Parts A & B*, Plenum: U.S. 2004.
2. Carruthers, W. *Modern methods of Organic Synthesis*, Cambridge University Press, 1971.
3. Warren, S. *Organic Synthesis: The Disconnection Approach*, John Wiley & Sons, 1984.
4. J. March. *Advanced Organic Chemistry, Reaction Mechanisms and Structure*, John Wiley, 2015
5. W. Carruthers. *Some Modern Methods of Organic Synthesis*, Cambridge University Press, 2012.
6. I. L. Finar, *Organic Chemistry*, ELBS, U.K, 2002.
7. Morrison R.T. & Boyd R. N.; *Organic Chemistry*, Prentice Hall India, 2010.

Recommended Reference Books:

1. Pierre Vogel, Robert H. Grubbs, *Organic Chemistry*, Wiley, 2019.
2. Clayden, J.; *Organic Chemistry*, Oxford University Press, 2012.
3. Klein David R., *Organic Chemistry*, 5th ed, Wiley, 2019.

Sebarshi Adhikari
Manal
A K
R. P. Saha
Ratna M
R

Semester I

Paper III: B190703T

Physical Chemistry

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Understand concept of kinetics of reaction and theories related to it
CO2	Gain knowledge about rate of reaction , chain reactions , catalysis and enzyme kinetics
CO3	Concept of electrochemistry and electrochemical reactions
CO4	Mechanism related to corrosion and corrosion preventive methods
CO5	Concept of Colloidal chemistry, surface chemistry and their various applications

Course details:

Unit I

Colloids and Surfaces

Introduction, types of colloidal system, Characterization of colloidal particles, emulsions, application of colloids in different industries (agricultural, chemical, pharmaceutical, petroleum recovery, coating, painting, food and cosmetics etc.)

Unit II

Reaction dynamics

Molecularity and order of reaction, Integrated rate equations, temperature dependent of reaction rate, activation energy, methods of determining reaction rates, complex reactions- chain reactions , reversible and irreversible reactions, Catalysed and Enzyme catalysed reactions, Heat of reaction and Equilibrium constant from thermodynamics.

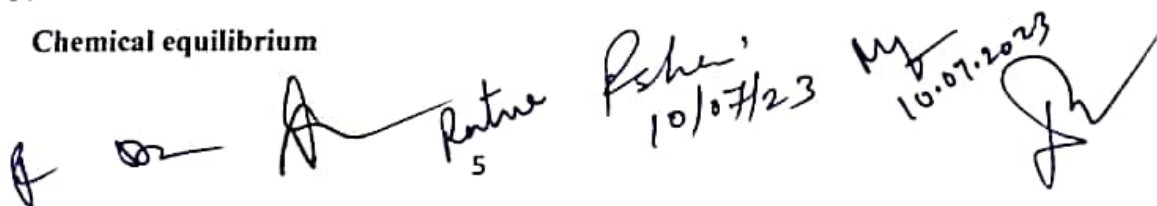
Unit III

Electrochemistry

Electrochemistry of solution ,electro catalysis, Deby- Huckel theory for activity coefficient of electrolytic solution, determination of activity coefficient, ionic strength, Donnan –membrane equilibrium, , Electrochemical and Concentration cells, Corrosion: classification, factors affecting corrosion and prevention , Polarization , Overvoltage , Decomposition voltage.

Unit IV

Chemical equilibrium

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Introduction, Law of chemical equilibrium, Lechateliers principle, application, equilibrium constant from thermodynamics consideration, Concepts of acids and bases, pH and pOH of solutions, Buffer solution, Solubility product.

Recommended Text Books:

1. K.J Laidler *Chemical kinetics*, 3rd Edn. Harper Internationa, 1987.
2. Bockris, J.M, and Reddy A.K.N. . *Electrochemistry*, Vol. 1 & 2, Plenum, 2004
3. Kapoor K.L., *Textbook of Physical chemistry*, Vol. 5, Mc Graw Hill India, 2015.,
4. P.W. Atkins, *Physical Chemistry*, 5th ed., Oxford Univ. Press, 2018.

Recommended Reference Books:

1. Silbey, Robert J., *Physical Chemistry*, 4th ed., Wiley, 2004.
2. Ira N. Levine, *Physical Chemistry*, McGraw Hill, 2008.
3. Langdon J, *Physical Chemistry*, NY Research Press, 2018.

Sebarhis Adhikari
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Pshini
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Semester I

Paper IV: B190704T

Analytical Techniques Part A

Credits:4

Course outcomes: After completion of this course the students will be able to:

CO1	Purification, separation and identification of compounds need special techniques.
CO2	Knowledge of solvent extraction.
CO3	Basics and application of electron microscopies like SEM and TEM
CO4	Separation of mixtures using different chromatographic Techniques.

Course details:

Unit I

Basics of Filtration processes

Introduction to unit processes and unit operations, Screening, Mixing, Coagulation and Flocculation Sedimentation: Type of settling, Filtration for wastewater treatment. Type of filters - rapid sand filter, slow sand filter, high rate filter, pressure filter. Gravitational settling, Centrifugal impaction, Inertial impaction, Diffusion, Electrostatic precipitation,

Unit II

Electron Microscopy

Introduction, Principle and Instrumentation of SEM and TEM.

Unit III

Separation Techniques

Solvent extraction (liquid-liquid extraction), general principles, relationship between extraction and distribution coefficient, distribution ratio, multiple extractions, extraction of metal organic complexes and ion association complexes.

Unit IV

Chromatographic Techniques

Classification, basic principles, theory of chromatography, Ion-exchange chromatography: ion exchange process, synthesis and structure of ion-exchange resin, resolution, retention parameters, ion-exchange capacity and separation of lanthanides; Paper and thin-layer chromatography, various techniques of development, visualization and evaluation of chromatograms, Liquid-gas chromatography, HPLC: introduction, methodology, instrumentation and industrial application.

Handwritten signatures and text:
A. K. Patra, P. K. Mishra, P. K. Mishra

Recommended Text Books:

1. Bassette and co-workers, *Vogel's Textbook of Quantitative Chemical Analysis*, , Longman Group UK, 1989.
2. Willard M.H., Merrit, L.L., Dean J.A., Settle, F.A *Instrumental methods of analysis*, 7th ed., United States: N. P., 1988.
3. Fifield F.W., Kaley D., *Principles and practice of analytical chemistry*, Blackie Academic and Professional, 4th Edition, 1995.

Recommended Reference Books:

1. Braithwaite A., Smith F.J., *Chromatographic Methods*, 5th ed., Kluwer Academic Publishers, 2000.
2. Kuo J., *Electron Microscopy*, Springer Protocols, 2014.
3. Schweitzer Philip A. *Handbook of Separation Techniques*, 3rd ed., Mc Graw Hill Professional, 1997.

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Semester I

Paper V: B190705P

Lab Course I

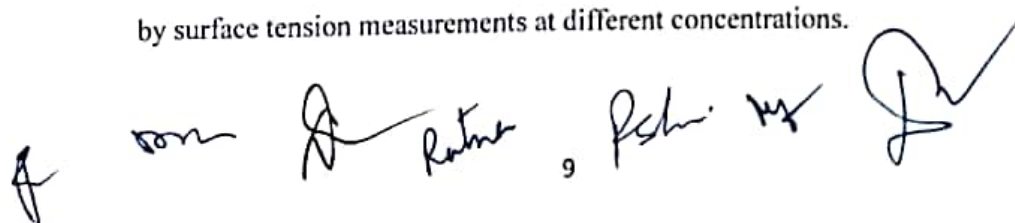
Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Able to determine the hardness, alkalinity/acidity and inorganic ions in water
CO2	Purification and distillation of water
CO3	Chromatographic separations by TLC, Paper and Column
CO4	Conduct metric titrations and CMC determination using Conductivity meter
CO5	Physical parameter determination Like pH, Viscosity, Optical activity, Melting Point etc. using various equipment

Course details:

1. Determination of total acidity/ alkalinity of given water sample.
2. To determine the total hardness of water.
3. Determination of chloride content of a water sample by Mohr's method.
4. Purification and distillation of tap water / organic solvent.
5. Preparation of phenol formaldehyde resin.
6. To separate the given organic compounds mixture by TLC / Paper chromatography.
7. To separate the different organic compounds by column chromatography.
8. To Prepare 2, 4, 6 – tribromo aniline.
9. To prepare phthalamide from phthalic anhydride.
10. To determine the relative viscosities of given liquids by Ostwald viscometer.
11. Determination of brix, specific gravity and pH of molasses.
12. Determination of total reducing sugar in molasses by Lane & Eynon method.
13. Determination of RS Brix / Pol/ Purity and RS (reducing sugar) in sugar.
14. Conductometric titrations of different acid-base mixtures.
15. Determination of CMC (critical micelle concentration) of a surfactant in water by surface tension measurements at different concentrations.



