Savitribai Phule Pune University

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**M.Sc. Chemistry (Inorganic/Organic/Physical/Analytical/Medicinal) @ Department of Chemistry, Savitribai Phule Pune University under Academic Flexibility**
2	Eligibility for Admission	B.Sc. Chemistry or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this university
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	Two
6	Level	PG
7	Pattern	Semester
8	Status	As per NEP 2020
9	To be implemented from Academic Year	From Academic Year: 2023-2024

Date: 23/07/2023 Signature:

Chairman BoS in Chemistry Dean, Science and Technology

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. Chemistry: Inorganic/Organic/Physical/Analytical/ Medicinal I year)

<table>
<tr><th>Year</th><th>Level</th><th>Sem</th><th colspan="4">Major</th><th>RM</th><th>OJT/FP</th><th>RP</th><th>Cum. Cr.</th><th>Degree</th></tr>
<tr><td></td><td></td><td></td><td colspan="3">Mandatory</td><td>Electives</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="14">1</td><td rowspan="14">6.0</td><td rowspan="7">Sem I</td><td colspan="3">3*4+ 2=14</td><td>4</td><td>4</td><td></td><td>-</td><td>22</td><td>PG Dip. (after 3 Y Degree)</td></tr>
<tr><td>Inorganic Chem.-(DIC-120)</td><td>T</td><td>4</td><td rowspan="6">Credits T- 2(2)
Inorganic -DIC-125/ Organic-DOC-135/ Physical-DPC-141/ Medicinal-DMC-105
and
Credits PR-2 (2)
Course 1:
Organic Chem.-(DOC-138)</td><td rowspan="6">Research Methodology (DRM-110)</td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>Organic Chem. (DOC-130)</td><td>T</td><td>4</td></tr>
<tr><td>Physical Chem. (DPC-140)</td><td>T</td><td>2</td></tr>
<tr><td>Inorganic Practical DIC-128</td><td>P</td><td>4</td></tr>
<tr><td>Physical Practical DPC 148</td><td>P</td><td>2</td></tr>
<tr><td>Only for Medicinal Chemistry (DMC-108)</td><td></td><td>4</td></tr>
<tr><td rowspan="7">Sem-II</td><td colspan="3">4*3+2=14</td><td>4</td><td>-</td><td>4 DOJT-210</td><td>-</td><td>22</td><td></td></tr>
<tr><td>Physical Chemistry (DPC-240)</td><td>T</td><td>4</td><td rowspan="6">Credits T- 2(2)
Inorganic -DIC-225/ Inorganic -DIC-221/ Organic-DOC-235/ Physical-DPC-245/ Medicinal-DMC-205
and
Credits P-2 (2)
Organic Chem.- (DOC-238)</td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>Organic Chem. (DOC-230)</td><td>T</td><td>4</td></tr>
<tr><td>Inorganic Chem. (DIC-220)</td><td>T</td><td>2</td></tr>
<tr><td>Physical Chem. Practical DPC-248</td><td>P</td><td>2</td></tr>
<tr><td>Inorganic Chem. Practical DPC-228</td><td>P</td><td>2</td></tr>
<tr><td>Only for Medicinal Chemistry (DMC-208)</td><td>P</td><td>4</td></tr>
<tr><td colspan="3">Cum. Cr. For PG Diploma</td><td colspan="3">28</td><td>8</td><td>4</td><td>4</td><td></td><td>44</td><td></td></tr>
<tr><td colspan="11">Exit Option: PG Diploma (44 credits) after Three Year UG Degree</td></tr>
</table>

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. Inorganic Chemistry II year)

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
1	6.5	Sem III	3*4+ 2=14			4			4	22	PG Dip. (after 3 Y Degree)
			Inorganic Chem. (DIC-320)	T	4	**Credits T-4(4)** Inorganic-DIC-325/ Inorganic-DIC-326/					
			Inorganic Chem. (DIC-321)	T	4						
			Inorganic Chem. (DIC-322)	T	2						
			Inorganic Chem. (DIC-328)	P	4						
		Sem-IV	4*3=12			4	-		6	22	
			Inorganic Chem. (DIC-420)	T	4	**Credits T- 4(4)** Inorganic-DI-425/ Inorganic-DIC-426/			DIRP-329		
			Inorganic Chem. (DIC-421)	T	4						
			Inorganic Chem. (DIC-428)	P	4						
Cum. Cr. For PG Diploma			26			8	0	0	10	44	

