Course Name: Master of Science
Discipline: Chemistry
CHOICE BASED CREDIT SYSTEM
(For those who joined in June 2023 and after)
Course scheme:

II year M.Sc. CHEMISTRY

Semester	Part	Subject Name	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of Revision
III	Core VII	**Organic Chemistry III**	5	4	25+75=100			✔						✔			**P24CHC31**	**10 % Revised**
	Core VIII	Inorganic Chemistry III	5	4	25+75=100			✔						✔			**P24CHC32**	**Mark Change**
	Core IX	Physical Chemistry III	5	4	25+75=100			✔						✔			**P24CHC33**	**Mark Change**
	Core IV Lab	**LAB:** Organic Chemistry Practical II	4	-	-----			✔								✔	-	-
	Core V Lab	**LAB:** Inorganic Chemistry Practical II	4	-	-----			✔								✔	-	-
	Core VI Lab	**LAB: Physical Chemistry Practical**	4	3	40+60=100			✔								✔	**P24CHCP31**	**New**
	Elective II	**Medicinal and Pharmaceutical Chemistry / Polymer Chemistry**	3	3	25+75=100			✔						✔			**P24CHE31/ P24CHE32**	**Credit Change**
	Total		**30**	**18**														
	Internship Programme (Extra Credit)		**60**	**2**													**P24IP31**	**New**
IV	Core XI	**Organic Chemistry IV**	5	4	25+75=100			✔						✔			**P24CHC41**	**10 % Revised**
	Core XII	**Inorganic Chemistry IV**	5	4	25+75=100			✔						✔			**P24CHC42**	**20 % Revised**
	Core XIII	**Physical Chemistry IV**	5	4	25+75=100			✔						✔			**P24CHC43**	**10 % Revised**
	Core IV Lab	**LAB: Organic Chemistry Practical II**	4	4	40+60=100			✔								✔	**P24CHCP41**	**Credit Change**
	Core V Lab	**LAB: Inorganic Chemistry Practical II**	5	5	40+60=100			✔								✔	**P24CHCP42**	**Credit Change**
	NME 3	**Project & Viva-voce**	6	5	40+60=100			✔								✔	**P24CH4PV**	**Credit Change**
	Total		**30**	**26**														

Self-Learning Courses:

Year	Semester	Subject	Credit	Ext =Tot	% of Change	Subject Code
II	III	Applied Chemistry	5	100 = 100	No Change	P22CHSL31
II	III	Critical Analysis of Gate/ MICR-Net Questions	5	100 = 100	No Change	P22CHSL32

SEMESTER-III

PART–III- CORE SUBJECT I- ORGANIC CHEMISTRY III

Hours per week: 5 **Credits: 4** **Subject Code: P24CHC31**

Course Outcome:

CO 1: To plan and execute organic synthesis and reagents.
CO 2: To get mastery over photochemical reactions and analytical techniques used in organic chemistry.
CO 3: To study the mechanism of Molecular rearrangements.
CO 4: To understand the knowledge about heterocycles and carbohydrate.
CO 5: To acquire the knowledge about reagents used in oxidation and reduction.

Unit I: Synthetic methods I and Reagents (15 hours)

Introduction to Organic synthesis - C-C bond forming reaction – functional group modification – 1,2-carbonyl addition- 1,4-carbonyl addition- nucleophilic addition to carbonyl compounds and olefin)-synthetic methods – Planning a synthesis – molecular history- Relay approach-starting material-Activating groups-protecting groups - molecular size –convergent approach-carbon skeletal complexity (Robinson annulation, Michael addition, Diel-Alder reaction)

Reagents in Organic synthesis – Gilman's reagent (lithium dimethylcuprate) - LDA (lithium diisopropylamide), 1,3-dithiane (Umpolung synthesis), DCC (dicyclohexylcarbodiimide), DDQ (2,3-dichloro-5,6-dicyanobenzoquinone), Woodward and Prevost hydroxylation, Baker yeast, Phase transfer catalyst.

Reference books :

1. R.E.Ireland, Organic synthesis, Prentice – Hall of India Pvt. Ltd., 1975.
2. R.T.Morrison and R.N.Boyd, Organic Chemistry, Prentice – Hall of India, New Delhi, 6th Edn., 1995.
3. Stuart Warren and Paul Wayatt, Organic Synthesis:The Disconnection Approach, II Edn, Wiley and Sons, Ltd., 2008
4. W.Carruthers and Iain Coldhain, Modern Methods in Organic Synthesis, 4th Edn., Cambridge University Press, U.K., 2008
5. F.A.Carey and R.J.Sundberg, Advanced Organic Chemistry, Part B, V Edn., Springer, New York, 2007.
6 R.O.C.Norman, Principles of Organic Synthesis, Methuen & co Ltd, 1968.
7. H.O.House., Modern Synthetic Reactions, W.A.Benjamin Inc. California, 2nd Edn., 1972.
8.P.S. Kalsi, Organic reactions and their Mechanisms, New Age International(P) Limited,Publishers,2nd Edn., 2007.

Unit II: Organic photochemistry (15 hours)

Organic photochemistry: Laws of Photochemistry: Grothus-Draper Law, Stark-Einsteins Law, Basic laws of light absorption -Beers-Lamberts Law, Quantum yield – electronic excitation – allowed and forbidden transition – Jablonski diagram-radiative and non-radiative process – singlet and triplet states-Photochemical reactions (primary and secondary step) – photosensitization- photochemistry of olefins (dimerization – *cis-trans*-isomerisation) Reaction of conjugated olefins; di- π-methane rearrangements (including oxa- and aza- di-π -methane rearrangements)– Photochemical reactions of ketones (Norrish type I and Norrish type II reactions) –Paterno-Buchi reaction – Photo-oxidation and photo reduction.

Reference books:

1. C.H.Depuy and O.L.Chapman,Molecular reactions and Photochemistry, Prentice Hall, New York, 1988.
2. Arora(M.G), Organic Photochemistry and Pericyclic Reactions, Anmol Publications Pvt. Limited, 2007
3. Gurdeep R. Chatwal, Organic Photochemistry, Himalaya Publishing House, 2007

Unit III: Molecular rearrangement (15 hours)

Mechanism of the following rearrangement reactions – Carbon to carbon migration (Wagner-Meerwein, Demzanov, Wolff and dienone-phenol rearrangement)-Carbon to nitrogen migration (Curtius, Schmidt and Lossen rearrangement) - Carbon to oxygen migration (Bayer-Villiger, Favorskii rearrangement)- Rearrangement proceeding through carbanions (Stevens and Sommelet-Hauser rearrangement). Free radical reactions –Barton, Sand Meyer, Gomberg and Hundsdiecker reaction.

Reference books:

1. J. March, Advanced Organic Chemistry, John Wiley & sons, 4th Edn., New York , 1992.
2. I.L. Finar, Organic Chemistry , Vol. II , 5th Edn., Pearson Education Ltd., New Delhi, 2011.
3. P.S. Kalsi, Organic reactions and their Mechanisms, New Age International(P) Limited,Publishers,2nd Edn., 2007.
4. V.K.Ahluwalia and R.K.Parashar, Organic reactions and their Mechanisms, Narosa publishing House, II Edn., New Delhi, 2005

Unit IV: Heterocyclic compounds and Carbohydrates (15 hours)

Heterocyclic compounds: Nomenclature of heterocycles having not more than two hetero atoms-Structure, synthesis and reactions of Oxazole, Imidazole, Thiazole, Coumarin and Flavone -Anthocyanins (Quercetin and Cyanin) –Pyrimidines (Uracil) and Purines (Structural elucidations of Caffeine, Theobromine and Theophylline).