Recommended Text Books:

1. Wagh G.S , *Experimental Methods for Water Analysis*, Nirali Prakashan, 2017.
2. Fresenius W., Quentin K.E., *Water Analysis: A Practical Guide to Physico-Chemical, Chemical, and Microbiological Water Examination and Quality Assurance* , Springer Verlag, 1988.
3. Robert Brent, Lazarus Harry, *A Golden book of Chemistry Experiment*, Createspace Independent Pub, 2015.

Recommended Reference Books:

1. Jahangirdar, *Experiments in Chemistry*, Himalaya Pub. House, New Delhi, 2014.
2. H. Clark, *Handbook of Organic Analysis*, Edward Arnold, 1946.
3. A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., John Willey (1996).



Semester II

Paper VI: B190801T

Credits:4

Research Methodology, Statistical Techniques and Computer Applications

Course outcomes: After completion of this course the students will be able to:

CO1	Identify and discuss the issues.
CO2	Concepts salient to the research process
CO3	The concept of data collection analysis
CO4	Reporting, selecting an appropriate research design and implementing research project.
CO5	To apply parametric and non-parametric Tests

Course details:

Unit I

Basics of Research Methodology

Introduction to research methodology and design, research definition, selection and formulation of research problem, types of research, formulation of hypothesis, review of literature, types of data- primary, secondary and tertiary data, research process, survey and census

Unit II

Sampling Techniques

Population and sample, Sampling theory and techniques, advantages and limitations of sampling, data collection, coding and tabulation, probability and non-probability sampling techniques, field research methodology

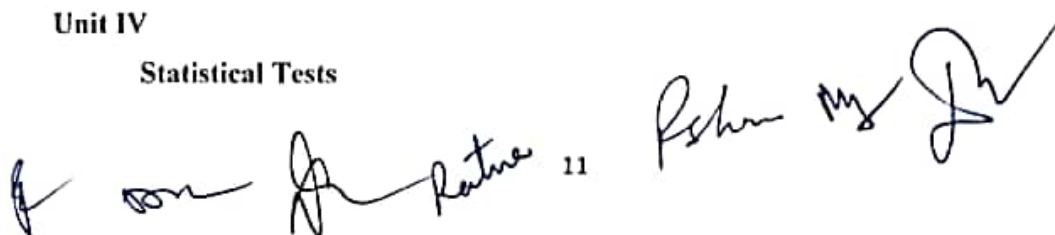
Unit III

Central Tendency

Measures of central tendency: mean, mode, median, data distribution, Chebyshev's theorem, variance, standard deviation, standard error, ratio and proportion, precision and accuracy, correlation, rank correlation, significance level, t-test, paired t-test

Unit IV

Statistical Tests

 11

Non-parametric tests: Chi square test for goodness of fit and relationship between two variables, Analysis of variance, F-test, Data presentation: Charts, graphs

Unit V

Fundamentals of Computer Organization and Applications

Fundamentals of computers, Computer organization, binary numbers, flow chart, Use of data analysis tools and text editors, power point presentations, different templates for report writing and dissertations, use of computers in report preparation and presentation

Recommended Text Books:

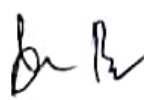
1. S.P.Gupta, *Statistical Methods*, Sultan Chand and Sons, 2012.
2. C.P.Kothari, *Research Methodology Methods and Techniques*, New Age international Publishers, 2004.
3. B.N.Gupta, *Statistics Theory and Practice*, SBPD Publications, 2021.
4. Santosh Gupta *Research Methodology Methods and statistical Techniques*, Deep & Deep Publications, 2010.
5. Reddy and Rao, *Research Methodology and statistical Measures*, Rellance publishing House, 2012.
6. Sharma & Jain, *Research Methodology*, Shree Publisher and Distributers, 2009.

Recommended Reference Books:

1. Mishra S.B., Alok Shashi, *Handbook of Research Methodology*, Edu creation, 2017.
2. Achari Prakash Divakaran, *Research Methodology*, Horizon Books, 2014.
3. Ranonyai Jerry, *Research Methodology*, 2021.

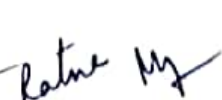


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Semester II

Paper VII : B190802T

Analytical Techniques Part B

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Basic concepts of IR, UV-Visible, NMR and Mass Spectroscopy
CO2	Apply the learned concept of IR, UV-Visible, NMR and Mass Spectroscopy in various fields
CO3	Concept behind the Polarography and its application in analysis of various kinds of organic, inorganic and biological materials
CO4	The principal, Basic concept and application of Electron Spin Resonance Spectroscopy in various areas
CO5	Bragg's law, its relation to crystal structure, different methods on interpretation and application in various fields

Course details:

Unit I

Spectroscopic Techniques

Introduction, Principles, Instrumentation and Application of IR, UV- Visible, NMR and Mass spectroscopy

Unit II

Electron Spin Resonance

Introduction, Technique, Instrumentation and Applications of ESR.

Unit III

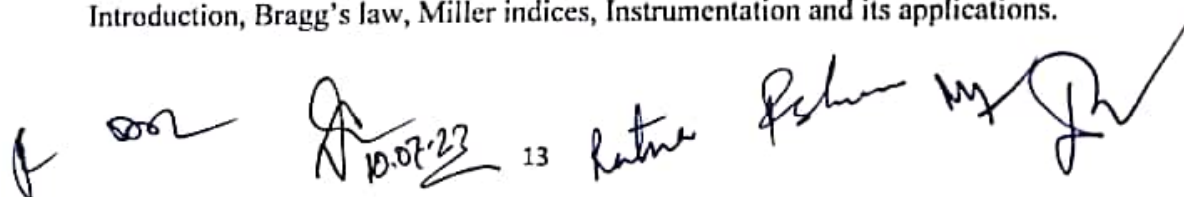
Polarography

Origin of polarography, Current-voltage relationship, Theory of polarographic waves (DC and sampled D polarograms), Instrumentation, Qualitative and Quantitative applications.

Unit IV

X-ray Diffraction

Introduction, Bragg's law, Miller indices, Instrumentation and its applications.

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Recommended Text Books:

1. Hollas, J. M. *Modern Spectroscopy* 4th Ed., John Wiley & Sons, 2004.
2. Kemp, W. *Organic Spectroscopy* 3rd Ed., W. H. Freeman & Co., 1991.
3. Silverstein, R. M., Bassler, G. C. & Morrill, T. C. *Spectroscopic Identification of Organic Compound*, John Wiley & Sons, 1981.
4. Ebsworth, E. A. O. *Structural Methods in Inorganic Chemistry* Blackwell Scientific Publications, 1991.
5. Drago, R. S. *Physical Methods in Chemistry*, W.B. Saunders Co., U.K., 1977.

Recommended Reference Books:

1. Vishwanathan K.S., Gopalan R., *Analytical Methods*, Orient Blackswan Pvt. Ltd., 2018.
2. Hamif M.A., Nadeem R., Ansari T.M., *A Smart book of Analytical Chemistry: Advanced Instrumental Techniques*, 2021.
3. Trimm Harold H., *Analytical Chemistry Methods and Applications*, Apple Academic Press, 2012.
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Semester II

Paper VIII : Elective 01

Paper IX: Elective 02

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Semester II

Elective Papers

Elective201: B190803T

Polymer Chemistry

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	The basics and different kind of polymers with their properties.
CO2	The concept of molecular weight and distribution
CO3	Difference between crystalline melting temperature and glass transition temperature with variation in properties of polymers
CO4	The effect of factors such as polymer structure, molecular weight, branching and diluents on crystallinity, mechanical properties.
CO5	Techniques of polymer processing

Course details:

Unit I

Basic Concepts, Kinetics and Rheology

Polymers and their classification, nomenclature, Types of Polymerization: condensation, addition (free radical, cationic and anionic), copolymerization, Kinetics, Polydispersity and Molecular weight distribution, practical significance and measurement of molecular weight

Unit II

Thermodynamics and Transition properties of polymer



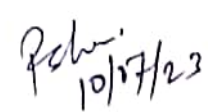

Glass transition temperature in polymers (T_g), Melt transition (T_m), factors influencing glass transition temperature, relationship between T_g and T_m .

Process of Polymer dissolution, The Flory-Huggins Theory of polymer dissolution

Unit III

Polymer Processing

Plastics, Elastomers and Fibres, Processing techniques: calendaring, casting, moulding, thermoforming, foaming, reinforcing and fiber spinning, film and laminates. Manufacturing of Thermocol.