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. in Organic Chemistry II year)

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
1	6.5	Sem III	3*4+ 2=14			4			4	22	PG Dip. (after 3 Y Degree)
			Organic Chem. (DOC-330)	T	4	**Credits T-4(4)** Organic-DOC-335/ Organic-DOC-336/					
			Organic Chem. (DOC-331)	T	4						
			Organic Chem. (DOC-332)	T	2						
			Organic Chem. (DOC-338)	P	4						
		Sem-IV	4*3=12			4	-		6	22	
			Organic Chem. (DOC-430)	T	4	**Credits T- 4(4)** Organic-DOC-435/ Organic-DOC-436/			DORP-339		
			Organic Chem. (DOC-431)	T	4						
			Organic Chem. (DOC-438)	P	4						
Cum. Cr. For PG Diploma			26			8	0	0	10	44	

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. Physical Chemistry II year)

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
1	6.5	Sem III	3*4+ 2=14			4			4	22	PG Dip. (after 3 Y Degree)
			Physical Chem. (DPC-340)	T	4	**Credits T-4(4)** Physical -DPC-345/ Physical -DPC-346/			DPRP-349		
			Physical Chem. (DPC-341)	T	4						
			Physical Chem. (DPC-342)	T	2						
			Physical Chem. (DPC-348)	P	4						
		Sem-IV	4*3=12			4	-		6	22	
			Physical Chem. (DPC-430)	T	4	**Credits T- 4(4)** Physical -DPC-445/ Physical -DPC-446/			DPRP-449		
			Physical Chem. (DPC-431)	T	4						
			Physical Chem. (DPC-438)	P	4						
Cum. Cr. For PG Diploma			26			8	0	0	10	44	

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. Analytical Chemistry II year)

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
2	6.5	Sem III	3*4+ 2=14			4			4	22	PG Dip. (after 3 Y Degree)
			Analytical Chem. (DAC-350)	T	4	**Credits T-4(4)** Analytical -DMC-353/ Analytical -DMC-354/			DARP-359		
			Analytical Chem. (DAC-351)	T	4						

			Analytical Chem. (DAC-352)	T	2						
			Analytical Chem. (DAC-358)	P	4						
			4*3=12			4	-		6	22	
		Sem-IV	Analytical Chem. (DAC-450)	T	4	**Credits T- 4(4)** Analytical Chem. DAC-452 Analytical Chem. DAC-453			DARP -459		
			Analytical Chem. (DAC-451)	T	4						
			Analytical Chem. (DAC-458)	P	4						
Cum. Cr. For PG Diploma			26			8	0	0	10	44	
Exit Option: PG Diploma (44 credits) after Three Year UG Degree											

Savitribai Phule Pune University

Credit Distribution Structure for Two Years

(M.Sc. Medicinal Chemistry II year)

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
2	6.5	Sem III	3*4+ 2=14			4			4	22	PG Dip. (after 3 Y Degree)
			Medicinal Chem. (DMC-300)	T	4	**Credits T-4(4)** Medicinal -DMC-305/ Medicinal -DMC-306/			DMRP -309		
			Medicinal Chem. (DMC-301)	T	4						
			Medicinal Chem. (DMC-302)	T	2						
			Organic Chem. (DMC-308)	P	4						
		Sem-IV	4*3=12			4	-		6	22	
			Medicinal Chem. (DMC-400)	T	4	**Credits T- 4(4)** Medicinal -DMC-405/ Medicinal -DMC-406/			DMRP -409		
			Medicinal Chem. (DMC-401)	T	4						
			Medicinal Chem. (DMC-408)	P	4						

Cum. Cr. For PG Diploma	26	8	0	0	10	44	
Exit Option: PG Diploma (44 credits) after Three Year UG Degree							

SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabus for Approval

Detailed Syllabus for M.Sc. Chemistry :
Inorganic/Organic/Physical/Analytical/Medicinal I year)

