AUXILIUM COLLEGE (AUTONOMOUS)

PG & RESEARCH DEPARTMENT OF CHEMISTRY

M.Sc. CHEMISTRY

Curriculum Development – Environmental Sustainability Needs

PCCHB20 - STRUCTURAL INORGANIC CHEMISTRY

Year: I **SEM:** I	**Course Code** PCCHB20	**Title of the Course** Structural Inorganic Chemistry	**Course Type** Theory	**Course Category** Core	**H/W** 5	**Credits** 4	**Marks** 100

Learning Objectives:

- To learn the concepts of Lewis acids and bases.
- To learn the structures of complex solids, metals, and alloys.
- To gain knowledge about the structure and bonding in poly acids, boron hydrides and metal clusters.

Course Outcomes:

The Learners will be able to

1. Summarize the theories of acids and bases.
2. Discuss conductors, semiconductors and insulators based on band theory.
3. Assess the structure and bonding in different types of ionic solids, metals and alloys.
4. Discuss the structure and bonding in polyacids, silicates and inorganic polymers.
5. Distinguish the structure and bonding in boranes, carboranes, metallo carboranes, boron nitrides and metal clusters.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	M	H	H	H
CO2	H	M	M	H	H	H
CO3	H	M	M	H	H	H
CO4	H	M	M	H	H	H
CO5	H	M	M	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Acids and bases, proton transfer equilibria in water - solvent leveling effects. (K1, K2, K3, K4, K5 & K6)

1.2 Aqua acids - periodic trends in aqua acids - simple oxo acids - anhydrous oxides - polyoxo compound formation. (K1, K2, K3, K4, K5 & K6)

1.3 Lewis acid - base concepts, hard and soft acids and bases, group characteristics of Lewis acids. (K1, K2, K3, K4, K5 & K6)

1.4 Lux - Flood theory of acids and bases, Usanovich acids and bases, super acids and super bases. (K1, K2, K3, K4, K5 & K6)

1.5 Non aqueous solvents, classification, protic and aprotic solvents, molten salts as solvents and ionic liquids. (K1, K2, K3, K4, K5 & K6)

1.6 Heterogeneous acids and bases - symbiosis and proton sponges. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Structure of complex solids - layered structures - conducting ionic solids – graphite - solids held together by covalent bonding - diamond - Madelung constants. (K1, K2, K3, K4 & K5)

2.2 Imperfections in crystals - stoichiometric defects - Schottky, controlled valency, F-center and Frenkel defect - non-stoichiometric defects - metal excess defect, metal deficient defect - impurity defect. (K1, K2, K3, K4 & K5)

2.3 Band theory of solids, intrinsic and extrinsic semiconductors, piezoelectric and pyroelectric crystals. (K1, K2, K3, K4 & K5)

2.4 Superconductivity – Meissner effect, critical temperature and critical magnetic field - BCS theory. (K1, K2, K3, K4 & K5)

2.5 Type I and Type II superconductors. (K1, K2, K3, K4 & K5)

2.6 Ternary oxides - structures of 123 oxides (YBa-Cu- O) - applications of high temperature superconducting materials. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Structures of simple solids - unit cell and crystal structures. (K1, K2, K3, K4, K5 & K6)

3.2 Close packing of spheres - holes in closed packed structures. (K1, K2, K3, K4, K5 & K6)

3.3 Structure of metals and alloys - non-closed packed structures. (K1, K2, K3, K4, K5 & K6)

3.4 Atomic radii of metals - polytypism - polymorphism of metals. (K1, K2, K3, K4, K5 & K6)

3.5 Alloys - substitutional solid solutions, interstitial solid solutions of non-metals - intermetallic compounds. (K1, K2, K3, K4, K5 & K6)

3.6 Characteristic structures of ionic solids - binary phases (AX and AX_2) - ternary phases (ABO_3 and AB_2O_4). (K1, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

1.1 Structure and bonding - polyacids - isopolyacids and heteropolyacids of molybdenum and tungsten. (K1, K2, K3, K4 & K5)
1.2 Dawson and Keggins structure of poly acids, heteropolyanions and heteropoly blues. (K1, K2, K3, K4 & K5)
1.3 Inorganic polymers - silicates, structures, properties, correlation and applications. (K1, K2, K3, K4 & K5)
1.4 Molecular sieves, feldspar, zeolites and ultramarines and their applications. (K1, K2, K3, K4 & K5)
1.5 Polysulphur-nitrogen compounds - structure and bonding in tetrasulphur tetranitride, poythiazyl and S_xS_y compounds. (K1, K2, K3, K4 & K5)
1.6 Poly organo phosphazenes. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Structure and bonding - boron hydrides - introduction, classification of boranes - diborane, tetra borane, pentaborane, hexaborane and decaborane. (K1, K2, K3, K4, K5 & K6)
5.2 Polyhedral boranes - Wade's rule - closo, nido and arachno structures, hydroboration. (K1, K2, K3, K4, K5 & K6)
5.3 Carboranes - closo, nido and arachno structures of carboranes. (K1, K2, K3, K4, K5 & K6)
5.4 Metallocarboranes - closo, nido and arachno structures of carboranes. (K1, K2, K3, K4, K5 & K6)
5.5 Structure and bonding of boronitrides. (K1, K2, K3, K4, K5 & K6)
5.6 Metal clusters - chemistry of low molecularity metal clusters (up to trinuclear metal clusters). (K1, K2, K3, K4, K5 & K6)