  Lecture 16  10/17/23 

Unit IV

Commercially Important Polymers and Applications

Commercially important Thermosetting and Thermoplastic polymers, Resins: Phenol- Formaldehyde resins, Urea- Formaldehyde resins, Epoxy resins, Melamine- Formaldehyde resins. Biomedical polymers, electrically conducting polymers, smart polymers

Recommended Text Books:

1. Fried JR, *Polymer Science and Technology*, Prentice-Hall of India, 2000.
2. Billmeyer F.W., *Textbook of Polymer Science*, Wiley-Interscience: New York, 1984.
3. DeGennes, P.G. *Scaling Concepts in Polymer Physics*, Cornell University Press, 1979.
4. Young R.J. & Lovell, P.A., *Introduction to Polymers* 2nd Ed., Chapman & Hall, 1991.
5. Bhatnagar M.S., *A Textbook Of Polymer Chemistry*, s Chand, 2012.

Recommended Reference Books:

1. Calhoun Allison, Peacock A J., *Polymer Chemistry: Properties and Applications*, Hanser Pub Inc., 2006.
2. Lodge T.P., Hiemenz P.C., *Polymer Chemistry*, 3rd ed., CRC Press, 2020.
3. Carraher Charles E. . *polymer Chemistry*, 6th ed., Marcel Dekker Inc. New York, 2003.

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Semester II

Elective 202: B190804T

Soft Materials and Nanocomposites

Credit 4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Acquire the knowledge and have the ability to describe the liquid crystals, their behaviour, orientation, type and applications.
CO2	Understand the soft materials, thin films, their preparation techniques, growth techniques and applications.
CO3	Understand the fundamentals of organic solids and fullerenes and its applications.
CO4	Learn about nanocomposites, their synthetic methods for synthesis and application in drug delivery system.

Course details:

UNIT I

Liquid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientation, order nematic & smectic mesophases, nematic transition & clearing temperature-homotropic, planer & schlieren textures, twisted nematic, chiral nematic, molecular arrangement in smectic A & Smectic B phases, optical properties of liquid crystals, Dielectric susceptibility & dielectric constants, Lyotropic phases & their description or ordering in liquid crystals.

UNIT II

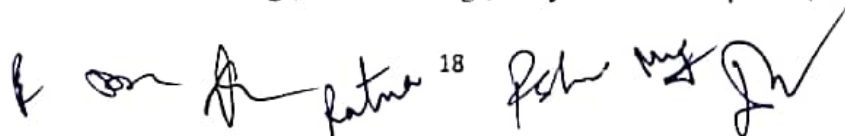
Soft Materials: Thin Films and Langmuir-Blodgett Films, Preparation techniques, vaporation/sputtering, chemical process, MOCVD, sol-gel etc. growth technique, photolithography, properties and applications of thin and L-B films.

UNIT III

Organic Solids and Fullerenes: Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes: doped fullerenes as superconductors.

UNIT IV

Nanocomposites: Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity. Synthetic methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; DLC coatings; Polymer nanocomposites; Thin film



nanocomposites; Applications of nanocomposites in drug delivery.

Recommended Text Books:

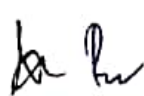
1. Callister W D., *Material science and Engineering*, , 10th Ed. , Wiley, 2018.
2. West A R. *Solid State Chemistry*, John Wiley, 2014.
3. Rao C N R. *Modern Prospective in Solid State Chemistry*, Springer, 1970.
4. Bahadur P and N.V Shastry, *Narosa Principles of Polymer Science*, , New Delhi, 2000.
5. *Polymer Science and Engineering*, D.J.Williams, Prentice Hall Inc, New Jersey, 1971.
6. *Theory and Basics of Polymer Science*, F.W. Billmeyer, John Wiley & Sons, NY, 1984
7. Ajayan P.M, Schadler L.S. and Braun P.V., *Nanocomposite Science & Technology* Wiley VCH GmbH Co., 2003.
8. Chatopadhyaya K.K. and Banerjee A.N, *Introduction to Nanoscience and Nanotechnology*, Prentice Hall India Learning Private Limited, 2009.
9. Rao C.N.R., Muller A. and. Cheetham A.K. *The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vol-I.*, Wiley VCH Verlag GmbH Co. KGaA, 2004.

Recommended Text Books:

1. Reddy B., *Advances in Nanocomposites*, IntechOpen, 2011.
2. Kharissova O. V., Martinez Leticia Myriam Torres, Kharisov B.I, *Handbook of Nanomaterials and Composites*, Springer Cham, 2021.
3. Ditcher John R., Marangoni A.G., *Soft Material: Structure and Dynamics*, CRC Press, 2004.



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Semester II

Elective 203: B190805T

Environmental Chemistry

Credits:4

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
CO2	Recognize different types of toxic substances & responses and analyze toxicological information.
CO3	Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
CO4	Describe water purification and waste treatment processes and the practical chemistry involved.
CO5	Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.

UNIT I

Introduction to Environmental Chemistry: Concept and scope of environmental chemistry, Environmental terminology and nomenclatures, Environmental segments, The natural cycles of environment (Hydrological, Oxygen, Nitrogen)

UNIT II

Atmosphere: Regions of the atmosphere, Reactions in atmospheric chemistry, Earth's radiation balance, Particles, ion and radicals in atmosphere; Chemistry of ozone layer.

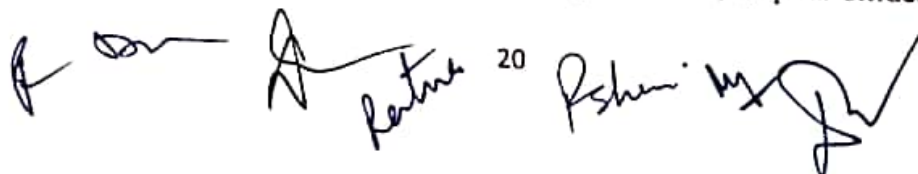
UNIT III

Hydrosphere and Lithosphere:Hydrosphere: Complexation in natural water and waste-water, Micro-organisms in aquatic chemical reactions, Eutrophication, Microbiology mediated redox reactions.

Lithosphere: Inorganic and organic components in soil, acid-base and ion-exchange reactions in soil, micro and macro nutrients, nitrogen pathways and N P K in soil.

UNIT IV

Chemical Toxicology:Toxic chemicals in the environments, Impact of toxic chemicals onenzymes,Biochemical effects of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur oxides.

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Semester II

Paper X: B190806P

Lab Course II

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to;

CO1	Isolation of different compounds(Caffeine and Lycopene) from plants
CO2	Estimation of Casein , acidity of provided fruit, identification of DNA, acetic acid in vinegar
CO3	Able to determine the acid value of oil, argemone oil in mustard oil, non-volatile extract of spices, salt % in curry powder
CO4	Enzyme catalysis using UV-Visible spectrophotometer, CO ₂ determination in water sample
CO5	Physical parameter determination such as density, surface tension etc. with the help of various equipment

Course details:

1. Isolation of caffeine from tea leaves.
2. Isolation of lycopene from tomato.
3. Estimation of casein in milk.
4. Determination of density of given liquid using pycnometer.
5. To determine the surface tension of given liquid by stalagmometer.
6. Determination of free CO₂ in given water.
7. Determination of dissolution of given Caplet or tablet.
8. To determine the amount of acetic acid present in a given sample of vinegar.
9. To prepare calcium stearate from stearic acid.
10. To determine the acidity of fruit provided.
11. To study the degradation of polymers through viscosity measurement (Ostwald viscometer).
12. To determine enzyme catalysis using UV-Visible spectrophotometer.
13. Extraction and identification of DNA from green peas and onions.
14. To determine the acid value of various vegetable oils.
15. To determine the non-volatile extracts of spices.
16. Determination of salt percentage in curry powder.
17. Determination of Argemone oil in mustard oil.

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Recommended Text books:

1. Ahluwalia V.K., *Comprehensive Experimental Chemistry*, Newage Publishers, 1997.
2. Halpern A., McBane G., *Experimental Chemistry*, 3rd Ed., W H Freeman, 2006.
3. Fresenius W., Quentin K.E., *Water Analysis: A Practical Guide to Physico-Chemical, Chemical, and Microbiological Water Examination and Quality Assurance*, Springer Verlag, 1988.
4. Robert Brent, Lazarus Harry, *A Golden book of Chemistry Experiment*, Createspace Independent Pub, 2015.