@

Department of Chemistry, Savitribai Phule Pune University

under Academic Flexibility

Semester I and II

Choice-Based Credit System
as per New Education Policy (NEP) 2020
(To be implemented from the academic year, 2023-2024)

Semester – I

Course code-	**Course/Unit Title: Symmetry, Group Theory and Spectroscopy**	Credits 04/ [60 L]
DIC-120		**[60L]**

	1. Definitions and theorems of group theory, subgroups, classes. (4L) 2. Molecular symmetry and symmetry groups - symmetry elements and operations. Symmetry planes reflections, inversion centre, proper / improper axes and rotations, products of symmetry operations , symmetry point groups ,classes of symmetry operations, classification of molecular point groups. (10L) 3. Representations of groups. Great orthogonality theorem, character tables, properties of characters of representations. (8L) 4. Group theory and quantum mechanics. Wave function as bases for irreducible presentation. (2L) 5. Symmetry Adapted Linear Combinations - (SALC) - projection operators and their use to construct SALC. (6L) 6. Molecular Orbital Theory. Transformation properties of atomic orbitals, MO's for Sigma bonding in ABn molecules, tetrahedral AB4 case, Hybrid orbital's, MO's for pi bonding in ABn molecules. (10L) 7. Application of group theory to infrared spectroscopy (Ref.-2, Chapter-8) Introduction, selection rules, polyatomic molecules, possible vibration in a linear molecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR spectra related to symmetry of some compounds, IR spectra of complex compounds. (10L) 8. Raman spectroscopy: Theory of Raman spectroscopy, Instrumentation, Sample handling and Illumination, structural analysis, polarization measurements, quantitative analysis , applications of Raman spectroscopy, other types of Raman spectroscopy, Comparison of Raman and Infrared spectroscopy, Problems (Ref. 7: p.533-549) (Ref.8: p.321-336) (10L)	

Books

1. Chemical applications and group theory F.A. Cotton, 3rd edition, John Wiley & Sons Asia Pvt. Ltd. (1999).

2. Group theory and its chemical applications: P.K Bhattacharya, 2nd edn, Himalaya pub. India,(1989).

3. Molecular symmetry and group theory -A. Vincent.

4. Symmetry in Chemistry: H.H. Jaffe' and M. Orchin, Dover Publications Inc, New York,(2002).
5. Symmetry in Inorganic Chemistry: J.P Fackler.

6. Principles of Materials Science and Engineering: William F. Smith (1980) (Chapter 3)

7. Instrumental analysis – By Douglas A .Skoog, F. James Holler, Stanley R. Crouch (Publisher: Cengage Learing India Pvt. Ltd . New Delhi , 2007)

8. Instrumental method of analysis (7th edition) By- H.H. Willard , L.L. Merritt. Jr. J.A. Dean and F.A. Settle,Jr (Publisher: CBS Publishers and distributors Pvt .Ltd. (Copyright – Wordsworth publishing copy USA .2000).

Course code-	Course/Unit Title: Organic reactions, reaction mechanism and stereochemistry	Credits 04/ [60 L]
DOC-130	**Stereochemistry, the reaction mechanism of substitution, addition & elimination reactions with electrophiles & nucleophiles across the C=C** The stereochemical aspects of SN^2, SN^1, mixed SN^1 & SN^2 & SET mechanism. The SN^i, ion pair mechanism. Reactivity effects of structure, attacking nucleophile, leaving group & reaction mechanism, solvent effect, phase transfer catalyst, ambient nucleophile & regioselectivity. The neighboring group mechanism, The Neighboring group participation by π & σ bonds, anchimeric assistance, classical & non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangements in neighboring group participation. Mechanistic & stereochemical aspects of addition reactions of C-C multiple bonds; ionic & free radical additions of halogens, hydrogen halides, hydration. Mechanistic & Stereochemical aspects of elimination reactions, E2, E1, E1cb, eliminations not involving C-H bonds, reactivity effect of attacking & leaving groups, competition between substitution & elimination, *anti* & *syn* eliminations.	**[20L]**