Alkaloids: Classification - general properties – general methods of elucidating the structure of the alkaloids - Structure, synthesis and stereochemistry of the following alkaloids –Quinine (Quinoline alkaloid) – Morphine (Iso-quinoline alkaloid) – Reserpine (Indole Alkaloid) – Biosynthesis of alkaloids.

Reference books:

1.Raj K.Bansal, Hereocyclic chemistry, Wiley Eastern Limited, New Delhi, 1990.
2. S.F.Dyke, Chemistry of Carbohydrates, Interscience Publishers Ltd., London, 1960.
3. J.L.Jain, Fundamental of Biochemistry, 4thEdn., S.Chand& Company Ltd., New Delhi, 1998.
4.Gurdeep R. Chatwal, Organic chemistry of Natural Products Vol I, Himalaya Publishing House, 2011, India.
5.O.P.Agarwal , Chemistry of Organic Natural Products, Vol.I, Goel Publishing House, Meerut, 2008.

Unit V: Oxidation and reduction (15 hours)

Reaction mechanism, application and stereochemical aspects of the following Oxidation and Reduction reactions – Oxidation reactions involving CrO_3, SeO_2, OsO_4, lead tetraacetate, periodic acid, NBS, H_2O_2 – Oppenauer oxidation.

Reduction involving catalytic hydrogenation, electron transfer, hydride transfer ($LiAlH_4$, and $NaBH_4$) reduction, DIBAL(diisobutylaluminium hydride), TIBAL-H (triisobutoxyalumino hydride), Hydroboration- Birch reduction –MPV reduction- Wolff Kishner reduction – Hauang – Minlon reduction.

Reference books:

1. P.S. Kalsi, Organic reactions and their Mechanisms, New Age International(P) Limited,Publishers,2ndEdn., 2007.
2. V.K.Ahluwalia and R.K.Parashar, Organic reactions and their Mechanisms, Narosa publishing House, II Edn., New Delhi, 2005
3. H.O.House., Modern Synthetic Reactions, W.A.Benjamin Inc. California, 2ndEdn., 1972.
4. P.S. Kalsi, Organic reactions and their Mechanisms, New Age International(P) Limited,Publishers,2ndEdn., 2007.

e-Resources:

1. https://nptel.ac.in/courses/104105034
2. https://www.soinc.org/sites/default/files/uploaded_files/forensics/For_Chromatography3.pdf
3. https://microbenotes.com/chromatography-principle-types-and-applications/
4. https://egyankosh.ac.in/bitstream/123456789/15757/1/Unit-13.pdf
5. http://stpius.ac.in/crm/assets/download/Photochemistry.pdf
6. https://application.wiley-vch.de/books/sample/3527347852_c01.pdf
7. https://tmv.ac.in/ematerial/chemistry/kpb/SEM_IV_HonoursRearrangement%20final.pdf

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Semester III – Part III – Core Subject VIII – Inorganic Chemistry III

Hours per week: 5 **Credits: 4** **Subject Code: P24CHC32**

Objectives:

CO1: To understand the link between coordination compounds and biomolecules
CO2: To appreciate the importance of coordination compounds and biomolecules
CO3: To have an idea to interpret the electronic spectra of any coordination compound.
CO4: To analyze the EPR spectra of inorganic compounds
CO5: To be well versed in NMR and NMR and Mossbauer Spectroscopy

Unit I: Bioinorganic Chemistry I **15 hours**

Porphyrin ring system – metalloporphyrins – cytochrome-C – dioxygen binding transport and utilization - hemoglobin and myoglobin – structure and work function – Synthetic oxygen carrier - physiology of blood - Chlorophyll – structure – photosynthetic sequence – Corrin ring system – Vitamin B12 and Vitamin B12 coenzymes – *in vivo* and *in vitro* Nitrogen fixation.

Essential and trace elements in biological system – Molecular mechanism of ion transport across membrane – natural and synthetic ionophores – sodium - potassium ion pump.

Unit II: Bioinorganic Chemistry II **15 Hours**

Metalloenzymes– superoxide dismutase, peroxidases and catalases. Zinc enzymes –structure and function - Carboxypeptidase A – Carbonic anhydrase and Alcohol dehydrogenase –structural role of zinc and zinc constellations.

Non-heme iron proteins – iron-sulphur proteins – Copper containing proteins –classification – blue copper protein – structure and function.

Chelate therapy – detoxification of metal poisoning in functional groups of enzyme –anticancer activity of cis-platin – interactions of cis-platin with DNA. Gold compounds as antiarthritic agents - Metals in radiodiagnosis and MRI.

Unit III: Electronic Spectra **15 hours**

LS coupling – Term symbols for ground and excited state – d-d transition – Charge transfer transition – selection rules – mechanism of breakdown of selection rules – bandwidths and shapes – Orgel diagram – Tanabe-Sugano diagram – Electronic spectra of transition metal complexes - Jahn-Teller effect – evaluation of 10Dq and β for octahedral complexes of d^2, d^3, d^6, d^7 and d^8 configurations.

Unit IV: EPR Spectroscopy of Inorganic Compounds **15 hours**

Principle of EPR – presentation of the spectrum – hyperfine splitting – g value – isotropy and anisotropy in g value – factors affecting the magnitude of g values – zero field splitting – Kramer's degeneracy – anisotropy and hyperfine splitting constant – Application of EPR in transition metal complexes VO^{2+} Fe^{3+} Co^{2+} ,Mn^{2+} and bis-salicylaldimine copper (II) –Covalency of metal complexes (Copper) - Jahn-Teller distortion studies in Cu(II) complexes .

Fundamentals of ENDOR techniques.

Unit V: NMR and Mossbauer Spectroscopy **15 hours**

NMR : Introduction – applications of ^{31}P, ^{19}F and ^{15}N - NMR spectroscopy used in structural problem – evaluation of rate constants – NMR of fluxional molecules – NMR of paramagnetic molecules –contact shifts and Pseudo contact shift and Lanthanide shift reagents.
Mossbauer spectroscopy: Mossbauer effect resonance absorption – Doppler effectDoppler velocity – Experimental technique of measuring resonance absorption – isomer shift –effect of quadruple nucleus – magnetic hyperfine splitting – Applications of Mossbauer spectroscopy in the study of iron, gold and tin complexes.