Reference Books:

1. J. E. Huheey, Inorganic Chemistry, Principles, Structure and Reactivity, Harper Collins, New York, 4th Edition, 2013.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry: A Comprehensive Text, John Wiley and Sons, 6th Edition, 2007.
3. K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Saunders Co., USA, 2010.
4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., New York, 1974.
5. G. S. Manku, Inorganic Chemistry, Tata McGraw Hill Publications, 1989.
6. D. F. Shrivers, P. W. Atkins and C. H. Langford, Inorganic Chemistry, OUP, 2006.
7. N. H. Ray, Inorganic Polymers, Academic Press, 1978.
8. F. Basolo and R. G. Pearson, Mechanism of Inorganic Reaction, Wiley NY, 1967.

Open Educational Resources (OER):

1. https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod2.pdf
2. https://nptel.ac.in/content/storage2/courses/104103069/module4/lec3/1.html
3. https://nptel.ac.in/courses/115/105/115105099/
4. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 (P-11, M-19)

SEMESTER I

PCCHC20 - KINETICS AND PHOTOCHEMISTRY

Year: I SEM: I	**Course Code** PCCHC20	**Title of the Course** Kinetics and Photochemistry	**Course Type** Theory	**Course Category** Core	**H/W** 5	**Credits** 4	**Marks** 100

Learning Objectives:

- To get exposed to the kinetics of reactions in solutions, acid- base catalysis and surface reactions.
- To gain knowledge on photochemical and photo physical processes.
- To have an in-depth knowledge on the kinetics of complex and fast reactions.

Course Outcomes:

The Learners will be able to

1. Describe Activated Complex Theory in terms of translational and vibrational partition functions and apply it to derive the kinetics of reactions in solutions, Hammett and Taft equations and kinetic isotope effects in studying the mechanism of chemical reactions.
2. Discuss the concepts and kinetics of homogeneous and heterogeneous catalysis and explain adsorption isotherms of Langmuir and BET.
3. Derive the kinetics of complex reactions and apply the techniques of fast reactions.
4. Analyse the principles involved in photo excitation of molecules.
5. Derive the kinetics of photochemical reactions, and explain the applications of radiation chemistry, kinetics of photochemical reactions, solar energy conversion and radiolysis of water.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	M	H	H	H
CO2	H	H	M	H	H	H
CO3	H	H	M	H	H	H
CO4	H	H	M	H	H	H
CO5	H	H	M	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Activated complex theory - derivation - partition functions and activated complex - Eyring equation in terms of translational and vibrational partition functions. **(**KI, K2, K3, K4, K5 & K6)

1.2 Determination of free energy, enthalpy and entropy of activation and their significance. **(**KI, K2, K3, K4, K5 & K6)

1.3 Potential energy surfaces. **(**KI, K2, K3, K4, K5 & K6)

1.4 Applications of activated complex theory to reactions in solution - effect of pressure, and dielectric constant. **(**KI, K2, K3, K4, K5 & K6)

1.5 Effect of ionic strength on reactions in solutions, cage effect. **(**KI, K2, K3, K4, K5 & K6)

1.6 Kinetic isotope effect, linear free energy relationships - Hammett and Taft equations. **(**KI, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Catalysis - homogeneous catalysis - acid-base catalysis - types of acid-base catalysis - specific and general acid-base catalysis. Mechanisms and kinetics of acid-base catalyzed reactions (protolytic and prototropic mechanism) – Bronsted catalysis law. **((**KI, K2, K3, K4 & K5)

2.2 Heterogeneous catalysis - surface reactions, types - physisorption and chemisorption, difference between physisorption and chemisorption, Lennard-Jones plots. **(**KI, K2, K3, K4 & K5)

2.3 Adsorption isotherms - Langmuir and BET isotherms - postulates and derivations. **(**KI, K2, K3, K4 & K5)

2.4 Kinetics of surface reactions - unimolecular and bimolecular reactions, catalysis by semiconductor oxides (n-type and p-type). **(**KI, K2, K3, K4 & K5)

2.5 Mechanism of heterogeneous catalytic reactions, Langmuir and Rideal-Eley mechanism - adsorption co-efficient and its significance. **(**KI, K2, K3, K4 & K5)