Recommended Reference Books:

1. Jahangirdar, *Experiments in Chemistry*, Himalaya Pub. House, New Delhi, 2014
2. H. Clark, *Handbook of Organic Analysis*, Edward Arnold, 1946.
3. Baruah J.B., Gogoi Parikshit, *Foundations of Experiments*, Pharmamed Press, 2018.
4. A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., John Willey (1996).
5. Signorelli James, *Chemistry Experiments*, Trafford Publishing, 2014.



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Semester II

Paper XI : MINOR ELECTIVE FROM OTHER FACULTY

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Semester II

Paper XII: B190807R

Credit 8

Research Project/ Industrial Training and Seminar I

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Provide comprehensive learning platform to students where they can enhance their employ ability skills and become job ready along with real corporate exposure.
CO2	Enhance knowledge in one particular technology.
CO3	provide learners hands on practice within a real job situation.
CO4	Ability to communicate efficiently.

Course Details:

Minimum 2-3 weeks training at an industry during summer

Report to be submitted after training.

Presentation of work done and things learnt at training in the coming semester.

It includes industrial training, seminar and project work

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Semester III

Paper XIII: B190901T

Sugar and Pulp Chemistry

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	The basic chemistry of sugars and concepts of sugar industry
CO2	The techniques used for the sugar manufacturing like, extraction, clarification, and concentration of sugarcane juice
CO3	Sugar extraction from alternate sources like sugarbeet
CO4	Industrial application of fermentation like production of alcohol from different sources
CO5	Basics of pulp and paper chemistry

Course details:

Unit I

Sugar Manufacturing

General idea about sugar factory, Introduction to carbonation and sulphitation processes and their comparison.

Carbonation process: composition of juice, extraction, clarification, sedimentation, evaporation and crystallization in brief. Sulphitation process: single and double sulphitation

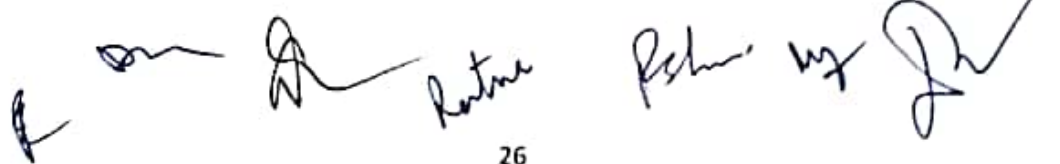
Unit II

Chemical Treatment of Byproducts

i. Molasses: composition of molasses, alcoholic fermentation of molasses - manufacture of industrial alcohol, power alcohol, absolute alcohol, rectified spirit, denatured spirit.

ii. Bagasse : characteristics of bagasse, pith and fibre, production of ferfural, production of bio-gas and bio-manure, use of bagasse as fuel and cattle food, production of pulp, paper, fibre board, card board, particle board from Bagasse..

iii. Colour: measurement of colour of sugar solution by ICUMSA (International Commission for Uniform Methods of Sugar Analysis) protocol.



Unit III

Distillery Industry

Fermentation: Types of fermentation, role of microorganisms and other conditions, production of grain spirit, production of alcohol from alternate feedstock viz. sugarbeet, cassava and lignocellulose.

Unit IV

Pulp and Paper Industry:

Pulp and paper industry in India, raw materials, classification and properties of fibrous materials, mechanical and chemical (acid, neutral and alkaline) pulping process, Lignin as a chemical raw material.

Recommended Text Books

1. R.B.L. Mathur, *Handbook of Cane Sugar Technology*, Oxford and Ibh., 1970.
2. D.P. Kulkarni *Cane Sugar Manufacture in India*, 1996.
3. E. Heogot *Handbook of Cane Sugar Engineering*, 3rd ed., Elsevier Science Ltd., 1986
4. Peter Rein *Cane Sugar Engineering*, 2nd ed., 2018
5. Unde Kofler L.A. *Industrial Fermentations*, Chemical Pub. Co., Newyork, 1954.
6. Monika E. K. Goran Gellerstedt, Gunnar Heneriksson, *Pulp and Paper chemistry and Technology*, 2009.

Recommended Reference Books:

1. Jenkins G.H. , *Introduction To Cane Sugar Technology*, Elsevier, 1966.
2. Pieter Honig, *Principles of Sugar Technology*, Elsevier, 1953.
3. Bajpai Pratima, Biermann's HANdbook of Pulp and Paper, Vol. 1, Elsevier, 2018.

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Semester III

Paper XIV :B190902T

Chemistry of life

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Basic concept related to cell biology. Describe biomolecules and their functions
CO2	Concepts of nuclei acid, synthesis, transmission and expressing hereditary information
CO3	Proteins, its synthesis and their function
CO4	Understand the nature of lipids, assembly in membranes and applications
CO5	Knowledge related to enzymes, classification and their various applications

Course details:

Unit I

Molecules and Life

Introduction, History, Cell theory, Cell biology and their biological science, Biomolecules, chemical and biological evolution, level of organization.

Unit II

Nucleic Acids

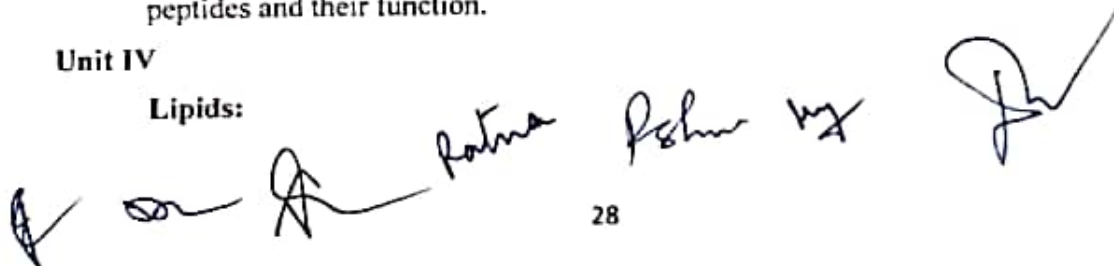
Introduction, Nucleic Acids: Nucleosides, Nucleotides, Biological importance of nucleotides and pentose sugar structure and properties of uracil, thymine, guanine, cytosine, adenine. Structures of different forms of RNA, DNA (Watson and Crick Model), Concept of gene, Nucleic acid metabolism – central dogma, features of genetic code, A brief introduction of replication, transcription and translation.

Unit III

Proteins and peptides : Classification, Level of organization and biological functions. **Peptides**: Structure, Nomenclature, Classification, sequencing of peptides and their function.

Unit IV

Lipids:



Fatty acids, essential fatty acids, structure and function , Role of lipid aggregates
- micelles ,bilayers, liposomes and their possible biological functions,
Lipid metabolism - oxidation of fatty acids and its significance.

Enzymes : History, nomenclature, classification, general characteristics,
difference between inorganic catalyst and enzyme, Theories of enzyme action,
Enzyme kinetics (Michael's Menton equation and its modification). Mechanism
of action -factors contributing the catalytic efficiency, Enzyme Inhibition:
Reversible and irreversible.


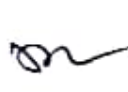
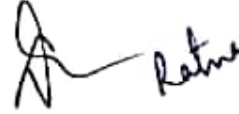


Recommended Text Books:

- 1 D. Robertis, *CELL and Molecular Biology* ,2017
- 2 Albertis, *Molecular Biology of Cell* ,4th ed., 2002.
- 3 U. Srayamarayana and U. Chakrapani *Biochemistry*,4th ed., Elsevier & Books and Allied (P) Ltd. 2002.
- 4 Stryer L. , *Biochemistry*, 4th ed., Freeman, 1999.
- 5 Well J.H. , *Outline of Biochemistry, Conn and Stumpf Biochemistry*, Wiley, 2006.
- 6 Bondensky & Bondensky *Peptide synthesis*.
- 7 J.L.Jain, Sunjay.Jain and Nitin Jain, *Fundamental of Biochemistry* , S Chand & Co Ltd.,2016.

Recommended Reference Books:

1. Lehninger, *Biochemistry*, Kalyani Publishers, 2021.
2. Bruce Alberts, Karen Hopkin Alexander Johnson David Morgan ,*Essential Cell Biology*,6th ed.,W.W. Norton & Company, 2022.
3. Rastogi V.B., *Zubey Priciples of Biochemistry*, Meditech,2020



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Semester III

Paper XV: Elective 01

Paper XVI: Elective 02

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Semester III

Elective Papers

Elective 301: B190903T

Environmental Impact Assessment and Wastewater Treatment *Credit 4*

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	About the environmental science, biodiversity and ecosystem.
CO2	Conventional and non-conventional energy resource, global warming, ozone layer depletion, water pollution and air pollution
CO3	BOD, COD, DO, TDS, concept of hard water and soft water.
CO4	Fundamentals of unit operations for waste water treatment and disinfection.
CO5	Advanced treatment operations, reverse osmosis, electro dialysis and ion exchange method

Course details:

Unit I

National Environmental Policy: The Environment Protection Act 1986. Objectives of Anti-pollution Acts. National Policy on EIA and Regulatory Framework: Rule, regulations of central and State Government. Central and State pollution control boards for Safeguard for Environmental Protection. Rules, regulations and guidelines given for disposal of hazardous waste, municipal solid waste and bio-medical waste.