Reference Books:

Units I & II

1. K.Hussain Reddy Bioinorganic Chemistry, New Age International Publishers, New Delhi, 2009.
2. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4th edition, Pearson Education Inc.,2006.
3. L.Stryer, Biochemistry, IV Edn., Freemann and Company, New York,1995.
4. D.L Nelson &M.M.Cox, Lehninger, Principles of Biochemistry , 5th edition, Freemann and Company, New York, 2011.

e-Resources:

1.biologydictionary.net › porphyrin
2.byjus.com › Biology › Biology Difference Between
3.chem.libretexts.org › ... › Proteins › Case Studies: Proteins
4.chemistry.du.ac.in › study_material › Nitrogen fixation.pdf
5.en.wikipedia.org › wiki › Carboxypeptidase_A
6.chem.libretexts.org › ... › 9: Metals in Medicine

Unit III

1. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4th edition, Pearson Education Inc.,2006.
2. F.A.Cotton and G.Wilkinson, Advanced Inorganic Chemistry, 6th edition, John Wiley & Sons, New York, 2006.
3. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Science, 2000.
4. D.F.Shriver, P.W.Atkins and C.H.Langford, Inorganic Chemistry, 3rd edition, Oxford Univ.Press, 1999.
5. R.S. Drago, Physical Methods in Inorganic Chemistry , Van Nostrand Reinhold Co., New York (1965).
6. D.N.Sathyanarayana, Electronic Spectroscopy and Related Techniques, Universities Press Limited, 2001.

e-Resources:

1.www.vpscience.org › materials › US06CCHE22 Term Symbol
2. www.hhrc.ac.in › ePortal › Chemistry

Units IV & V

1. R.S. Drago, Physical Methods in Inorganic Chemistry, Van Nostrand Reinhold Co., New York, 1965.

2. Atkins, Overton. Inorganic Chemistry-IV Edn, 2006.
3. E.B.A. Ebsworth, D.W.H. Ranklin and S. Gadock Structural Methods in Inorganic Chemistry, ELBS Edn., 1988.
4. R. L. Dutta and A. Syammal, Elements of Magnetochemistry, 2nd edition, EWP Pvt. Ltd., New Delhi, 1993.

e-Resources:

1.sites.cns.utexas.edu › epr_facility › what-epr
2.chem.libretexts.org › ... › Electron Paramagnetic Resonance
3.en.wikipedia.org › wiki › Electron_nuclear_double_resonance
4.wwwchem.uwimona.edu.jm › courses › JahnTeller
5.dradchem.files.wordpress.com › 2016/06 › file-7-esr-applications
6.chem.ch.huji.ac.il › nmr › whatisnmr › whatisnmr
7.epgp.inflibnet.ac.in › 12.organic_spectroscopy › 9112_et_et_19
8.www.ilpi.com › organomet › fluxional
9.en.wikipedia.org › wiki › Mössbauer_spectroscopy
10.www.blogs.uni-mainz.de › files › 2017/11 › Moessbauer_Lectures

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Semester III– Part III – Core Subject IX – Physical Chemistry III

Hours per week: 5 **Credit: 4** **Subject code: P24CHC33**

Course Outcome:

CO1: To discuss the need for statistical thermodynamics, basic concepts of chemical kinetics, catalysis and Group theory.
CO2: To predict entropy of mono-atomic gases, various theories and their validity for the study of uni & bi-molecular reactions and the spectral selection rules of molecules with the aid of their symmetric properties.
CO3: To apply the concepts of Huckel molecular -orbital calculations for the prediction of delocalization energies of π-electron systems, the study of reaction mechanism to fix the explosion limit of gas phase reactions and group theory for the theoretical prediction of hybridization in molecules.
CO4: To establish kinetics and mechanism for several branched and non-branched chain reaction and catalytic reactions and to construct the character tables using Great Orthogonality theorem.
CO5: To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics and can develop applications of homogeneous, heterogeneous and enzyme catalytic reactions.

Unit I: Statistical Thermodynamics **15 Hours**

Canonical – Grand canonical and microcanonical ensembles- Maxwell-Boltzmann most probable distribution law and its derivation –Thermodynamic probability and entropy (Boltzmann – Planck equation) – Entropy of mono atomic gas or vapour (Sakur – Tetrdode equation). Partitions functions – translational, rotational vibrational and electronic partition functions –

calculation of thermodynamic properties in terms of partition functions –partition functions and equilibrium constant. Quantum statistics - Fermi-Dirac statistics, Bose-Einstein's statistics – Photon gas and electron gas according to such statistics – Einstein's and Debye's theories of heat capacities of solids – Statistical thermodynamics of ortho&para hydrogen – Calculation of residual entropy of hydrogen.

Unit II: Chemical kinetics I **15 Hours**

Brief resume of basic terms of chemical kinetics; Rate of a reaction, order &molecularity of a reaction, Empirical rate laws and units of rate and rate constants – influence of temperature on the rate of reaction – Arrhenius equation – Determination of activation energy of a reaction – Problems; Steady state approximation; Theories of reaction rates – Bimolecular collision theory and Absolute Reaction Rate Theory (ARRT); Theories of uni-molecular reactions – Lindemann's treatment – Rice, Ramsperger and Kassel (RRK) theory – The RRKM (Marcus) theory – Slater's theory; Reactions in solutions – influence of solvent dielectric constant, effect of ionic strength – Bronsted - Bjerrum equation – primary and secondary kinetic salt effect – effect of pressure on reaction rates – significance of volume of activation; Chain reactions and non-branched chain reactions – Kinetics and mechanism of H_2 - Br_2 reaction, Decomposition of CH_3CHO with order 3/2 and 1/2; Branched chain reactions; Explosion limits for gas phase reaction between H_2 and O_2.

Unit III: Catalysis **15 Hours**

Homogeneous catalysis – acid base catalysis – van't Hoff and Arrhenius intermediates for protolytic and prototropic mechanisms; Catalysis in Biological systems – enzyme catalysis – Michaelis – Menten kinetics – Line weaver and Burk plot – influence of pH on the enzyme catalysis; Heterogeneous catalysis – kinetics and mechanism of uni-molecular and bimolecular reactions – Langmuir-Hinshelwood and Langmuir - Rideal mechanism – ARRT of surface reactions.

Unit IV: Introduction to group theory **15 Hours**

Molecular symmetry elements and symmetry operations – various operations with illustrations; Groups and their basic properties – symmetry point group classification – rotational (C), dihedral (D), tetrahedral (Td) and octahedral (Oh) point groups; Order of a group - Classes and similarity transformation – Group multiplication table – cyclic and inverse rule – matrix representation of symmetry operations; Trace or character of the matrix – reducible and irreducible representations – Mulliken notation - Great orthogonality theorem – construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups.

Unit V: Application of group theory to solve spectroscopic and molecular problems **15 Hours**

Symmetry of normal modes of vibrations: linear ($C_{\infty v}$) and non-linear (C_{2v} and C_{3v}) molecules – physical basis of spectroscopic selection rules – properties of dipole moment, polarizability and definite integrals – IR and Raman active vibrational normal modes of homonuclear diatomic molecule (N_2) and heteronuclear diatomic linear molecules (CO and HCN) and non-linear molecules (H_2O, NH_3 & BF_3) – Mutual exclusion principle with illustration (CO_2 and XeF_4); Prediction of electronic transition and selection rules of organic compounds such as formaldehyde, ethylene and benzene; Group theoretical prediction of types of hybridization in

CH_4, BF_3 and $PtCl_4^{2-}$ systems.Application of Hückel Molecular Orbital theory to electronic conjugated system: Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene.