2.6 Enzyme catalysis - types of enzyme catalysis, rate of enzyme catalyzed reactions by Michaelis-Menton mechanism - study of effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition in enzyme catalyzed reactions. **(**KI, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Complex reactions - definition with examples, kinetics of reversible, consecutive and parallel reactions. **(**KI, K2, K3, K4, K5 & K6)

3.2 Chain reactions - types of chain reactions (stationary and non-stationary). **(**KI, K2, K3, K4, K5 & K6)

3.3 General treatment of chain reactions - chain length - explosion limits. **(**KI, K2, K3, K4, K5 & K6)

3.4 Rice Herzfeld mechanism - order of reactions of unity, one-half and three-halves for photolysis of acetaldehyde. **(**KI, K2, K3, K4, K5 & K6)

3.5 Fast reactions - relaxation methods - pressure and temperature jump methods **(**KI, K2, K3, K4, K5 & K6)

3.6 Stopped flow and flash photolysis methods. **(**KI, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Photochemistry - introduction, absorption and emission of radiation - intensity distribution in the electronic, vibrational species - Franck Condon Principle. **(**K1, K2, K3, K4 & K5)

4.2 Jablonski diagram - radiative and non-radiative processes - fluorescence and phosphorescence - E-type and P-type delayed fluorescence - spin forbidden radiative transition - internal conversion and intersystem crossing. **(**K1, K2, K3, K4 & K5)

4.3 Electronically excited states - excited state dipole moment and acidity constant. **(**KI, K2, K3, K4 & K5)

4.4 Decay of electronically excited states, dissociation and predissociation of diatomic molecules - energy transfer process. **(**KI, K2, K3, K4 & K5)

4.5 Photophysical processes - kinetics of unimolecular and bimolecular photophysical processes - kinetic treatment of excimer and exciplex formation. **(**KI, K2, K3, K4 & K5)

4.6 Quenching - static and dynamic quenching - Stern-Volmer equation. **(**KI, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Photochemical reactions - photo assisted mechanism, hydrogen and halogen reactions. **(**KI, K2, K3, K4, K5 & K6)

5.2 Kinetics of photochemical reaction, photoredox, photosubstitution, photoisomerization and photosensitized reactions. **(**KI, K2, K3, K4, K5 & K6)

5.3 Photovoltaic and photogalvanic cells, photo assisted electrolysis of water, application of solar energy conversion. **(**KI, K2, K3, K4, K5 & K6)

5.4 Radiation chemistry - interaction of high-energy radiation with matter - primary and secondary processes**. (**KI, K2, K3, K4, K5 & K6)

5.5 G value - radiolysis of water - hydrated electron, ion pair yield. **(**KI, K2, K3, K4, K5 & K6)

5.6 Photocatalysis - applications of TiO_2 photocatalyst for oxidation of organic pollutants - photochemical reaction of vision. **(**KI, K2, K3, K4, K5 & K6)

Reference Books:

1. R. G. Frost and Pearson, Kinetics and Mechanism, Wiley, New York, First Reprint 1970.
2. Keith J. Laidler, Chemical Kinetics, Pearson Edition Company Pvt. Ltd., 3rd Edition, 2005.
3. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., January 2019.
4. N. J. Turro, Modern Molecular Photo Chemistry, Benjamin, Cumming, Menlo Park, California, 1978.
5. K. K. Rohatgi Mukherjee, Fundamentals of Photo Chemistry, Wiley Eastern Ltd., 2nd Edition, 1992.
6. Gurdeep Raj, Photochemistry, Goel Publishing House, 4th Edition, 2002.
7. A. Singh, R. Singh, Photochemistry, Campus Books International, 1st Edition, 2005.
8. P. W. Atkins, Physical Chemistry, Oxford University Press, 11th Edition, 2018.
9. G. W. Castellan, Physical Chemistry, Narosa Publishing House, Seventh Reprint, 2004.
10. Donald A. Mc Quarrie and John D. Simon, Physical Chemistry: A Molecular Approach - 1997, Viva Books Pvt., Ltd., New Delhi, Reprint 2004.
11. J. Rajaram J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations: Applications of Femto Chemistry, Mc Millan Publishers India Ltd., Reprint, 2009.