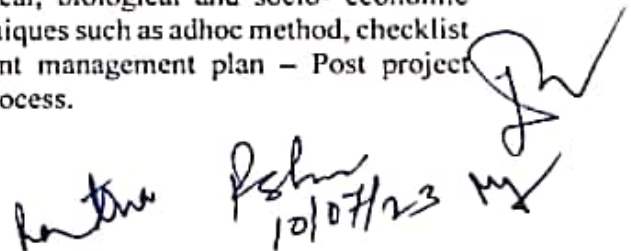
Unit II

Basics of Sustainable Development: Scope and Importance of environmental studies, Need for public awareness, Segments of environment, biodiversities: Genetic diversity, Species diversity, Ecosystem diversity, Landscape diversity, Causes of pollution and detrimental effects, Eco systems- Types of ecosystems, energy flow in an ecosystem, Balanced ecosystem.

Unit III

Methodologies for Impact Assessment: Baseline collection of data, Significant impacts, Assessment of impacts of physical, biological and socio- economic environment, Impact prediction tools / techniques such as adhoc method, checklist methods etc. Development of environment management plan – Post project monitoring, EIA report and EIS, Review process.




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Unit IV

Water Quality Assessment and Treatment: Water quality assessment by DO, COD, BOD, TDS, TSS and dissolved ions determination. Hardness of water, softening of water, Reverse osmosis, Treatment of boiler feed water by Calgon process, Ion-exchange resins and Zeolites

Unit V

Disinfection of Water and Advanced Water Treatment Techniques: Chemical unit processes for Wastewater treatment

Disinfection: Objectives, Different Types - Bleaching Powder, Ozone Treatment, UV Irradiation, Chlorination – Types, Breakpoint chlorination, Dechlorination

Advanced treatment operations, Adsorption Isotherms, Advanced Oxidation Process, Membrane processes, Reverse osmosis, Electro dialysis, Desalination, Ion exchange: Removal of specific chemical contaminants as fluorides, arsenic, nitrates and organics.

Recommended Text Books

1. *Environment and Ecology*, Gupta K.M., Umesh Publications, Delhi, 2008
2. *Perspectives in Environmental Studies*, Kaushik A, Kaushik CP. New Age International Publishers, 2014
3. *Environmental Engineering Science*, Nazaroff W.W., Alvarez-Cohen L., Wiley India Pvt. Ltd., 2004
4. *Wastewater Engineering: Treatment and Reuse*, Metcalf and Eddy, Fourth Edition, Tata McGraw Hill.
5. Larry W. Canter "Environmental Impact Assessment", Tata McGraw Hill Co. Singapore, 1996.
6. Suresh K. Dhameja, "Environment Engineering and Management", S.K. Kataria & Sons Delhi, 2004.
7. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules, New Delhi, 2006.
8. Whyte, Anne, V. and Ian Burlonfeds), *Environmental Risk Assessment*, John Wiley and Sons, 1980
9. Pares Distr. *Environmental Laws in India (Deep, Deep, Lated edn.)*
10. *The ISO 14000 Handbook*: Joseph Cascio.
11. *ISO 14004 – Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004: 1996 (E))*.
12. *ISO 14001: Environmental management systems: Specification with guidance for use (ISO 14001: 1996b (E))*. (International organization for standardization – Switzerland).

Recommended Reference Books

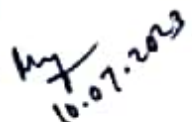
1. Raman N.S., Gajbhiye A.R., Khandeshwar S.R. , *Environ Impact Assessment*, I K International Publishing House Pvt. Ltd, 2014
2. Anjaneyulu Y., *Environmental Impact Assessment Methodologie*, B.S. Publications, 2010
3. Krzysztof Barbusiński, Maciej Thomas and Krzysztof Filipek, *Water and Wastewater Treatment: March 2022*













Semester III

Elective 302: B190904T

Natural Products, Cosmetics and Perfumery

Credits:4

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Learn the different types of alkaloids, terpenes & terpenoids etc. and their chemistry and biological importance and as lead molecules for new drug discovery
CO2	Learn the constituent present in natural products responsible for anti-diabetic, anti-malarial, activity.
CO3	Learn the constituent present in natural products used as pain killer, local anaesthetic, violent poison etc.
CO4	Learn advanced methods of structural elucidation of compounds of natural origin.
CO5	Understand isolation, purification and characterization of chemical constituents from the natural source.

Course details:

Unit I

Carbohydrates

Disaccharides and Polysaccharides (Maltose, Cellulose, Lactose and Sucrose)

Unit II

Natural Products

A general introduction, isolation, synthesis and structure of

Alkaloids: Nicotine, Morphine. Terpenoids: Camphor, Menthol,

Steroids: Cholesterol and Ergocalciferol

Flavonoids: Quercetin and Kaempferol.

Unit III

Cosmetics

Raw materials, Cosmetics for Skin (toners, cleansing agents, moisturizers, sunscreens, talcum powder, bleaching products) and Hair Cosmetics (shampoos, conditioner, colorants, herbs used in hair cosmetics).

Unit IV

Perfumes

Introduction, Composition and Extraction of Perfume (flowers, clove, heena and rice bran) and Identification of compounds used in perfumery.

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Recommended Text Books:

1. Carey, F.A. & Sundberg, R.J. *Advanced Organic Chemistry, Parts A & B*, Plenum: U.S., 2004.
2. Carruthers, W. *Modern methods of Organic Synthesis*, Cambridge University Press, 1977
3. J. March, *Advanced Organic Chemistry, Reaction Mechanisms and Structure*, John Wiley, 2015.
4. W. Carruthers *Some Modern Methods of Organic Synthesis*, Cambridge University Press, 1987.
5. I. L. Finar, *Organic Chemistry*, ELBS, U.K, 2012.
6. Morrison R.T. & Boyd R. N. ; *Organic Chemistry*, Prentice Hall India, 2018.
7. Clayden, J.; *Organic Chemistry*, Oxford University Press, 2012.

Recommended Reference Books

1. Warren, S. *Organic Synthesis: The Disconnection Approach*, John Wiley & Sons, 01984.
2. Ramesh Kumari , *Chemistry of Cosmetics*, Prestige Books, 2018
3. Charles S. Sell , *Fundamentals of Fragrance Chemistry*, Wiley VCH, 2019

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Sebarish Adhikari *Dr. R. K. S. Patra*
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Semester III

Elective 303: B190905T

Pharmaceutical Chemistry

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Fundamentals of Pharmaceutical Chemistry, structure and characteristics of drug
CO2	Pharmacokinetics , Pharmacodynamics, Natural and synthetic lead compounds
CO3	Structure –Activity Relationship and drug design
CO4	Synthesis of Antibiotics and knowledge of some important drug categories
CO5	Strategies in design of anticancer , anti- HIV drugs and drug delivery system

Course details:

Unit I

Basics of Pharmaceutical Chemistry

Introduction: Characteristics of drug, Common drug targets, Efficacy, inhibitory concentration, lethal dose, therapeutic index, half-life, pass time and frequency of dosing, agonists, antagonists, competitive and non-competitive inhibitors

Unit II

Drug Synthesis and Testing Techniques

In vitro testing, Line-Weaver-Burk Plot, Pharmacokinetics and pharmacodynamics, ADME, biological testing, natural and synthetic lead compounds, combinatorial synthesis, stereochemistry considerations and optimizing reactions

Unit III

Structure - Activity Relationships

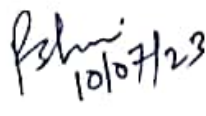

Quantitative structure-activity relationships, Pharmacophore: skeletal and non-skeletal, substrate based drug design and target based drug design, Case study

Unit IV

Antibiotics

Synthesis of selected antibiotics, Structure, activity, resistance issues, Different classes of antibiotics: Cephalosporins, Penicillins and other beta lactam antibiotics, Fluoroquinolones and other synthetic antibiotics

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Unit V

Advanced Therapeutics Techniques

Strategies in design of Anticancer and anti-HIV drugs, Cytotoxicity and bioavailability issues, Drug delivery systems, Gene therapy, Immunotherapy








Important Drug Categories: Psychoactive drugs and cardiovascular drugs

Recommended Text Books:

1. T.L. Lippincott Williams and Wilkins, *Foye's Principles of Medicinal Chemistry*, 7th ed., Lippincott Williams & Wilkins, 2005.
2. Kar, A *Medicinal Chemistry*, New Age International Publishers, 2007.
3. Gringauz, A., *Introduction to Medicinal Chemistry: How drugs act and why?*, John Wiley and Sons, 1997.