	Aromatic Electrophilic & Nucleophilic substitution reactions Introduction of aromaticity benzenoid & non–benzenoid compounds, arenium ion mechanism, orientation & reactivity, energy profile diagram, calculation of partial rate factor, the *ortho/ para* ratio, *Ipso* substitution, orientation in other ring systems such as naphthalene, anthracene, six & five-membered heterocycles, diazonium coupling, Vilsmeier reaction, Gattermann–Koch reaction, *etc*. The $ArSN^1$, benzyne & S_NR^1, mechanisms, reactivity effect of substrate structure, leaving group & attacking nucleophile. **Basic Concept of Stereochemistry of Organic Compounds** Origin of stereochemistry, optical activity, chirality & molecular symmetry, axial & central chirality. Projection formulae, configuration (D/L, d/l, R/S, E/Z configuration in C, N, S, P containing compounds), concept of enantiomerism, diastereomerism, pseudoasymmetric carbon, allenes, biphenyls & spiranes nomenclature & enantiomerism, isomerism in molecules with more than one chiral center. Optical activity in biphenyls, spiranes, allenes & helical structures. Concept of prochirality homo topic and hetero topic ligand, & faces, enantomeric excess. Conformational concepts, conformations of acyclic & cyclic (ethane, propane, butane, cyclohexane, methylcyclohexane) molecules, **Molecular rearrangement & reaction intermediate** Reactive intermediates: carbocations, carbaions, carbenes, niterenes Rearrangement name reactions: Pinacol-pinacolone, Beckmann, Baeyer-Villiger, Wagner-Meerwein, Favorskii, Benzil-Benzillic acid, Wolff, Hofmann, Schmidt, Curtius, Lossen, Fries, Claisen, Cope, Sommelet-Hauser, Stevens etc.	**[10L]** **[15L]** **[15]**

Course Learning Outcomes

After completing the course students will be able to:

1) Predict the reactivity of organic compound from its structure.
2) Understand various Organic Reaction Mechanism
3) Understand the fundamental concept in stereochemistry by applying various symmetry elements of organic molecule.
4) Acquire the knowledge of chirality by taking examples of symmetrical and unsymmetrical molecule.
5) To develop interest in stereochemistry by studying stereochemical features of different classes of organic compounds
6) Identify the nomenclature of various stereochemical phenomena

Course code	**Course/Unit Title: Chemical Kinetics and Reaction Dynamics**	Credits 02/ [30 L]
DPC-140		**[30L]**

	(Students are expected to know the basics viz. rate law, order and molecularity, rate constant, 1st 2nd and nth order, integrated rate laws, graphical methods to estimate rate constants. 1. **Mathematical preparation** Integration, indefinite integral, definite integral, integral calculus, applications of integral calculus. (7L) 2. **Complex Reactions *(derivations expected)*:** (5L) Rate laws for complex reactions viz. parallel reaction and fluorescence decay, opposing reactions; Rate constants by temperature jump method, consecutive reactions and steady state approximation pre-equilibrium approximations. 3. **Reaction Mechanism of Prominent Complex Reactions *(derivations expected)*:** (8L) Lindemann- Hinshelwood mechanism for the unimolecular reaction, Enzyme catalysis –Michaelis Menten Mechanisms, competitive, non-competitive, and uncompetitive inhibitions, Lineweaver and Eadie plots, Chain reactions, free radical polymerization, Autocatalysis and oscillating reactions, B-Z mechanism. 4. **Method of Studying Fast Reactions *(Introduction):*** (3L) Flash photolysis, stop flow technique, pump and probe methods 5. **Gaseous Phase Molecular Reaction Dynamics:** (7L) Collision theory for bi-molecular reactions *(derivation expected)*, steric factor, Activated complex (Transition state) theory, Eyring equation (derivation expected). Thermodynamic interpretation of ACT, Potential Energy Surface (example: H_2-D_2 reaction plotting), Application of ACT to understand effect of ionic strength (Primary salt effect) on rate of reaction *(derivation expected)*. Diffusion controlled reaction (derivation expected), Marcus Theory (qualitative).	

Books/References:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 11th Ed., Oxford University Press (2018).
2. McQuarrie, D. A. & Simon, J. D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).
3. Glasstone, S. Thermodynamics for chemists, 2nd ed. (2014).
4. Marron and Pruton., Principles of Physical Chemistry.
5. G. M. Barrow, Physical Chemistry, Tata-McGraw Hill, Vth edition, 2003.