Open Educational Resources (OER):

1. http://photobiology.info/Ilichev.html (Photochemistry basics)
2. https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_107B%3A_Physical_Chemistry_for_Life_Scientists/Chapters/2%3A_Chemical_Kinetics/2.10%3A_Fast_Reactions_in_Solution.
3. https://swayam.gov.in/nd1_noc20_cy22/preview (Introduction to Chemical Thermodynamics and Kinetics)

4. Brian Wardle, Principles and applications of photochemistry, Wiley publications, 2009, ISBN – 978-0-470-01494.
https://cds.cern.ch/record/1254287/files/9780470014936_TOC.pdf

SEMESTER III

PECHE20 - ELECTIVE III A: ANALYTICAL CHEMISTRY

Year: II **SEM:** III	**Course Code** PECHE20	**Title of the Course** Analytical Chemistry	**Course Type** Theory	**Course Category** Core Elective	**H/W** 5	**Credits** 5	**Marks** 100

Learning Objectives:

- To study in detail the different types of chromatographic techniques and their applications.
- To give an in-depth knowledge on environmental chemistry and its impacts.
- To understand the applications of computers in chemistry.

Course Outcomes:

The Learners will be able to

1. Compare different thermal methods of analysis and explain their applications in material science.
2. Elaborate the principle, instrumentations of the Gas, HPLC and SCF chromatographic techniques and their applications.
3. Examine the identification of metal ions using AAS and photo acoustic spectroscopy.
4. Solve simple problems in chemistry using 'C' program.
5. Analyze the importance of Green Chemistry and its impact on the sustainable environment and the quality of water.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	L	H	H	H
CO2	H	M	L	H	H	H
CO3	H	M	L	H	H	H
CO4	H	M	L	H	H	H
CO5	H	M	L	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Thermal Analysis - Thermo Gravimetric Analysis (TGA) - principle, instrumentation, thermogravimetric curves of $CaC_2O_4.H_2O$, $MgCr_2O_4$, Hg_2CrO_4, Ag_2CrO_4, $AgNO_3$ and $Cu(NO_3)_2$. (K1, K2, K3, K4, K5 & K6)

1.2 Factors affecting TGA, applications of TGA. (K1, K2, K3, K4, K5 & K6)

1.3 DTG - principles, comparison of DTG & TGA. (K1, K2, K3, K4, K5 & K6)

1.4 Differential Thermal Analysis (DTA) - principle, instrumentation, simultaneous TGA and DTA curves and applications. (K1, K2, K3, K4, K5 & K6)

1.5 Differential Scanning Calorimetry (DSC) - principle, instrumentation and applications. (K1, K2, K3, K4, K5 & K6)

1.6 Thermometric titrations - principle, instrumentation and applications. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Chromatographic techniques: Gas Chromatography, principle, types, instrumentation with block diagram - carrier gas, sample injection system, column, thermal compartment, detectors, recorder. (K1, K2, K3, K4 & K5)

2.2 Applications of GC. ((K1, K2, K3, K4 & K5)

2.3 High Pressure Liquid Chromatography (HPLC) - principle, characteristics of HPLC. (K1, K2, K3, K4 & K5)

2.4 Instrumentation, applications, comparison of HPLC with GLC. (K1, K2, K3, K4 & K5)

2.5 Super Critical Fluid Chromatography (SCFC) - principle, properties, instrumentation. (K1, K2, K3, K4 & K5)

2.6 Comparison with other types of chromatography, super critical fluid extraction and applications. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Atomic absorption spectrometry - principle, difference between AAS and AES, measurement of absorption. (K1, K2, K3, K4, K5 & K6)

3.2 Instrumentation with block diagram - radiation source, atomization unit, oxidizing agents, flame and non-flame atomizer, burners, monochromators, detectors, and amplifier and readout devices. (K1, K2, K3, K4, K5 & K6)

3.3 Interferences in AAS - spectral, chemical, ionization, dissociation of metal compounds, effect of solvent. (K1, K2, K3, K4, K5 & K6)

3.4 Differences between atomic absorption and emission methods, advantages and disadvantages of atomic emission spectroscopy, advantages of AAS over flame emission spectroscopy, disadvantages of AAS. (K1, K2, K3, K4, K5 & K6)

3.5 Applications of AAS, some typical analysis like determination of metals like Na, K, Ca and Mg in blood serum, lead in petrol, metals in food stuff. (K1, K2, K3, K4, K5 & K6)

3.6 Photo acoustic spectroscopy: Principle, instrumentation with block diagram and applications. (K1, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Computers in Chemistry - introduction to computers - types of computers, hardware, software, types of software and programming languages - implementation and uses. (K1, K2, K3, K4 & K5)

4.2 C-Programming - definition, types of variables with examples, constant - definition, types with examples, C-operators - classification with examples. (K1, K2, K3, K4 & K5)

4.3 Input and output functions, control statement, loop, go to statement - functions, arrays and pointers. (K1, K2, K3, K4 & K5)

4.4 Calculation of pH, solubility product, calculation of bond energy using Born-Lande equation. (K1, K2, K3, K4 & K5)

4.5 Internet: Introduction to internet service providers in India, terms used in internet, www, http, html, TCP/IP band width, dialup service. (K1, K2, K3, K4 & K5)

4.6 ISDN and search engines. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Environmental chemistry: Water quality standards - BOD, COD, TDS, TSS & TS. (K1, K2, K3, K4, K5 & K6)