Text Books:

1. J.N. Gurtu and A. Gurtu, Advanced Physical Chemistry, Pragati Prakashan Pub., Eighteenth Edn., 2015.
2. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd Edn., Narosa Publishing House, New Delhi,1991.
3. V.Ramakrishnan, & Gopinath, Group Theory in Chemistry, New Delhi: Vishal Publications, 2nd Edition, 2013
4. A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition.
5. D.N.Bajpai, Advanced Physical Chemistry. New Delhi**:** S.Chand& Co.,Ltd.,1st Edition, 2011.
6. B.R Puri**,**. .L. R. Sharma and M.S.Pathania, Principles of Physical Chemistry. New Delhi, Vishal Publishing Co**,** 1st Edition, 2003**.**

Reference Books:

1. D. A. McQuarrie and J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books (P) Ltd., New Delhi, 1998.
2. S.Gurdeep Raj, Advanced Physical Chemistry, Meerut: Goel Publishing Co.25thEdition, 2003.
3. P.W. Atkins, and J.D. Paula, Physical Chemistry. New York: ELPS and Oxford University press, 7th Edition, 2012.
4. K.V.Raman, Group Theory and Its Applications to Chemistry. New York: Tata McGraw-Hill Publishing Company, 1st Edition, 1990.
5. F. A. Cotton, Chemical Applications of Group Theory, 3rdEdition, John Wiley and Sons, New York, 1999.
6. A.Salahuddin Kunju, and G. Krishnan, Group Theory and Its Application in Chemistry.Delhi: PHI Learning Pvt. Ltd., 3rdEdition, 2015.
7. G. Davison, Introduction to Group Theory for Chemist, Applied Sci., Pub., Ltd., London, 1971.
8. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Co., London, 1977.

e - Resources:

1. https://nptel.ac.in/courses/104101124
2. https://ipc.iisc.ac.in/~kls/teaching.html
3. https://drive.google.com/file/d/1zOzNV_gNlJLkXWtYee7PIe2V60Q12CDJ/view?usp=drivesdk – Basics of Chemical kinetics_pdf study material
4. https://youtube.com/playlist?list=PLxgQTTdYjh9pYy8abUUqDZibHbnDvJqbS - Chemical Kinetics
5. https://www.google.co.in/url?sa=t&source=web&rct=j&url=http://www.jiwaji.edu/pdf/ecourse/chemistry/Chemical%2520Kinetics.pdf&ved=2ahUKEwirhKvyv5z1AhUDsVYBHX5IA6g4ChAWegQIDxAB&usg=AOvVaw3AoZV_FpJBePZfCvOrX-tl – Chemical kinetics

6. .https://www.google.co.in/url?sa=t&source=web&rct=j&url=http://mpbou.edu.in/slm/mscche1p4.pdf&ved=2ahUKEwiRrLLG4Zr1AhXSwosBHT46BDUQFnoECAMQAQ&usg=AOvVaw1Z7DbM1yusaSajeBkxqWNS– Symmetry & Group theory Study Material

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<table>
<tr><td>Title of the Course</td><td colspan="7">PHYSICAL CHEMISTRY PRACTICAL</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">P24CHCP31</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>1</td><td colspan="3">4</td><td colspan="2">5</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basic knowledge of physical chemistry</td></tr>
<tr><td>Objectives of the course / Course outcome</td><td colspan="7">Will be in a position to apply the theoretical concepts of electrochemistry, partition coefficients, chemical kinetics, surface chemistry and spectroscopy by the way of performing simple experiments.
Will be able to extend the applications of potentiometric and conductometric techniques to find out dissociation constant of weak electrolytes, pH of solutions and solubility of sparingly soluble salts.
Can calculate various physical constants by the way of performing experiments.
Will be able to interpret the UV Visible and IR spectra and spectrofluorometric data of simple compounds.
Can establish the applications of various techniques learnt for designing projects.</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT-I: Conductivity Experiments
1.Determination of equivalent conductance of a strong electrolyte &the verification of DHO equation.
2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.
3. Verification of Kohlrausch's Law for weak electrolytes.
4. Determination of solubility of a sparingly soluble salt.
5. Acid-base titration (strong acid and weak acid vsNaOH).
6. Precipitation titrations (mixture of halides only).</td></tr>
<tr><td colspan="7">UNIT-II: Kinetics
1. Kinetic study of the reaction between $K_2S_2O_8$ and KI – second order reaction under equimolar concentration.
2. Study the Study the effect of ionic strength on the rate of the above reaction: Bronsted – Bjerrum equation</td></tr>
</table>

	UNIT-III: Distribution experiments (i) Distribution of iodine between CCl_4 and H_2O (a) Determination of partition coefficient (b) Determination of equilibrium constant of the reaction $KI + I_2 \rightarrow KI_3$ (c) Determination of concentration of given KI solution method. **(ii)** Distribution of benzoic acid between water and benzene
	UNIT IV: Adsorption Experiments 1. Adsorption of oxalic acid on charcoal 2. Adsorption of acetic acid on charcoal Determination of surface area (Freundlich isotherm only)
	Unit V: Potentiometric methods 1. Precipitation titration: Ag^+ *vs* halide mixture 2. Redox titrations: a) permanganate *vs* iodide ion b) dichromate*vs* ferrous ion. 3. Determination of dissociation constant of weak acids 4. Determination of pH of buffer solutions 5. Determination of solubility product of sparingly soluble salts.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Titrations using pH meter (Class work only) Determination of first, second and third dissociation constants of phosphoric acid. Experiments based on UV-Visible, Infrared spectrophotometers and spectrofluorometer. (Class work only) *Field/Industrial visit (Report submission only)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009. 2. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996. 3. V.D. Athawale and ParulMathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008. 4. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011.
Reference Books	1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001. 2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

	3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987. 4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014. 5. F. Jensen, Introduction to Computational Chemistry, 3rd Ed., Wiley-Blackwell.
Website and e-learning source	https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:
CO1: To recall the principles associated with various physical chemistry experiments.
CO2: To scientifically plan and perform all the experiments.
CO3: To observe and record systematically the readings in all the experiments.
CO4: To calculate and process the experimentally measured values and compare with graphical data.
CO5: To interpret the experimental data scientifically to improve students' efficiency for societal developments.

Semester - III - Part – III – Major Elective III
Medicinal and Pharmaceutical Chemistry

Hours per week: 3 **Credits: 3** **Subject Code: P24CHE31**

Course Outcome:
CO1: To get mastery over all the fundamentals of medicinal chemistry.
CO2: To know the concepts of prodrugs, agonist & medicinally useful antibiotics and hormones
CO3: To have a knowledge on a few important Chemotherapeutic agents
CO4: To study the synthesis, mechanism, action and applications of various types of drugs.
CO5: To learn the synthesis, SAR and therapeutic uses of anti-inflammatory and CNS drugs

Unit I: Fundamentals of Medicinal Chemistry **12 hours**

Definitions of Medicinal Chemistry, Pharmacology, Pharmacodynamics, Pharmacognosy, drugs – Nature and sources of drugs, routes of administration of drugs – General principle of drug action – drug action at active sites – biotransformations of drug – factors affecting the drug action – catalytic role of enzymes.
Receptor – Drugs – receptor bonding, Drug action at receptor – theories of receptor – QSAR – Hansch approach, Craig plot – bioisosteres.

Unit II: Prodrugs, Agonist & medicinally useful antibiotics and hormones **12 Hours**

Prodrugs, classification, design, bioprecursor and application. Structural features and mode of action of β-lactum antibiotics. agonist, design of agonist and its requirements-antagonist, design of antagonist – partial agonist. Biosynthesis of insulin and thyroid hormones

Unit III: A few important Chemotherapeutic agents **12 Hours**

Antineoplastic Agents: Classification, synthesis and assay eg: Chlorambucil, Busulfan, Methotrexate, 5-Flurouracil, Ifosfamide, and *cis*-platin

Antitubercular drugs: Classification, synthesis and assay eg: Isoniazid, Rifampicin(assay only), Ethionamide, Pyrazinamide, Thiacetazone and *p*-Aminosalicylic acid.