Course Outcome: After undergoing the course, the student should acquire the following skills:

1. Impart fundamental knowledge about the basic concepts of classical thermodynamics.
2. Understand the applications of partial molar quantities in getting information of mixing properties from single component

3. Impart the knowledge of functions and differential in understanding thermodynamic equations.
4. Enable to design and set different experiments or models for understanding energetics of processes

Major Elective

Course code	Course/Unit Title: Classical Thermodynamics and Chemometrics	Credits 02/ [30 L]
DPC-141	1.Mathematical preparation Polynomials, algebraic functions and transcendental functions and their graphical representation, functions of several variables, differentiation, partial differentiation, total differential, exact differential (8 L) 2.Temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule, mixtures, partial molar quantities, mixtures of nonelectrolytes, dilute solutions, activity and activity coefficient of mixtures of nonelectrolytes, solutions of electrolytes (10 L) 3.Thermodynamics of liquid solutions, equilibrium constant, homogeneous reactions in liquid solutions, properties of ideal solutions, Duhem-Margules equation, effect of temperature on liquid solution, effect of temperature on solubility, nonideal solutions, liquid and vapour composition, dilute solutions, molecular weight determination, partial molar quantities, numerical problems (12 L)	**[30L]**

Books/References:

1. Physical Chemistry, D. A. McQuarrie, Viva Book private limited, 1998.
2. Chemical Kinetics and Reaction Dynamics: Paul L. Houston, International Edition 2001, ISBN 0-07-243537-2
3. The Chemical Maths Book, E. Steiner, Oxford University Press (1996).

Supplementary Books:

1. Chemical Kinetics, K. J. Laidler, Third edition, Pearson Education Inc., 1987.
2. Atkins' Physical Chemistry, Peter Atkins and Julio De Paula 9th edition, Oxford University Press 2011.

Course Outcome: At the end of course, the students will acquire the following understanding and skill-sets to study rate of chemical reactions.

1. Various methodologies and techniques to estimate rate constant of the reaction.
2. Various mechanism of the well-known gaseous phase and biochemical reactions.
3. Classical and quantum mechanical models to interpret observed rate constants.
4. Contemporary techniques to study the fast reaction kinetics.

Course code-	Course/Unit Title- Main Group Chemistry	Credits: 02/30 lectures
DIC-125	1. Hydrogen & its compounds (2L) Hydrides, classification, e- deficient, e- precise & e- rich hydrides PH3,SbH3,AsH3, Selenides, Tellurides. 1. Alkali & alkaline earth metals (4L) Solutions in non-aqueous Media. Application of crown ethers in extraction of alkali & alkaline earth metals. 3. 2. Organometallic compounds of Li, Mg, Be, Ca, Na (2L) Synthesis, properties, uses & structures. 3. Boron group (4L) Boron Hydrides, preparation, structure & bonding with reference to LUMO, HOMO, interconversion of lower & higher boranes, Metalloboranes, Carboranes. 4. Carbon group (4L) Allotropes of Carbon, C60 and compounds (fullerenes), Intercalation compounds of Graphite, Carbon nanotubes, synthesis, properties, structure-single walled, multiwalled, applications, classification of organometallic compounds. Organometallic compounds of B, Si, Sn,Pb, Ga, As, Sb, Bi. Structures, Synthesis, Reactions 5. Nitrogen group (4L) Nitrogen activation, Boron nitride, Oxidation states of nitrogen & their nterconversion PN & SN compounds NOx & their redox chemistry 6. Oxygen group (4L) selenides & tellurides, oxyacids & oxoanions of S & N, Ring, Cage and Cluster compounds of p-block elements. Silicates, including Zeolites 7. Halogen group (4L) Interhalogens, Pseudohalogen, synthesis, properties & applications, structure, oxyacids & oxoanions of Halogens Bonding. 8. Noble gases (2L) Synthesis, properties, uses, structure & bonding with respect to VSEPR.	**[20]** **[10]**