5.2 Analysis of waste water and its treatment. (K1, K2, K3, K4, K5 & K6)

5.3 Salinity of water and its treatment - Reverse Osmosis. (K1, K2, K3, K4, K5 & K6)

5.4 Toxic chemicals in environment - toxicity of mercury, lead, chromium, arsenic. (K1, K2, K3, K4, K5 & K6)

5.5 Green chemistry - principle, conditions followed in green synthesis. (K1, K2, K3, K4, K5 & K6)

5.6 Carbon-carbon bond formation in aldol condensations like silyl enol ethers in aqueous media, solid phase, supercritical water and asymmetric aldol condensation. (K1, K2, K3, K4, K5 & K6)

Reference Books:

1. H. Kaur, Instrumental Methods of Chemical Analysis, Pragati Prakashan, Meerut, 3rd Edition, 2010.
2. B. K. Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media (P) Ltd., 2014.
3. Y. Anjaneyulu, K. Chandrasekhar, Valli Manickam, A Textbook of Analytical Chemistry, Pharma Book Syndicate, Hyderabad, 2019.
4. V. K. Ahluwalia, Strategies for green organic synthesis, Ane Books Pvt. Ltd., New Delhi, 2012.
5. Willard Merritt, Dean Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, New Delhi, 7th Edition, 2018.
6. Skoog, Holler, Nieman, Principles of Instrumental Analysis, Thomson Books, United Kingdom, 5th Edition, 2005.
7. Skoog, West, Holler, Rouch, Fundamentals of Analytical Chemistry, Brooks/ Cole Cengage Learning, 9th Edition, 2013.
8. Jag Mohan, Organic Analytical Chemistry Theory and Practice, Narosa Publishing House, New Delhi, 2014.
9. A. K. De, Environmental Chemistry, New Age International Publishers, New Delhi, 7th Edition, 2010.
10. G. S. Sodhi, Fundamental Concept of Environmental Chemistry, Narosa Publishing House, 3rd Edition, New Delhi, 2013.
11. S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, S. Chand and Company Ltd., New Delhi, 2004.
12. S. M. Khopkar, Basic Concept of Analytical Chemistry, New Age International (P) Ltd. Publishers, New Delhi, 3rd Edition, 2008.

13. G. I. David Krupadanan, D. Vijaya Prasad, K. Varaprasad Rao, K. L. N. Reddy, C. Sudhakar, Analytical Chemistry, University Press, Hyderabad, Andhra Pradesh, 2001.
14. K. V. Raman, Computers in Chemistry, Tata McGraw-Hill, New Delhi, 2013.
15. Krishnan Kannan, Environmental Chemistry, Chand and Co. Ltd., 1995.
16. M. S. Yadav, Instrumental Methods of Chemical Analysis, Campus Books International, 2006.
17. A.K. Srivatasava, P.C. Jain, Instrumental Approach to Chemical Analysis, S. Chand & Company, 2010

OER:

1.https://www.americanpharmaceuticalreview.com/Featured-Articles/36776-Thermal-Analysis-A-Review-of-Techniques-and-Applications-in-the-Pharmaceutical-Sciences/
2.https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod5.pdf
3.https://www.iitk.ac.in/che/pdf/resources/AAS-GTA-reading-material.pdf
4.https://www.epa.gov/greenchemistry/basics-green-chemistry

SEMESTER III

PECHF20 - ELECTIVE III B: GREEN CHEMISTRY

Year: II SEM: III	Course Code PECHF20	Title of the Course Green Chemistry	Course Type Theory	Course Category Core Elective	H/W 5	Credits 5	Marks 100

Learning Objectives:

- To understand the goals and principles of green chemistry.
- To explain the green reactions.
- To understand the good laboratory practices and designing of green synthesis.
- To learn selected green preparations.
- To analyze the future trends in green chemistry.

Course Outcomes:

The Learners will be able to

1. Explain the goals and progress of green chemistry.
2. Summarize the principle of green chemistry and green reactions.
3. Discuss the good laboratory practices and designing of green synthesis, and to explain the mechanism and applications of certain named reactions and rearrangements.
4. Explain selected green preparations.
5. Analyze the future trends in green chemistry.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	M	H	H	H
CO2	H	M	M	H	H	H
CO3	H	M	M	H	H	H
CO4	H	M	M	H	H	H
CO5	H	M	M	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Green chemistry - definition, need for green chemistry. (K1, K2, K3, K4, K5 & K6)
1.2 Goals of green chemistry, the roots of innovation and its limitations. (K1, K2, K3, K4, K5 & K6)
1.3 Progress of green chemistry and planning a green synthesis in a chemical laboratory. (K1, K2, K3, K4, K5 & K6)
1.4 Percentage atom utilization, atom economy. (K1, K2, K3, K4, K5 & K6)
1.5 Evaluating the type and selection of starting materials. (K1, K2, K3, K4, K5 & K6)
1.6 Biocatalysts - production of bulk and fine chemicals by microbial fermentation. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Principles of green chemistry - twelve principles of green chemistry. (K1, K2, K3, K4 & K5)
2.2 Green reactions – addition and elimination reactions. (K1, K2, K3, K4 & K5)
2.3 Green reactions - substitution reactions. (K1, K2, K3, K4 & K5)
2.4 Concept of selectivity - chemoselectivity and regioselectivity. (K1, K2, K3, K4 & K5)
2.5 Enatioselectivity and diastereoselectivity. (K1, K2, K3, K4 & K5)
2.6 Green solvents - definition and uses. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Good laboratory practices - sampling preparation for analysis. (K1. K2, K3, K4, K5 & K6)
3.2 Equipment & glass wares - selection, suitability, cleaning and drying. (K1. K2, K3, K4, K5 & K6)
3.3 Designing a green synthesis - choice of starting materials (reagents, catalysts, solvents) (K1. K2, K3, K4, K5 & K6)
3.4 Mechanism and applications of Barbier and Barton reactions. (K1. K2, K3, K4, K5 & K6)
3.5 Mechanism and applications of Cannizzaro reaction. (K1. K2, K3, K4, K5 & K6)
3.6 Mechanism and applications of Claisen rearrangement and Baker-Venkataraman rearrangements. (K1. K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Green preparations - **a**queous phase reactions (hydrolysis, iodoform). (K1, K2, K3, K4 & K5)
4.2 Solid state reactions (phenyl benzoate). (K1, K2, K3, K4 & K5)
4.3 Photochemical reactions (benzopinacol, conversion of trans-stilbene into cis-stilbene). (K1, K2, K3, K4 & K5)
4.4 PTC catalyzed reactions (phenyl isocyanide, flavone). (K1, K2, K3, K4 & K5)
4.5 Microwave assisted reactions - Hofmann elimination and esterification. (K1, K2, K3, K4 & K5)
4.6 Microwave assisted reactions – saponification, preparation of Schiff's bases. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Future trends in green chemistry - green nanosynthesis (biosynthesis of nanoparticles using plant extracts). (K1, K2, K3, K4, K5 & K6)
5.2 Green analytical methods - enzymatic transformation (ethanol, benzoin). (K1, K2, K3, K4, K5 & K6)
5.3 Green polymer chemistry - polymer from renewable resources. (K1, K2, K3, K4, K5 & K6)
5.4 Redox reagents and green catalysts. (K1, K2, K3, K4, K5 & K6)
5.5 Proliferation of solvent-less reactions and biomimetic. (K1, K2, K3, K4, K5 & K6)
5.6 Combinational green chemistry, green chemistry in sustainable developments. (K1, K2, K3, K4, K5 & K6)

Reference Books:

1. V. Kumar, Introduction to Green Chemistry, Vishal Publishing Co., 1st Edition, 2007.
2. V. K. Ahluwalia, Green Chemistry, Ane Books India, 1st Edition, 2006.
3. V. K. Ahluwalia, Agarwal K., Organic Synthesis: Special Techniques, Narosa Publishing House, 1st Edition, 2005.
4. Rashmi Sanghi, M. M. Srivastava, Green Chemistry, Alpha Science, Fourth Reprint, 2009.
5. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, Cengage Learning, 9th Edition, 2013.

OER:

1. https://shodhganga.inflibnet.ac.in/bitstream/10603/55041/7/07_chapter%201.pdf (Introduction to green chemistry)
2. https://www.youtube.com/watch?v=J9SpYVx8H68 (Dr. Paul Anastas - Father of green chemistry)
3. https://www.youtube.com/watch?v=NycWPUcN4YI (Dr. Paul Anastas)
4. https://www.youtube.com/watch?v=v6V22gwqxeY (Dr. Paul Anastas)

PECHH20 - ELECTIVE IVB: ORGANIC FARMING AND SOLID WASTE MANAGEMENT

Year: II **SEM:** IV	**Course Code** PECHH20	**Title of the Course** Organic Farming and Solid Waste Management	**Course Type** Theory	**Course Category** Core Elective	**H/W** 5	**Credits** 4	**Marks** 100

Learning Objectives:

- To understand the importance of solid waste management.
- To learn about hazardous waste management.
- To get a thorough knowledge on the concept of organic farming, components and practices.

Course Outcomes:

The Learners will be able to

1. Elaborate the concept of organic farming.
2. Explain the vision and importance of organic farming movements, apply vermicomposting process and prepare bio-fertilizers.
3. Evaluate the technology to approach the benefits of organic farming.
4. Explain the various aspects of solid waste management.