Antimalarial drugs: Classification, synthesis and assay eg: Chloroquine, Mefloquine, Proquanil, Pyrimethamine and Amodiaquine

Unit IV: Synthesis, mechanism of action and uses of antihypertensive, antiviral and diuretics drugs **12 Hours**

Antihypertensive drugs: Methyldopa, Hydralazine, Propranolol, Nifedipine and Captopril.

Antiviral drugs: Acyclovir, Methisazone, Amantadine, Didanosine and Delavirdine

Diuretics: Furosemide, Acetazolamide and Chlorothiazide

Unit V: Synthesis, SAR and therapeutic uses of anti-inflammatory and CNS drugs **12 Hours**

Anti-inflammatory drugs: Aspirin, Paracetamol, Phenylbutazone, Ibuprofen and Mefenamic Acid.

CNS - Stimulant drugs**:** Amphetamine, Caffeine, Theobromine, Theophylline and Nikethamide.

CNS - depressant drugs: Phenelzine, Imipramine, Desipramine, Nortiptyline and Amitriptyline.

Reference Books:

Unit I

1. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press, 1995.

Unit II

1. Text book of Medicinal Chemistry, Volumes I & II, K. Ilango and P.Valentina, Keerthi Publishers, 2007.

Units III to V

1.Medicinal Chemistry, D.Sriram and P.Yogeeswari, Pearson Education publishers, 2007.
2.Medicinal Chemistry, G.R.Chatwal, Himalaya Publishing House, 2002
3.A text book of Pharmaceutical Chemistry, Jeyashree Ghosh, S.Chand Publishers 2012.
4. Medicinal Chemistry, Ashutosh Kar, New Age International Publishers, 2007.

e-Resources:

1. https://www.pharmacopoeia.com/

SEMESTER - III –

Part – III – Major Elective II - Polymer Chemistry

Hours per week: 3 **Credits: 3** **Subject Code: P24CHE32**

Course Outcome:

CO1: To study the classifications and properties of different polymers
CO2: To acquire knowledge on a few individual polymers
CO3: To have a knowledge on the properties of polymers
CO4: To learn the various polymerization techniques and uses of polymers
CO5: To understand the various polymer processing

Unit I : Classification of polymers and chemistry of polymerization **9 Hours**

Classification of polymers: Linear polymers, non-linear or branched polymers, cross – linked polymers, homo chain and hetero chain, homopolymers, co-polymers, block polymers and graft polymers.

Chemistry of polymerization: Types of polymerization – mechanism – chain, growth, free radical, ionic, co-ordination, ring opening, group transfer, polyaddition and polycondensation polymerizations.

Unit II: Individual polymers **9 Hours**

Monomers required for general methods of preparation, repeat units and uses of the following polymers and resins – polyethylene, polystyrene, polyacrylonitrile, polymethylacrylate, PVC, polytetrafluoroethylene, polyisoprenes, polybutadienes and polychloroprene, polyesters, polycarbonates, polyimides, polyamides (Kelvar), polyurethanes, polyethylene glycols, phenol-formaldehyde, urea-formaldehyde, melamine formaldehyde and epoxy resins – silicone polymers.

Unit III: Properties of polymers **9 Hours**

Intrinsic properties – processing properties – article properties – basic idea of isomerism of polymers – configuration of polymer chain – geometrical structure – syndiotatic, isotatic and atatic polymers.

Glass transition temperature – Definition – factors affecting glass transition temperature – relationships between glass transition temperature and (a) molecular weight, (b) melting point and (c) plasticizer – importance of glass transition temperature – heat distortion temperature.

Molecular weight and size of polymers: Number average, weight average, sedimentation and viscosity average molecular weights – molecular weights and degree of polymerization – poly dispersity – molecular weight distribution in polymers – size of polymer molecules – kinetics of polymerization.

Unit IV: Polymerization techniques, degradation and uses of polymers **9 Hours**

Polymerization techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerizations.

Degradation: Types of degradation – thermal, mechanical, ultrasonic and photo degradation – photostabilizers – oxidative degradation – antioxidants – hydrolytic degradation. Uses of polymers in electronics and biomedicine.

Unit V: Polymer processing **9 Hours**

Polymer processing – plastics (thermo and thermosetting), elastomers, fibres, compounding, plasticizers, colorants, flame retardants.

Compression and injection mouldings – film extrusion and calendaring – die casting and rotational casting – thermoforming – reinforcing.

Reference Books:

Units I & II

1. V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi, 1986.
2.G. Odian, Principles of Polymerization, 2nd edn., John Wiley and Sons, New York, 1981.

3. B.K.Sharma, Polymer Chemistry , Goel Publishing House, Meerut, 1989.
4. P.J.Flory, Principles of Polymer Chemistry , Cornell Uni. Press, Ithaca, 1953.

Unit-III

1. D.W.vanKrevelen and P.J.Hoftyrager, Properties of Polymers , Elsevier, New York, 1976.

Unit IV

1. F.W.Billmeyer, Textbook of Polymer Science , 3rd edn., John Wiley and Sons, New Your, 1984.
2. Harry R.Allcock, F.W.Lampe and J.E.Mark, Contemporary Polymer Chemistry , 3rd edn., Pearson, Prentice Hall, New Delhi, 2005.

Unit V

1. J.A.Brydson, Plastics Materials, 7th edn., Butterworth – Heinemann Publishers, New Delhi, 1999.
2. R.J.Crawford, Plastics Engineering, 3rd edn., Butterworth – Heinemann Publishers, Singapore, 1999.

***Field visit: Visit to nearby industries – Preparation of Industrial visit report**

SEMESTER-IV

PART–III- CORE SUBJECT XI- ORGANIC CHEMISTRY IV

Hours per week: 5 **Credits: 4** **Subject Code: P24CHC41**

Course Outcome:

CO 1: To learn disconnections approach in organic synthesis.
CO 2: To acquire the knowledge about ORD, CD and pericyclic reactions.
CO 3: To study the structural elucidation of terpenoids, steroids and vitamins.
CO 4: To understand the knowledge about alkaloids and proteins..
CO 5: To gain the basic knowledge in green chemistry

Unit- I: Synthetic methods II **(15 hours)**

Functional group interconversions-diastereoselectivity-enanatioselectivity-stereoselectivity-regioselectivity- retrosynthetic analysis-carbon skeleton-functional group located on the skeleton-disconnection approach-basic principles-one group disconnection-two group disconnection-C-X and C-C disconnections-1,2-, 1,3- 1,4-, 1,5- difunctionalized compounds- A schematic analysis of the total synthesis of the following compounds-2,4-dimethyl-2-hydroxypentanoic acid, trans-9-methyl-1-decalone and isonootkatone.