Course code-	Course/Unit Title- **Physical Organic Chemistry**	Credits: 02/30 lectures

DOC-135	Types of mechanisms & reactions, thermodynamic & kinetic requirements for reaction, Substituent effect, Basic Mechanistic concept, Kinetic verse thermodynamic control, Hammonds's postulates, Curtain-Hammond Principle, Characterization of reaction intermediates, isotopes & labeling experiments, Effect of solvent on catalysis, stereochemical evidence, Importance in the elucidation of organic reaction mechanisms. Trapping of intermediate(s), competition experiments, testing proposed/common intermediate, isolation & identification, characterization using spectral methods of product & intermediate. **Stereochemistry of C=C bond formation** Introduction to the ylildes of P & S. Wittig & related, Peterson, Julia, Shapiro & elimination reactions. Optical isomerism and optical isomerism due to asymmetric carbon atom	**[20]** **[10]**

Books/References:

1. Organic Chemistry by J. Clayden, N. Greeves, S. Warren & P. Wothers (Oxford)
2. Advanced Organic Chemistry by J. March 6th Edition
3. Advance Organic Chemistry (part A & B) by F. A. Carey & R. J. Sundberg (Ed. IV)
4. R.O.C. Norman, Organic Chemistry.
5. E.S. Gould, Mechanism & Structure in Organic Chemistry.
6. H.O. House, Synthetic Organic Chemistry.
7. R. T. Morrison & R. N. Boyd, Organic Chemistry
8. Stereochemistry of carbon compound by E. L. Eliel
9. Stereochemistry of organic compound by Nasipuri
10 Name Reactions by Jie Jack Li (3rd Ed.)

Practical

Course code-	Course/Unit Title-: Experiments in Inorganic Chemistry Part A	Credits 02/ 60 Lectures
DIC-128	**DIC 128: Experiments in Inorganic Chemistry Part A** 1. Ore Analysis: At least two of the following: a. Determination of silica and manganese in pyrolusite . b. Determination of copper and iron from chalcopyrite. c. Determination of silica and iron from hematite 2. Alloy analysis (At least two of the following) a. Determination of tin & lead from solder. b. Determination of iron & Chromium from mild steel. c. Determination of copper and nickel from cupronickel. 3. Inorganic Synthesis and purity determination (any five) a. Cis-trans potassium di-aquo di-oxalato chromate (III)	

	b. Chloro penta-ammino cobalt (III) chloride c. Nitro penta-ammino cobalt (III) chloride d. Nitrito penta-ammino cobalt (III) chloride e. Bis,2-4 pentanedionato cobalt (II) and cobalt (III) f. Potassium tri-oxalato aluminate **Chelation in Nickel complexes:** Preparation of Ni (II) ethylenediamine complexes and studying their absorption spectra. (b) Solution state preparation of [Ni(en)3]S2O3, [Ni(H2O)6]Cl2, [Ni(NH3)6]Cl2. Record the absorption spectra in solution of all three complexes and analyze it. Arrange the ligands according to their increasing strength depending on your observation	

References:

1. Textbook of Quantitative Analysis, A. I. Vogel. 4th edn (1992).

2. Inorganic Electronic spectroscopy: A. B. P. Lever, 2nd edn Elsevier Science Publishers, New York, (1984).

3. Inorganic Synthesis (Vol. Series)

4. Practical Manual made By Department of Chemistry, University of Pune

5. Experiments in Chemistry, D.V. Jahagirdhar, Himalaya Publishing House OC

Course code-	**Course/Unit Title- Purification techniques**	Credits 02/ 60 Lectures
DOC-138	Crystallization, fractional crystallization, distillation, fractional distillation, sublimation, thin layer chromatography and column chromatography.	

	Derivatives: Acetyl, 2,4-DNP, anilide, amide, aryloxy acetic acid etc.	