5. Demonstrate the methods to reduce hazards.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Organic farming - concepts, relevance of organic farming to Indian agriculture. (K1, K2, K3, K4, K5 & K6)
1.2 Effects of green revolution, adverse effects of continuous use of chemicals. (K1, K2, K3, K4, K5 & K6)
1.3 Categories of organic farming, organic vs natural farming. (K1, K2, K3, K4, K5 & K6)
1.4 Essential characteristics of organic farming. (K1, K2, K3, K4, K5 & K6)
1.5 Key principles in organic farming system - components of organic farming systems. (K1, K2, K3, K4, K5 & K6)
1.6 Management of organic farming - research needs. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Principles and practices of organic farming. (K1, K2, K3, K4 & K5)
2.2 The vision and importance of organic farming movements. (K1, K2, K3, K4 & K5)
2.3 Guidelines for organic production system - organic farming practices - bulky organic manures. (K1, K2, K3, K4 & K5)
2.4 Role of micro-organisms (bio-fertilizers) in organic farming. (K1, K2, K3, K4 & K5)
2.5 Vermitechnology. (K1, K2, K3, K4 & K5)
2.6 Research advances in organic farming. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Benefits of organic farming**.** (K1, K2, K3, K4, K5 & K6)
3.2 Nutritional values of organic foods. (K1, K2, K3, K4, K5 & K6)
3.3 Health benefits of organic foods. (K1, K2, K3, K4, K5 & K6)
3.4 SREP approach for promoting organic farming. (K1, K2, K3, K4, K5 & K6)

3.5 Use of organic practices in enhancing crop productivity. (K1, K2, K3, K4, K5 & K6)
3.6 Participatory technology development in organic farming. (K1, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Solid Waste Management - introduction. (K1, K2, K3, K4 & K5)
4.2 Classification of solid wastes. (K1, K2, K3, K4 & K5)
4.3 Mismanagement and side effects. (K1, K2, K3, K4 & K5)
4.4 Physical and chemical characteristics. (K1, K2, K3, K4 & K5)
4.5 Waste collection, storage and transport. (K1, K2, K3, K4 & K5)
4.6 Waste disposal - types - composting, incineration, bio gasification. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Plastics, bio medical and hazardous waste management. (K1, K2, K3, K4, K5 & K6)
5.2 Various types of plastics - plastic recycling and the environment. (K1, K2, K3, K4, K5 & K6)
5.3 Guidelines for the plastic waste hazards control. (K1, K2, K3, K4, K5 & K6)
5.4 Sources of biomedical waste - pathological waste, pharmaceutical wastes, genotoxic wastes, chemical wastes, radioactive wastes. (K1, K2, K3, K4, K5 & K6)
5.5 Measures to reduce hazards. (K1, K2, K3, K4, K5 & K6)
5.6 Household hazardous waste management - precautions, disposal, waste minimization. (K1, K2, K3, K4, K5 & K6)

References Books:

1. L. V. Hirevenkanagoudar, Extension Strategies for Promotion of Organic Farming, Agrotech Publishing Academy, 2007.
2. B. B. Hosetti, Prospects and Perspectives of Solid Waste Management, New Age International Publishers, 2006.
3. A. Kamala, D. L. Kanth Rao, Environmental Engineering, Water Supply, Sanitary Engineering and Pollution, Tata McGraw-Hill Publishing Ltd., New Delhi, 13th Reprint, 2002.
4. S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd., 7th Edition, 2004.
5. B. K. Sharma, Environmental Chemistry, Goel Publishing House, Meerut, 2005.

OER:

1. http://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2. https://www.nationalgeographic.com/environment/future-of-food/organic-farming-crops-consumers/
3. https://www.britannica.com/topic/organic-farming
4. https://www.conserve-energy-future.com/sources-effects-methods-of-solid-waste-management.php
5. https://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/WEDC/es/ES07CD.pdf
6. https://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/videunilgtspejigaattistiba/VidZ1000/16.LECTURE-Solid_waste_management.pdf
7. http://www.indiaenvironmentportal.org.in/files/file/municipal%20solid%20waste%20management.pdf

PICHJ20 - IEP - LEATHER CHEMISTRY

Year: II **SEM**: IV	**Course Code** PICHJ20	**Title of the Course** Leather Chemistry	**Course Type** Theory	**Course Category** Independent Elective	**H/W** Own Pace	**Credits** 2	**Marks** 100

Learning Objectives:

The Learners will be able

- To acquire technical competence on leather manufacturing with eco -friendly and sustainable approach.
- To develop indigenous and adaptable technologies related to leather for small scale production and to develop entrepreneurial skills, towards betterment of society.
- To develop state-of-art facilities for testing and consultancy for leather industries.