Recommended Reference Books:

1. Khar R.R.K, Lachman Liebermans *Theory and practice of Industrial Pharmacy*, CBS, 4th ed., 2020.
2. Banker and Gilberts, *Modern Pharmaceutics*, 4th ed., CRC Press, 2002.
3. A.H. Beckett and J.B. Stenlake, *Practical Pharmaceutical Chemistry*, CBS, 2005d


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Semester III

Elective 304 : B190906T

Chemistry of Materials, Petrochemicals and Fertilizers

Credits:4

Course outcomes (CO): After completion of this course the students will be able to:

CO1	The chemical composition of cement, ceramics and glass and their industrial applications.
CO2	Learn the chemistry of magnetic materials and nano-materials and their new-age applications.
CO3	Understand the chemical composition of fertilizers and their application to society/agriculture
CO4	Understand the chemical composition of natural gas, crude petroleum, and lubricants and their application to daily life.

Course details:

Unit I

Cement, Composites, Ceramic and Glass

Composition of cement, mixing of cement clinker with Gypsum, Setting of cement. Microscopic and Macroscopic Composites, Dispersion, Strengthened, Particle and Fiber- reinforced Composites. Composition, Physical and Chemical properties of Glass, Varieties of glass, Introduction to ceramics

Unit II

Magnetic and Nanomaterials

Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Hysteresis, Remanence and Coercivity, Design of Molecular- based magnets: Three dimensional magnetic ordering. Preparation, Properties, Characterization and Applications of Nano materials (SEM, TEM).

Unit III

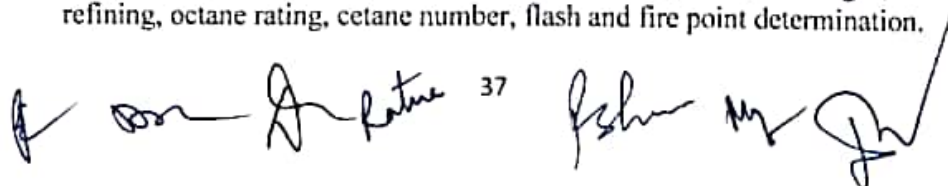
Fertilizers

N - Ammonia, Ammonium nitrate and Urea; P - Phosphoric acid, Single and Triple superphosphate, DAP; K- Potassium Nitrate and Muriate of potash.

Unit IV

Petrochemicals and Lubricants

Introduction, Occurrence, Composition of Petroleum, Natural gas, cracking, refining, octane rating, cetane number, flash and fire point determination.

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Lubricating oils and additives, Naphtha crackers and Profile of their products, Synthetic and Blended oils.

Recommended Text Books:

1. *Oliver Kahn. Molecular Magnetism, VCH Publishers, (UK), 2018*
2. *W. D. Callister. Materials Science and Engineering: An Introduction, Wiley, 2017.*
3. *N. W. Aschcroft and N. D. Mermin. Solid State Physics, Cengage, 2003.*
4. *Kelker and Hatz. Hand Book of Liquid Crystals, Wiley VCH, 1998.*

Recommended Reference Books:

1. *J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rowlings. Materials Science. ELBS, 2013.*
2. *Fahlman B.D. Materials Chemistry, 3rd ed. Springer, 2018*
3. *Baboo Prem, Fertilizer Technology: Pure Knowledge, 2020.*
4. *Matar S., Hutch L.F., Chemistry of Petrochemical Process, 2nd ed., Science Direct, 2001.*

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Semester III

Paper XVII: B190907P

Lab Course III

Credits:4

Course outcomes (CO) : After completion of this course the students will be able to:

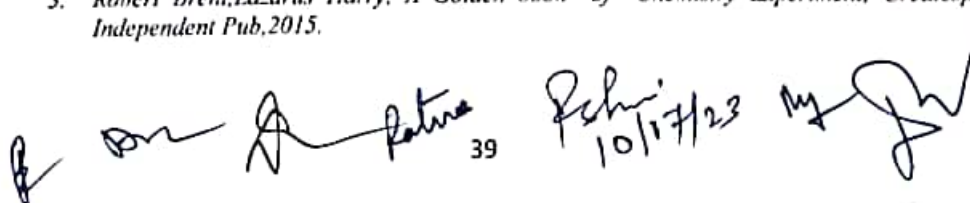
CO1	Understand the concept and properties of soaps and detergents.
CO2	Understand the process of extraction of essential oils.
CO3	Synthesis soaps , detergents ,sanitizers and house hold chemicals
CO4	Understand the preparation of cosmetics cream.
CO5	Analysis of soaps , detergents and edible oils.

Course details:

1. Preparation of detergent and study of the properties.
2. To prepare liquid soap and study its properties.
3. Preparation of flower extracts in water (eg. Rose water)
4. Preparation of flower extracts in oil (Itar)
5. Preparation of Hand Sanitizer.
6. Preparation of disinfectant (Phenyle)
7. Preparation of cream (cosmetics i.e. cold and vanishing)
8. Saponification of edible oil
9. Qualitative analysis of soap by foaming
- 10.To determine the Iodine value of soap.

Recommended Text Books:

1. Wagh G.S. , *Experimental Methods for Water Analysis*, Nirali Prakashan, 2017.
2. Fresenius W., Quentin K.E., *Water Analysis: A Practical Guide to Physico-Chemical, Chemical, and Microbiological Water Examination and Quality Assurance* , Springer Verlag, 1988.
3. Robert Brent,Lazarus Harry. *A Golden book of Chemistry Experiment*, Createspace Independent Pub,2015.

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Recommended Reference Books:

1. Jahangirdar, *Experiments in Chemistry*, Himalaya Pub. House, New Delhi, 2014.
2. H. Clark, *Handbook of Organic Analysis*, Edward Arnold, 1946.
3. A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., John Willey (1996).
4. Farhat M., Ali B.M.E., Speight J.G., *Handbook of Industrial Chemistry*, Mc Graw Hills, 2005.

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Semester IV

Paper XVIII: Elective 01

Paper XIX: Elective 02

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Semester IV

Elective 401: B191001T

Food Technology and Agrochemicals

Credits:5

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Nutrients of food like Proteins, carbohydrates, fats etc.
CO2	Structure, sources and importance of vitamins, minerals, pigments and flavor in food
CO3	Cause and prevention of food born bacterial diseases
CO4	Knowledge of food additives and food preservation
CO5	Importance, classification , mode of action, structure and properties of agrochemicals

Course details:

Unit I

Food Chemistry

Introduction, Classification, Properties of sugar and polysaccharides in foods, Proteins and amino acids, Vitamins and Minerals, Industrial application of enzymes, Water in food, Water activity and shelf life of food, Natural food flavours, Pigments in food and their industrial application.

Unit II

Food Microbiology

Food born infections and intoxications: bacterial with examples of infective and toxic type Clostridium, Salmonella, Staphylococcus. Govt. Regulatory practices and policies, FDA, ISI. Application of microbial enzymes (proteases and lipases) in dairy industry (cheese production)

Unit III

Food Processing and Preservation

Food additives, Contaminants, Food Preservation methods, Food packaging and preservation methods of fruits, vegetables, cereals and grains.

Unit IV

Agrochemicals and their effects

Introduction, Importance and general classification of agrochemicals, mode of action, Public health issues related to agrochemicals.



Classification, Physical and Chemical Properties of Pesticides & Insecticides
(BHC, DDT, Parathion & from natural sources i.e neem seed etc.), Herbicides (2,
4-dichlorophenoxyacetic acid & atrazine).

Recommended Text Books:

1. Adams M.R. & Moss M.O., *Food Microbiology*, 2nd ed., Panima Publishing Corporation, 2002.
2. Prajapati J.B., *Fundamental of Dairy Microbiology*, Indian Council of Agriculture, 2018.
3. Brian J. Wood, *Microbiology of Fermented Foods, Vol. I & II*, Elsevier Applied Science Publication, 1985.
4. John M. DeMan *Principles of Food Chemistry*, Springer 1976.
5. Richard Owusu -Apenten, *Introduction to food Chemistry*, CRC Press, 2019.
6. Knowles A., *Chemistry and Technology of Agrochemical Formulation*, Springer, 2012.