Reference Books:

1. R.E.Ireland, Organic synthesis, Prentice – Hall of India Pvt. Ltd., 1975.
2. F.A.Carey and R.J.Sundberg, Advanced Organic Chemistry, Part B, V Edn., Springer, New York, 2007.
3. W.Carruthers and Iain Coldhain, Modern Methods in Organic Synthesis, 4thEdn., Cambridge University Press, U.K., 2008.
4. I.L.Finar, Organic chemistry, Vol.II, English Language Book Society,1977.
5. Stuart Warren and Paul Wayatt, Organic Synthesis:The Disconnection Approach, II Edn, Wiley and Sons, Ltd., 2008

Unit-II: Chiroptical techniques and pericyclic reactions (15 hours)

ORD and CD – principle - Cotton effect - Types of ORD curves - axial α-haloketone rule - Octant rule - Applications to determine the configuration and conformation of simple monocyclic and bicyclic ketones-Comparison of ORD and CD.

Pericyclic reaction: Conservation of orbital symmetry-construction of molecular orbital and symmetry elements to simple molecules like 1,3-butadiene, 1,3,5-hexatriene, cyclobutene, cyclohexadiene- Electrocyclic reactions – Cycloaddition reactions- Sigmatropic rearrangement reactions – Application of FMO approach – Correlation approach – Huckel-Mobius approach-(dis- and con- rotatory ring closure of 1,3-butadiene, 1,3,5-hexatriene and (2 π + 2 π),(4 π + 2 π) cycloaddition reaction).

Reference Books:

1. Nasipuri, Stereochemistry of Organic Compounds, Wiley Eastern Ltd., New Delhi, 1991.
2. Ratan Kumar Kar, Frontier orbital and symmetry controlled Pericyclic reactions, Books and Allied(P) Ltd, 2010

Unit- III: Natural Products-I (15 hours)

Terpenoids : Classification – Structural elucidation of α-pinene, zingiberene and squalene - Biosynthesis of terpenoids.

Steroids: Classification - conformational aspects of A/B cis and A/B trans steroids – Structure of cholesterol (position of the hydroxyl group and double bond and nature of the side chain (Barbier-Wieland degradative study) hormones-classification - male sex hormones – testosterone – female sex hormones - oestrone and progesterone

Vitamins: Classification of vitamins – Sources and deficiency diseases – Chemistry of vitamins A, B_1, C and D_2

Reference Books:

1. I.L.Finar, Vol.II, 5th Edn., Pearson Education Ltd., New Delhi, 2011.
2. O.P.Agarwal , Chemistry of Organic Natural Products, Vol.I, Goel Publishing House, Meerut, 2008.
3. Gurdeep R. Chatwal, Organic chemistry of Natural Products Vol I, Himalaya Publishing House, 2011, India.
4. .W.Klyne, The Chemistry of Steroids, Methuen and Co., New york, 1965.

Unit IV: Natural Products-II (15 hours)

Carbohydrates: Ring structure of the monosaccharides – Methods for determining the size of sugar rings – Chemistry, configuration and conformation of lactose and sucrose – Chemistry of starch and cellulose.

Proteins and Nucleic acids: Peptides - End group analysis (N-terminal analysis-Edman method – Sanger method or DNP method-C-terminal analysis) - structural elucidation and synthesis of

peptides - structural elucidation of Glutathione and Oxytocin- an elementary treatment on enzymes, coenzymes and nucleic acids – properties of RNA & DNA - Genetic code.

Reference Books:

1. I.L.Finar, Vol.II, 5th Edn., Pearson Education Ltd., New Delhi, 2011.
2. O.P.Agarwal , Chemistry of Organic Natural Products, Vol.I and II, Goel Publishing House, Meerut, 2008.
3. Gurdeep R. Chatwal, Organic chemistry of Natural Products Vol I and II, Himalaya Publishing House, 2011, India.
4. K.W. Benty, Alkaloids, Vol I &II Interscience 1957.

Unit- V: Green Chemistry (15 hours)

Introduction to Green chemistry- Definition- Need for Green chemistry - Principles of green chemistry – Planning a green synthesis in the laboratory: choice of starting materials , reagents, catalysts and solvents - mode of supplying energy to a reaction - general interest for solvent free processes – solvent free techniques – green solvents. Microwave assisted synthesis: Introduction - characteristics of microwave heating – interaction of microwave radiation with materials - difference between conventional heating and microwave heating - applications and advantages of microwave heating over conventional heating.

Microwave assisted reactions in water and organic solvents - solvent free reactions.

Reference Books:

1. K.R.Desai, Green Chemistry (microwave synthesis) Himalaya Publishing House.Mumbai, 2005.
2. A.K.Ahluwalia, Green Chemistry, Narosa Publishing House, New Delhi, 2013.
3. V.Kumar, An Introduction to Green chemistry, Vishal Publishing Co., Jalandhar, 2013.
4. V. K. Ahluwalia and M. Kidwai, New Trends in Chemistry", Anamaya Publishers, 2nd Edition, 2007.

e-Resources:

1. https://old.amu.ac.in/emp/studym/100013568.pdf
2. https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/spivey-group/teaching/pericyclic-reactions/2122---Lecture-4---The-FMO-Approach---All-Parts.pdf
3. http://www.adichemistry.com/organic/pericyclics/introduction/pericyclic-reactions.html
4. http://www.people.vcu.edu/~urdesai/intro.htm
5. https://www.pmfias.com/vitamins-minerals-deficiency-diseases-food-sources-of-vitamins-minerals/
6. https://www.thoughtco.com/nucleic-acids-373552
7. https://www.organic-chemistry.org/topics/microwave-synthesis.shtm

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Semester IV – Part III – Core Subject XII – Inorganic Chemistry IV

Hours per week: 5 **Credits: 4** **Subject Code: P24CHC42**

Course Outcome:

CO1: To apply the knowledge of nuclear reactions in its applications.
CO2: To incorporate the knowledge of lanthanides and actinides to understand their properties.
CO3: To understand the VB and MO theories of bonding to explain the structure of homonuclear and heteronuclear diatomic and triatomic molecules, and VSEPR theory to explain the bonding in xenon compounds.
CO4: To understand and examine the various photochemical reactions involved in metal complexes
CO5: To study the molecular rearrangement reaction of coordination compounds

Unit I: Nuclear Chemistry **15 Hours**

Transmutation reactions - Nuclear Q value – Capture cross section – Threshold energy and excitation function- types of nuclear reactions – spallation, fragmentation, transfer reactions – Buckshot hypothesis, fission and fusion.
Nuclear fission – mass distribution of fission products – liquid drop model for nuclear fission. Nuclear fusion - thermonuclear reaction in stars.
Nuclear reactor and its components: Nuclear materials – fissile and fertile isotopes - production of feed material for nuclear reactors – Nuclear waste disposal and radiation protection. Breeder reactor – Atomic power projects in India – Visit to Nuclear power plant.

Unit II: Chemistry of Lanthanides and Actinides **15 Hours**

Lanthanides – occurrence, extraction from ores – separation procedure – ion exchange method – solvent extraction method. Properties of lanthanides – electronic configuration – common oxidation state – lanthanide contraction and its consequences – colour of lanthanide ions – spectral and magnetic properties of lanthanides.
Actinides – separation of actinide elements – separation of plutonium from fission products – electronic configuration – oxidation state – spectral and magnetic properties – comparison of lanthanides and actinides.

Unit III: Bonding theory **15 Hours**

Qualitative treatment of VB and MO theories– σ and π bonds – hybridization and resonance – MO equivalent of hybridization – application of VB and MO theories to the structures of homonuclear and heteronuclear diatomic (CO, HF and HCl) and triatomic molecules ($BeCl_2$ and H_2O) – comparison of VB and MO theories. VSEPR theory – bonding in xenon compounds.