Course Outcomes:

The Learners will be able to

1. Outline the tanning processes in leather industry.
2. Discuss the cleaner technology in leather industry.
3. Illustrate the chrome tanning process.
4. Outline the mechanism of tanning and role of surface charge and importance of electrostatic, H-bond, dipole-dipole and hydrophobic interactions.
5. Apply waste water management and zero discharge approaches in leather industry.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	L	M
CO2	H	H	M	H	L	M
CO3	H	M	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I

1.1 Raw materials, stages in the leather processing. (K1 & K2)
1.2 Pre-tanning operations - soaking, liming, deliming, bating, pickling, degreasing. (K1 & K2)
1.3 Tanning process - chrome tanning, vegetable tanning. (K1 & K2)
1.4 Post-tanning operations - rechroming of wet blue leathers, neutralization. (K1 & K2)
1.5 Retanning, dyeing and fatliquoring. (K1 & K2)

1.6 Drying and finishing. (K1 & K2)

Unit II

2.1 Environmental challenges in leather industries. (K1 & K2)

2.2 Cleaner technology options - curing, air drying, frame drying, freezing, chemical methods, biocides for curing and control drying. (K1 & K2)

2.3 Desalting, soaking after desalting. (K1 & K2)

2.4 Liming and unhairing. (K1 & K2)

2.5 Advantages of sulphide free unhairing system by using dehairing process, advantages of less sulphide unhairing system, and advantages of sulphide lime unhairing system. (K1 & K2)

2.6 Deliming and bating. (K1 & K2)

Unit III

3.1 Chrome tanning - method of chrome tannage, masking principle of masking, effect of masking on chrome tannage. (K1 & K2)

3.2 Influence of reducing agent on nature of chrome complexes. (K1 & K2)

3.3 Mechanism of chrome tanning, variable parameters of chrome tanning. (K1 & K2)

3.4 Wet finishing operations - rechroming, neutralization, retanning, dyeing, fatliquoring and finishing. (K1 & K2)

3.5 Chrome management options - chrome recovery and reuse - partial replacement of chrome tanning agent by other tanning agents. (K1 & K2)

3.6 High exhaust tanning systems - closed loop tanning systems. (K1 & K2)

Unit IV

4.1 Mechanism of tanning - transport of tanning materials into pelt. (K1 & K2)

4.2 Role of surface charge and importance of electrostatic, H-bond, dipole-dipole and hydrophobic interactions. (K1 & K2)

4.3 Theory of finishing with special emphasis to optical properties of pigments and binders. (K1 & K2)

4.4 Diffusion equilibria and mechanism of vegetable, mineral and combination tannages. (K1 & K2)

4.5 Role of crosslinking in leather finishing. (K1 & K2)

4.6 Fibre coating in matrix stability. (K1 & K2)

Unit V

5.1 Quality control in leather processing. (K1 & K2)

5.2 Tannery effluents, effluent disposal, types of effluent disposal. (K1 & K2)

5.3 Recovery and reuse of water in tanning industry, utilization of treated effluents. (K1 & K2)

5.4 Productivity and quality consistency. (K1 & K2)

5.5 Waste water management and zero discharge approaches. (K1 & K2)

5.6 Energy audit and environmental footprints. (K1 & K2)

Reference Books:

1. P. S. Briggs, Gloving, clothing and special leathers, Tropical Products Institute, London, 1981.
2. J. H. Sharphouse, Leather Technicians Hand Book, Leather Producers Association, Northampton NN3 1 JD, Reprinted 1995.

3. O. Flaherty, William T. Roddy and Robert M. Lollar, The Chemistry and Technology of Leather, Vol. 1, Preparation for tannages, EL. Robert Krieger Publishing Company, New York, 1978.
4. Bienkiewicz, Physical Chemistry of Leather Making, Krieger Publishing Co., Florida, 1982.
5. D. Covington, Tanning Chemistry: The Science of Leather, Royal Society of Chemistry, 2009.

OER:

1. http://wwwchem.uwimona.edu.jm/courses/CHEM2402/Textiles/Leather.html
2. https://www.researchgate.net/publication/337720281_Leather_Processing_Its_Effects_on_Environment_and_Alternatives_of_Chrome_Tanning
3. https://www.iloencyclopaedia.org/component/k2/item/872-tanning-and-leather-finishing
4. https://shodhganga.inflibnet.ac.in/bitstream/10603/7476/10/10_chapter%201.pdf
5. https://www.researchgate.net/publication/337720281_Leather_Processing_Its_Effects_on_Environment_and_Alternatives_of_Chrome_Tanning
6. https://shodhganga.inflibnet.ac.in/bitstream/10603/75047/14/14_chapter%206.pdf
7. http://en.kimyasal.boun.edu.tr/webpages/courses/leathertechnology/deri16.htm
8. https://www.researchgate.net/publication/223418622_Reducing_the_environmental_impact_of_the_unhairing-liming_process_in_the_leather_tanning_industry