Recommended Reference Books:

1. Vaaclavik V.A, Christian E.W., *Essentials of food Science*, Springer, 2013.
2. Newton David E., *Food Chemistry*, New York: Facts on Files, 2007.
3. Jack R. P., Rasdale N.N., Gammon D., *Encyclopaedia of Agrochemicals*, 2002.

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Semester IV

Elective 402: B191002T

Essential Oils, Dyes and Paints

Credits:5

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Source and Chemistry of Essential oils
CO2	Various techniques used for the extraction of EOs, recognizing physical and chemical properties
CO3	Uses of Essential oils in various industries
CO4	Basic concepts, composition and classification of dyes, process of dyeing and its application
CO5	Basic concept of paints, composition, classification , properties and applications in various fields

Course details:

Unit I

Essential Oils

Sources, Classification, chemistry of essential oil bearing materials , Methods of production of some important essential oils(rose, jasmine, khus, sandal wood etc.), Grading and Standardization , Physico-chemical characteristics.

Unit II

Dyes

Introduction, General characteristics of colour and constitution, Classification, Basic operations in dyeing, some commercial dyes (azo dyes, acidic dyes, basic dyes, mordant, vat dyes, indigo dyes, dispersive dyes etc.)

Unit III

Paints

General characteristic, their function, Manufacture and Classification, Enamels, Emulsion paints, Water based paints. Formulation of paints: Function of vehicles , solvent, thinner, pigment, dyes, filler, resins, drier, insecticides, additives in paint formulation

Recommended Text Books:

1. Guenther *Essential Oils, Vol. I-V, 1950.*
2. Colleen, K. Dodt *The Essential Oil Book , Storey Publishing LLC, 1996*
3. . Turner G.P.A . *Introduction to Paint Chemistry, , Chapman& Hall, 1967.*
4. Malshe V. C. and Meenal Sikchi *Basics of Paint Technology, Part I & II, Antar Prakash Center for Yoga, 2002.*
5. Waring.R. David, Geoffery, *Chemistry and Application of Dyes, Springer Link, 1990.*
6. Georgievce, *Textbook of Dye Chemistry, London Scott Greenwood, 2013.*









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7. Klaus Hunger., *Industrial Dyes: Chemistry, Properties and applications*, Wiley Science, 2002.

Recommended Reference Books:

1. Curtis Susan, Johnson F, *Essential Oils*, DK, 2016
2. Stanley Et. Al. *Lesota, Paints and Coatings*, Federation of Societies For , 1978.
3. Freitag W, Stoye D., *Paints , Coatings and Solvents*, 2nd ed., Wiley, 2008.



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Semester IV

Elective 403: B191003T

Waste Management

Credits:5

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Understand types of Waste
CO2	Describe the components of solid and liquid waste management and the laws governing it.
CO3	Discuss hazardous waste management and disposal of hazardous waste
CO4	Outline the design, operation, and maintenance of different methods of treatment of biomedical and industrial waste
CO5	Conclude the recent trends in reuse of different type of waste

Course details:

Unit I

Introduction and Types of Waste

Introduction to environmental Science. Definition, Types and Categories of Waste. Collection, Sorting and Transfer of Waste, The Five R's.

Unit II

Solid and Liquid Waste Management

Techniques in Solid and Liquid Waste Management. Waste Disposal and Scientific Landfill Cultivation. Municipal waste management

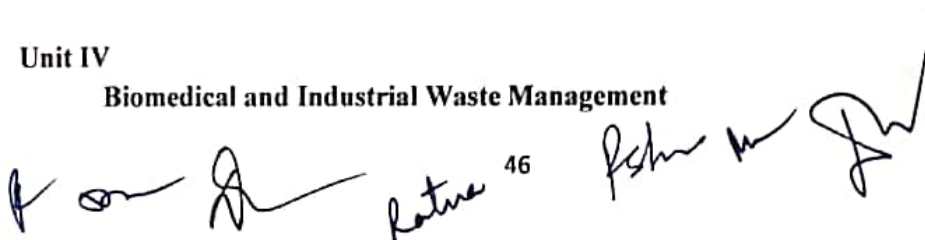
Unit III

Hazardous Waste Management

Introduction to Hazardous Waste Management (Nuclear waste and e-waste), Management and disposal of hazardous waste, Impact of Biomedical waste on environment and human health. Treatment and disposal of Biomedical waste.

Unit IV

Biomedical and Industrial Waste Management

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Infection control, prevention and patient safety. Waste management in food industry, Reuse and recycling Techniques.
Entrepreneurship in waste management, Human Resource and Financial Management. Industry based case studies

Recommended Text Books:

1. Frank Kreith, *Hand Book of Solid Waste Management*, Mc Graw Hills, Newyork , 2017.
2. Yung-Tse Hung, *Hand Book of Environment and Waste Management vol1*, World Scientific Publishing Company Pte Ltd. 2012.
3. John Pichtel, *Waste Management Practices; Municipal, Hazardous and Industria*, CRC Press, 2014

Recommended Reference Books:

1. Jennings L., *Waste Management ; Status and Challenges*, Educo Publisher, 2002.
2. Hullely V. *Waste Management*, Arcler Education Inc., 2020.

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Semester IV

Elective 404: B191004T

Green Chemistry

Credits:5

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Understand the principle and concept of green chemistry.
CO2	Apply the principles of green chemistry to chemical-related problems and waste reduction
CO3	Apply the principles of green chemistry to improve chemical manufacturing processes.
CO4	Analyze toxicology data, materials properties, and regulatory requirements to choose safer chemicals for product formulations and process chemistry and application of non conventional energy sources.
CO5	Explain environmentally benign Solutions to organic solvents

Course details:

Unit I

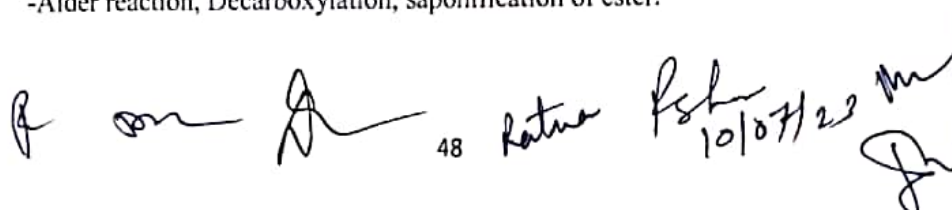
Introduction Principle and Concepts of green Chemistry: Need for green chemistry, Inception and evolution of green chemistry, twelve principles of Green Chemistry with their explanation and examples, designing a green synthesis using these principles, Green chemistry in day to day life.

Unit II

Non Traditional Greener Alternative Approaches: Different approaches to green synthesis: Use of green reagents in organic Synthesis-Dimethyl carbonate, Polymer supported reagents- Peracids and Chromic acids, Green Catalysis, role of catalysis in sustainable development, homogeneous and heterogeneous catalyst, Introduction, advantages and applications of Biocatalyst.

Unit III

Application of Non-Conventional Energy Sources: Introduction of microwave induce synthesis: Microwave activation, equipment, time and energy benefits, limitations, Organic transformations under microwaves- Fries rearrangement, Diels -Alder reaction, Decarboxylation, saponification of ester.

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Introduction of ultrasound assisted green synthesis: Instrumentation, Physical aspects, application in organic transformations.

Unit IV

Environmentally Benign Solutions to organic solvents: Ionic liquids as green Solvents: Introduction, properties and types of ionic liquids, Synthetic applications- Diels -Alder reaction.

Aqueous phase reactions: Synthesis applications- 1,3- Dipolar Cycloadditions, Carbon-Carbon bond- forming processes and bromination reactions. Role of supercritical Carbon dioxide in green chemistry, Ethyl lactate as a renewable green solvent: Properties and applications.

Recommended Text Books:

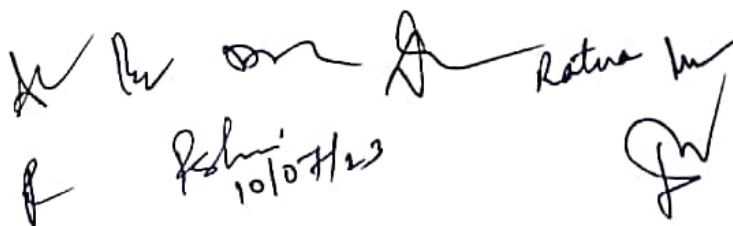
1. P.A.G. blackie , *Organic synthesis in water*, Springer (1998).
2. P.T. Anastas, *Green Chemistry : Theory and Practice*, Oxford University Press (2002).
3. M. Lancaster, *Green Chemistry : An Introductory Text* , Royal Society of Chemistry (2016)

Recommended Reference Books:

1. Ahluwalia V.K., *Green Chemistry: A Textbook Hardcover*, Alpha Science International Ltd, 2013
2. James H. Clark and Duncan J. Macquarrie, *Handbook of Green Chemistry and Technology*, Wiley, 2002.
3. Paul Anastas and John C. Warner *Green Chemistry: Theory and Practice* Oxford University Press, 2000.