Unit IV: Inorganic Photochemistry **15 Hours**

Electronic transition in metal complexes. Photophysical process of coordination compounds. Photochemical process of coordination compounds – photoisomerisation reaction – photosubstitution reaction – photoanation reaction – photoredox reaction. Photochemistry of cobalt(III) ammine complexes – photochemistry of chromium(III) ammine complexes – Adamson's rule. Photochemistry of ruthenium bipyridyl complexes.Photochemistry of organo metallic compounds – ligand photoreaction.Applications of metal complexes in solar energy conversion.

Unit V: Molecular rearrangement reaction of coordination compounds 15 Hours

Molecular rearrangement of four coordinated complexes - six coordinated complexes - reactions at coordinated ligands – reaction due to metal ion polarization of coordinated ligands - hydrolysis of amino acid esters, amides and peptides – aldol condensation – imine formation - the template effect and macrocyclic ligands.

Reference Books:

Unit I

1. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th edition, New Age Publishers New Delhi, 2009.
2. S. Glasstone, Source book on Atomic energy, 3rd edition, East West Press, 1967.

e-Resources:

1.byjus.com › Chemistry › Structure of Atom
2. https://preparatorychemistry.com/Bishop_Book_atoms_16.pdf
3. www.oecd-nea.org › jcms › radioactive-waste-management
4.byjus.com › Govt Exams › Government Exam Articles

Unit II

1. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity (4th edition): Addison-Wesley Publishing Company, New York, 1996.
2. F.A.Cotton and G.Wilkinson, Advanced Inorganic Chemistry (5th edition), John Wiley & Sons, New York, 1988.
3. J.D. Lee, Concise Inorganic Chemistry , 5th edition, Blackwell Science, 2000.
4. D.F.Shriver, P.W.Atkins and C.H.Langford, Inorganic Chemistry, 3rd edition, Oxford Univ. Press, 1999.
5. H.D. Mathur and O.P. Tandon, Chemistry of Rare Elements, IV Edn., S.Chand & Co.,1986.

e-Resources:

1.unacademy.com › Home › JEE 2022 › JEE Study Materials › Chemistry
2.www.nou.ac.in › econtent › MSc Chemistry Paper-II Unit-3

Unit III

1. J.E.Huheey, E.A.Keiter, R.L.KeiterandO.K.Medhi**,** Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Pearson Education Inc., 2006.
2. F.A.Cotton and G.Wilkinson, Advanced Inorganic Chemistry, 6th edition, John Wiley and Sons, New York, 2009.
3. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Science Ltd., Oxford, 2000.
4. D.F.Shriver and P.W.Atkins, Inorganic Chemistry, 4th edition, Oxford Univ. Press, 2009.

Unit IV

1. Inorganic Chemistry, A Unified Approach, William W.Potterfield, Academic Press, An inprint of Elsevier, California, 1993.
2. A.W. Adamson and F.D. Fleischer, Concepts of Inorganic Photochemistry, John Wiley –Inter Science, New York, 1975.

3. Arunachalam, Inorganic Photochemistry, Raasi Print House, 2002**.**
4.Rohatgi-Mukherjee, Fundamentals of Photochemistry, Revised Ed., Wiley Eastern Ltd, 1986.

e-Resources:

1.www.usb.ac.ir › FileStaff
2.citeseerx.ist.psu.edu › viewdoc › download › type=pdf

Unit V

1. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, W.B. Saunders Company, 1977.

Semester IV– Part III – Core Subject XIII– Physical Chemistry IV

Hours per week: 5 **Credit: 4** **Subject code: P24CHC43**

Course Outcome:

CO1: To understand the basic principles of elctronic, magnetic resonance and NQR spectroscopy, photochemistry and also about non-equilibrium thermodynamics.
CO2: To apply electronic, NMR, EPR and NQR spectral techniques.
CO3: To establish kinetics and mechanism for photophysical and photochemical processes and understand the reactions of radicals
CO4: To apply the concepts of surfaces and interfaces.
CO5: To develop applications of non-equilibrium thermodynamic principles to biological reactions.

Unit I: Electronic & NQR spectroscopy **15 Hours**

Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, rotational fine structure of electronic vibrational spectra- the Fortrat parabola-dissociation and predissociation spectra.

Photoelectron Spectroscopy: Basic principles, Instrumentation- Chemical identification of elements – Koopmen's theorem - photoelectron spectra of simple molecules like N_2, O_2&HCl – X-Ray fluorescence and Auger process.

Nuclear Quadrupole Resonance (NQR) spectroscopy – Principle of NQR – Transitions for axially and non-axially symmetric systems – Applications of NQR – Halogen group frequencies & hydrogen bonding

Unit II: Magnetic Resonance Spectroscopy **15 Hours**

Magnetic properties of nuclei – Resonance condition - Larmor precession - Bloch equations - The chemical shift - The coupling constant - Coupling between several nuclei- - NMR instrumentation – Basic concepts on NMR imaging.

EPR spectroscopy – EPR of hydrogen atom – Interpretation of ESR spectra and structure elucidation of organic radicals: methyl radical, benzene radical anion – p-benzosemiquinone radical anion – p-nitrobenzoatedianion, DPPH, TEMPO and naphthalene anion- Zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons)

Unit III: Photochemistry and Radiation Chemistry **15 Hours**

Photophysical processes of electronically excited molecules - Excited state dipole moment, acidity constants (pKa* - values) and redox potentials –Intermolecular deactivation of excited states – Photosensitized reactions – Kinetics of photophysical processes - Stern – Volmer equation and its applications – Excimers and exciplexes - Kinetics of Photochemical H_2 –Br_2 and H_2 – Cl_2 reactions –Photochemical conversion and storage of solar energy. Radiation Chemistry – radiolysis of water – definition of G-value – mode of reactions of hydrated electrons – – Experimental techniques of radiation chemistry –Dosimetry.

Unit IV: Surface Chemistry, Colloids & Micelles **15 Hours**

Adsorption of gases on solids - Physisorption and chemisorptions – Adsorption isotherms - Freundlich, Langmuir and Brunauer–Emmett– Teller (BET) isotherms -Types of adsorption isotherms – surface area determination – Adsorption on liquid surface – surface tension – Gibbs adsorption isotherm-Applications of adsorption. Colloids: Different colloidal systems – General properties of colloidal system – coagulation, flocculation / precipitation of colloidal solution – Protective colloids – Gold number – Hardy- Schulze rule – Hofmeister series – Emulsions – Micelles – Reverse micelles – Critical micelle concentration – surfactants.

Unit V: Non-Equilibrium Thermodynamics **15 Hours**

Phenomenological laws of transport processes – Principle of microscopic reversibility and Onsager's reciprocal relations - Entropy production and entropy flow in open system. Applications of non-equilibrium thermodynamics to biological systems – Bioenergetics and metabolism – catabolism – anabolism – Energy relationship between catabolic and anabolic pathways – High energy metabolites – ATP and its role in bioenergetics – Phosphoryl group transfers and ATP- Role of singlet oxygen I biology – Molecular recognition and introduction to supramolecular chemistry.

Text Books:

Units I and II

1. G.Aruldhas, Molecular Structure and Spectroscopy, New Delhi: Prentice –Hall of India Pvt. Ltd., 1st Edition, 2001.
2. R.S.Drago, Physical Methods in Chemistry. London: W.B. Saunders Co., 1st Edition, 1977.
3. C.N.Banwell, & E.M.McCash, Molecular Spectroscopy. New York: Tata McGraw Hill,4th Edition, 2000.
4. G.R. Chatwal, S.K. Anand, Spectroscopy (Atomic and Molecular), Himalaya Publishing House, Mumbai, 2009.
5. E.A.V. Ebsworth, D.W.H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, English Language Book society / Black Well Scientific Publications, 1987.
6. R.Chang, Basic Principles of Spectroscopy. London: McGraw Hill, 1st Edition,1976.

Unit III

7. K.K Rohatgi .& Mukherjee, Fundamentals of Photochemistry. New Jersey: Wiley Eastern, 1st Edition, 2008.
8. C.Kutal, Photochemical Conversion and Storage of Solar Energy, Journal of Chemical Education, **60**, p. 882 -887, 1983.

Units IV and V

9. J,.N.Gurtu & Gurtu, Biophysical Chemistry, Meerut: Pragati Prakashan Publishers, 2nd Edition.
10. Upadhyay & Nath, Biophysical Chemistry, New Delhi, S.Chand & Company Ltd., 2nd edition.
11. J.L.Jain, Fundamentals of Biochemistry, New Delhi, Himalaya Publishing House, 3rd Edition, 1996.
12. U. Satyanarayana, Biochemistry, Calcutta, Books and Allied (P) Ltd., 1st Edition, 1999.

Reference Books:

1. A. Rahman, Nuclear Magnetic Resonance-Basic Principles, Springer-Verlag, New York,1986.
2. J. A. Weil, J. R. Bolton and J. E. Wertz, Electron Paramagnetic Resonance, Wiley Interscience, 1994.
3. D. A. McQuarrie and J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books (P) Ltd., New Delhi, 1998.
4. P.W. Atkins, and J.D. Paula, Physical Chemistry. New York: ELPS and Oxford University press, 7th Edition, 2012.
5. D.N.Bajpai, Advanced Physical Chemistry, New Delhi**:** S.Chand & Co.,Ltd.,1st Edn, 2011.
6. N.J. Turro, Modern Molecular Photochemistry, Benjamine Cummings, 1965.
7. M.M.Cox & D.L. Nelson, Lehninger, Principles of Biochemistry, 5thEdn., W.H. Freemman & Co., 2008.

Website and e-learning source	1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

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Part III – Core Lab IV – LAB: Organic Chemistry Practical II

Hours per week: 4 **Credits: 4** **Subject Code: P24CHCP41**

Organic analysis and spectral interpretation

Course Outcome:

CO1: To study the basics of separation of mixture of organic compounds
CO2: To realize the theory of analysis of the components of the mixture of organic compounds
CO3: To prepare of the solid derivatives to confirm the functional groups of the components
CO4: To interpret the UV and IR spectra of organic compounds
CO5: To record and interpret the NMR spectra of organic compounds

Separation and analysis of the two component mixtures: Separation and analysis of the components, preparation of solid derivative and submission of physical constants for the components and its solid derivatives, identification of the components also from UV, IR and NMR spectral data.

Part III – Core Lab V – Inorganic Chemistry Practical II

Hours per week: 5 **Credits: 5** **Subject Code: P24CHCP42**

Quantitative Analysis and Inorganic Preparation

Course Outcome:

CO1: To apply the principles of volumetric and gravimetric methods to separate the cations

CO2: To practice quantitative estimation of more than one cation opting volumetric and gravimetric estimations.

CO3: To analyse the cations present in the ores and alloys

CO4: To practice the preparation of simple co-ordination compounds.

CO5: To study the basics of photocolorimetric estimation of metals.

I. Quantitative estimation of a mixture containing two metal ions (volumetric and gravimetric estimations)

1.Estimation of Cu^{2+} and Ni^{2+}
2.Estimation of Cu^{2+} and Zn^{2+}
3.Estimation of Zn^{2+} and Cu^{2+}
4.Estimation of Fe^{2+} and Cu^{2+}
5.Estimation of Fe^{2+} and Ni^{2+}
6.Estimation of Ca^{2+} and Mg^{2+}
7.Estimation of Ca^{2+} and Ba^{2+}
8.Estimation of Ca^{2+} and Cu^{2+}

II. Analysis of Ores and Alloys (Course Work only)

III. Photocolorimetric estimation of metal ions (Course Work only)

IV: Inorganic Complexes: Preparation

1. Preparation of Sulphatotris(thiourea)zinc(II) complex
2. Preparation of *cis*-Potassium dioxalatochromate(III)
3. Preparation of Potassium dioxalatocuprate(II) bishydrate
4. Preparation of Tetramminecopper(II) sulphate
5. Preparation of *tris*-(thiourea)copper(I) sulphate
6. Preparation of Potassium trioxalatoferrate(III)
7. Preparation of Potassium trioxalatoaluminate(III) complex
8. Preparation of *trans*-Potassium dioxalatodiquochromate(III)
9. Preparation of Hexaminecobalt(III) chloride

References:

Text Books:

1. A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, Arthur I. Vogel , Third Edition, ELBS and Longmans, Green & Co Ltd., 1961
2. Laboratory Experiments Inorganic Chemistry, William George Palmer, Ph.D. University Press, University of Michigan, 1954.

e-Resources:

1.https://www.selfstudys.com/books/cbse-lab-manual/english/12th/7-preparation-of-inorganic-compounds/7155
2. https://www.youtube.com/watch?v=5SWGoc3mbHc
3. https://amrita.olabs.edu.in/?sub=73&brch=8&sim=114&cnt=676.

For examination, a mixture will be given from which one cation is to be estimated volumetrically and the other gravimetrically.

Project & Viva-voce	Hours : 6 Credit : 5

Marks : 40 + 60 Marks Subject Code: **P24CH4PV**

Course Outcome:

CO1: To train the students in various research/industry learning skills like critical thinking, creativity, synthesis of knowledge, analyzing capacity, instrument basics and handling and scientific report writing.

CO2: To introduce the frontier areas of research in chemistry and in the interdisciplinary areas among students

CO3: To understand the scope of research programme in chemistry and in the interdisciplinary areas.

CO4: To inculcate students to learn adequate / to enhance their knowledge/skills on research methodology/chemical industry process & R&D work in the subject

CO5: To and prepare them for pursuing research in experimental or computational areas of the subject or work in Industry

The aim of project work (field/ lab work) is to inculcate students to learn adequate / to enhance their knowledge/skills on research methodology/chemical industry process & R&D work in the subject and prepare them for pursuing research in *experimental or computational* areas of the subject or work in Industry. Students will be allotment by lot system. The project work / Field Work / Study carried out in Our College Chemistry Department or Field work in Chemistry or related Industry / National labs / University Labs /DAE Labs is to be undertaken under the guidance of a Teacher of the Department. The guiding teacher will make continuous internal assessment of the Project Work/ Field Study. No teacher shall be permitted to guide more than ***three*** students in a semester for Project Work/Field work / Study under his/her supervision. The project / Field work will be evaluated by the external examiner.

- Project will be done by the final year students in the fourth semester under the guidance of respective guides.
- For projects internal marks (max 40) will be awarded by the respective guide and external marks (max 60) will be awarded in the external examinations.
- Minimum number of Pages for M.Sc. Project thesis should be 35.

Field visit: Visit to nearby industries – Preparation of Industrial visit report

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