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Semester IV

Elective 405: B191005T

Chemical Analysis in Agro, Food, Soap and Detergent Industries and Safety Measures

Credit 5

Course outcomes (CO): After completion of this course the students will be able to:

CO1	Definition of toxic chemicals
CO2	Understand the properties of soils, oils, soaps, detergents, food components.
CO3	To apply the safety measures in labs, plants, storage etc.
CO4	Analysis of soil , food, soap, detergents etc.
CO5	Investigates the food stuffs, manufacturing soaps , detergents

Course details:

Unit I

Analysis of soil: Moisture, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur and alkali salts.

Fuel analysis: Solid, liquid and Gas , ultimate and proximate analysis heating values , grading of coal , liquid fuels , flash points , aniline point , octane number and carbon residue , gaseous fuels – producer gas and water gas – calorific value.

Unit II

Oils, soaps and Detergents: Refining of edible oils, manufacturing of soaps, detergents-classification-anionic, cationic, non-ionic and amphoteric detergents, detergent builders and additives, liquid soaps. Manufacturing of fatty acids and glycerol, greases from fatty acids, turpentine oil

Unit III

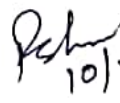
Food analysis: Moisture, ash, crude protein, fat, crude fiber, carbohydrate, calcium, potassium, sodium, and phosphates, food adulteration – common adulteration in food, contamination of food stuffs, microscopic examination of foods for adulterants, Pesticide analysis in food products, Extraction and purification of sample, HPLC, gas chromatography for organo – phosphates, thin layer chromatography for identification of chlorinated pesticides in food products.

Unit IV

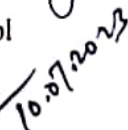
Safety: Flammable material handling and firefighting equipment's, control

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measures for toxic chemicals, industrial hygiene, safety in laboratories & plant, safety in the transportation & storage of chemicals. OHSAS 18000.

Chemical Warfare Convention: Definitions and schedules. Toxic chemicals, remote control systems, tear gas, chemical weapons, ocean dumping of chemical weapons.

Recommended Text Books

1. *Statistical Quality Control, 2nd Edn., Manohar Mahajan Dampat Rai and Sons, 1995.*
2. *Quality management: a process improvement approach, Fryman Mark A, Cengage learning, 2002.*
3. *Quality Control, Paranthaman D, Tata, McGraw Hill, 1987.*
4. *Gupta R. N. Chemical warfare and casualty management 2011*
5. *Vyas M. N. Safety and hazards management in chemical industries, Atlantic publication, 2013*
6. *Dikshith T.S.S, Safety evaluation of environmental chemicals. New Age International, 1996.*
7. *Chemical Safety Matters-IUPAC-IPCS, Cambridge univ. Press, 1992.*
8. *A.K. Dey Environmental Chemistry, Wiley Eastern.*
9. *S.K. Banerji Environmental Chemistry, Prentice Hall India, 1993.*
10. *S.D. Faust and O.M Chemistry of Water Treatment, Aly, Butterworths, 1983.*
11. *Ahluwalia V K Environmental chemistry, Anne Books India, 2008.*
12. *Sawyer and McCarty. Chemistry for Environmental Engineering, McGraw Hill, 1978.*
13. *I. Williams Environmental Chemistry, John Wiley, 2001*
14. *Peltcher, Industrial electrochemistry*

Recommended Reference Books:

1. *Farhat M., Ali B.M.E, Speight J.G., Handbook of Industrial Chemistry, Mc Graw Hills, 2005.*
2. *Carson P., Mumford C., Hazardous Chemicals Handbooks, 2nd ed., Butterworth Heinemann, 2002.*
3. *Nielsen S.S., Introduction to Food Analysis, Springer, 2017.*

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Semester IV

Paper XX: B191006R

Research Project / Industrial Training and Seminar II

Credits: 16

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	To provide comprehensive learning platform to students where they can enhance their employ ability skills and become job ready along with real corporate exposure.
CO2	To enhance students' knowledge in one particular technology.
CO3	To provide learners hands on practice within a real job situation
CO4	Ability to communicate efficiently.

Course details: As per Ordinance.


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Open elective course for other departments

Paper Code: B190808T

Industrial applications in Chemistry

Credits: 5

Course outcomes (CO) : After completion of this course the students will be able to:

CO1	Understand the concept of cement, ceramics and glass.
CO2	Understand the polymeric materials and study their applications
CO3	Understand the concept of fertilizers
CO4	Understand the concept of petrochemicals and lubricants

Course details:

Unit I

Medicinal Chemistry: Drugs: Introduction, classification of drugs, brief discussion of drug targets, synthesis of Drugs, Sulfa drugs, aspirin, paracetamol etc.

Unit II

Polymeric Materials: Introduction, classification, types of polymerisation, properties, Miscellaneous polymers (Thermoplastic, Thermosetting, conducting, Biopolymers, polymers in medicine and surgery) and their applications.

Unit III

Fertilizers: N - Ammonia, Ammonium nitrate and Urea; P - Phosphoric acid, Single and Triple superphosphate, DAP; K- Potassium Nitrate and Muriate of potash.

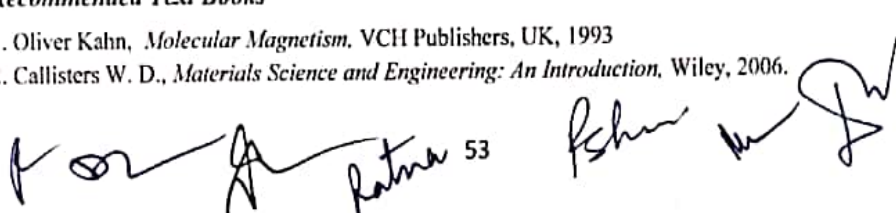
Unit IV

Petrochemicals and Lubricants: Introduction, Occurrence, Composition of Petroleum, Natural gas, cracking, refining, octane rating, cetane number, flash and fire point determination.

Lubricating oils and additives, Naphtha crackers and Profile of their products, Synthetic and Blended oils.

Recommended Text Books

1. Oliver Kahn, *Molecular Magnetism*, VCH Publishers, UK, 1993
2. Callisters W. D., *Materials Science and Engineering: An Introduction*, Wiley, 2006.

 The block contains several handwritten signatures and initials in black ink. One signature appears to be 'Ratna' followed by the number '53'. Other signatures are more stylized and less legible.


3. Aschcroft N. W. and Mermin N. D., *Solid State Physics*, Holt, Rinehart and Winston, New York, 1976.
4. J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rowlings *Materials Science*. ELBS ,2003.
5. Bahadur P. and Shastry N.V, *Principles of Polymer Science*, Narosa, New Delhi, 2000.
6. Williams, D.J., *Polymer Science and Engineering*, Prentice Hall Inc, New Jersey, 1971.
7. G. Thomas, *Medicinal Chemistry – An Introduction*, John Wiley, 2001.

Recommended Reference Books:

1. Kelker and Hatz, *Hand Book of Liquid Crystals*, 2nd Ed. Wiley ,2014
2. *Theory and Basics of Polymer Science*, F.W. Billmeyer, John Wiley & Sons, NY,1984

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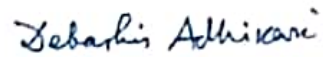

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BOS Meeting



Prof. Deepak Srivastava,
Dept. of Plastic Technology
HBTU.



Dr. Debashis Adhikari
Associate Professor
Dept. of Chemical Sciences
IISER Mohali



Prof. Sudhir Kumar Srivastava
Dean, Science Faculty
DAV College



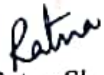
Prof. Meet Kamal
Dept. of Chemistry
Christ Church P.G. College



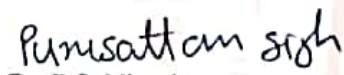
Dr. B.P. Singh
Dept. of Chemistry
CSJM University



Dr. Rashmi Dubey
Dept. of Chemistry
CSJM University.



Dr. Ratna Shukla
Dept. of Chemistry
CSJM University.




Dr. P.S. Niranjan
Dept. of Chemistry
CSJM University.



Dr. Meraj Jafri
Dept. of Chemistry
CSJM University.



Dr. R.K. Dwivedi (Convenor)
Director, School of Basic Science
CSJM University



Dr. Dhananjay Dey (Coordinator)
Dept of Chemistry
CSJM University.