Reference/Book

1. Laboratory Safety for Chemistry Students Robert H. Hill, Jr., David C. Finster A John Wiley & Sons, Inc., Publication
2. Vogel′s Textbook of Practical Organic Chemistry, 5th Ed., A. Vogel, et al., ed., Prentice Hall
3. Chemical Laboratory Safety and Security A Guide to Developing Standard Operating Procedures, By National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies, Committee on Chemical Management Toolkit Expansion: Standard Operating Procedures, Board on Chemical Sciences and Technology · 2016

Course code	Course/Unit Title: Physical Chemistry Practical-I	Credits 02/ [60 hours]
DPC-148	**Mathematical preparation for Chemistry** 1. Methods of Integration, reduction formula, parametric differentiation of integrals (4L) 2. First order differential equations Concept, solution of differential equation, separable equations in chemical kinetics, first order linear equations, linear equations in chemical kinetics (5L) 3. Second order differential equations, homogeneous linear equations, the general solution, particular solution. (6L) 4. Probability Permutations, combinations and theory of probability (4L) 5. Vectors, matrices and determinants Vectors, dot, cross and triple products, introduction to matrix algebra, addition and multiplication of matrices, inverse, adjoint and transpose of matrices, unit and diagonal matrices (4L) 6. Special functions, Gamma functions, integral involving exponential and Gaussian functions, Taylor and McLaurin series, series solution method of differential equation, Hermite polynomials, Legendre polynomials, Laguerre functions – definitions and recursion relation (no proof required). (7L) **Experiments in Physical Chemistry** **Non-Instrumental:** 1. Freundlich and Langmuir isotherms for adsorption of acetic acid on active charcoal. 2. Molecular weight by steam distillation. 3. Kinetic decomposition of diacetone alcohol by dilatometry. 4. Determination of an order of a reaction.	**[02/30 hours]** **[02/30 hours]**

Reference/Book

1. Findlay's Practical Physical Chemistry, B. P. Levitt and J. A. Kitchener 9th Edition, Longmans, London (1972).
2. Experiments in Physical Chemistry by J. M. Newcombe, R. J. Denaro, A. R. Rickett, R.M.W Wilson, Pergamon (1962).
3. Senior Practical Physical Chemistry, 5th Edition, B. D. Khosla, V. S. Garg and A. Khosla, R. Chand (1987).
4. The Chemical Maths Book, E. Steiner, Oxford University Press (1996).

Research Methodology
(RM-110)

Course code-	Course/Unit Title- Research Methodology	Credits 04/ 120 Hours
RM 110	**9. Fundamental Laboratory Techniques**: **(1 credit)** (a) Basic laboratory procedures, Basic principles, working with liquids (b) Making and recording measurements, SI units and their use.	**[15L]**
	2. **Chemical safety and Disaster Management**: **(1 credit)** (a) General safety: General safety and operational rules, safety equipment, personal protective equipment, safety practices for disposal of broken glass wares, centrifuge safety, treated biomedical wastes and scientific ethics. How to extract the safety information from MSDS. (b) Emergency response: chemical spills, radiation spills, biohazard spills, leaking compressed gas cylinders, fires, medical emergency accident reporting	**[15L]**
	3. Research Analysis, Presentation of data and Statistics; (1 credit) (a) Using graphs, Presenting data in tables, drawing chemical structures, Hints for solving numerical problems. (b) Descriptive statistics, choosing and using statistical tests.	**[15L]**
	4. **Information technology and Library resources and Intellectual Property right**: (**1 credit**) (a) The Internet and World Wide Web, internet resources for chemistry/biochemistry, spread sheets, word processors, databases and other packages, Search engines, Scifinder (b) IPR: Introduction to IPR, Types of IPR, Criteria for patentability and novelty, patent filling.	**[15L]**

Reference books:

1. Laboratory Safety for Chemistry Students Robert H. Hill, Jr., David C. Finster A John Wiley & Sons, Inc., Publication
2. Vogel′s Textbook of Practical Organic Chemistry, 5th Ed., A. Vogel, et al., ed., Prentice Hall
3. Chemical Laboratory Safety and Security A Guide to Developing Standard Operating Procedures, By National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies, Committee on Chemical Management Toolkit Expansion: Standard Operating Procedures, Board on Chemical Sciences and Technology · 2016
4. Chemical Safety in the Laboratory, By Stephen K. Hall · 1994 CRC-Press
5. School Chemistry Laboratory Safety Guide, By Centers for and Prevention, Department of Human Services, National Institute Health and Safety · 2014 , Publisher: CreateSpace Independent Publishing Platform
6. Research Methodology in Chemical Sciences Experimental and Theoretical Approach Edited ByTanmoy Chakraborty, Lalita Ledwani, Edition1st Edition , First Published 2016, eBook Published10 March 2017, New York, Apple Academic Press DOIhttps://doi.org/10.1201/9781315366616
7. Statistical Methods in Analytical Chemistry, Author(s): Peter C. Meier, Richard E. Zünd , First published:30 March 2000, Print ISBN:9780471293637 |Online , SBN:9780471728412 |DOI:10.1002/0471728411, Copyright © 2000 John Wiley & Sons, Inc. All rights reserved.
8. Fundamentals of Intellectual Property Rights for Students, Industrialist and Patent Lawyers By B. Ramakrishna, H. S. Anil Kumar, 2017
9. Intellectual Property Law by Avtar Singh Publisher: Eastern Book Company ISBN: 9789350289853

Semester II

Major Core

Course code-	Course/Unit Title- Coordination Chemistry	Credits: 02/30 lectures
DIC-220	1. Concept & Scope of ligand Fields. (1L) 2. Energy levels of transition metal ions, Free ion terms, spin –orbit coupling. (7L) 3. Effect of ligand fields on energy levels of transition metal ions, weak cubic ligand field effect on Russell-Saunders terms, strong field effect, correlation diagrams, Tanabe-Sugano diagrams, Spin-pairing energies. (8L) 4. Electronic spectra of complexes, band intensities, band energies, band width & shapes, spectra of 1st, 2nd & 3rd row ion and rare earth ion complexes, spectrochemical & Nephelauxetic series, charge transfer & luminescence spectra, calculations of Dq, B, ı parameters. (8L) 5. Magnetic properties of complexes, paramagnetism,1st & 2nd ordered Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A,E,T ground terms in complexes, spin free–spin paired equilibria. (6L)	**[30]**

Books:

1. Ligand field theory & its application: B.N.Figgis & M.A.Hitchman Wiely VCH publ. (2000), Chapters 5, 6, 8,9,11.
2. Principles of Bioinorganic Chemistry: S.J.Lippard & J.M Berg, University science books, Mill Valley, California (1994), Chapters- 1,2,3,5,6,7,8.
3. Inorganic Chemistry: D. F. Shriver & P. W. Atkins, Oxford (1999).
4. Inorganic Electronic spectroscopy: A. B. P. Lever, 2nd edn Elsevier Science Publishers, New York, (1984).

Course code-	**Course/Unit Title- Organic Chemistry** **Synthetic Organic Chemistry**	Credits: 04/60 lectures
DOC-230	**Oxidation and Reduction:** Oxidation Reactions: CrO_3 (Jones reagent) PDC, PCC, $KMnO_4$, MnO_2, Swern Oxidation, SeO_2, $Pb(OAc)_4$, Pd/C, OsO_4, m-CPBA, O_3, $NaIO_4$, HIO_4, R_3SiH, Bu_3SnH, Reaction of NBS. Reduction viz. Wilkinson's catalyst, metal hydrides, $NaCNBH_3$, NH_2NH_2, DIBAL, Zn, etc. Stereochemistry involved in hydrogenation, hydroboration, B.V. oxidation, $KMnO_4$, OsO_4, $Pb(OAc)_4$, oxymercuration, Wilkinson's catalyst, O_3, $NaIO_4$, HIO_4 etc. **Organo-metallic chemistry:** Li, Zn, Cu, Mg, Al, Si etc., Hydroboration and synthesis of borane reagents and its use in oxidation and protonation. **Spectroscopy:** Basics of UV, IR and NMR. Instrumentation and recording of spectra of UV, IR and NMR, Elementary ideas of NMR, integration, chemical shifts etc. Factors affecting chemical shifts, coupling (First order, analysis), Problems based on UV, IR and NMR. **Heterocyclic Chemistry:** Structure, reactivity, synthesis, and reactions of pyrrole, furan, thiophene, pyridine, indole, benzofuran, quinolone and isoquinoline. Chemistry of heterocycles containing two heteroatoms: Pyrazines, pyradiazins, pyrimidines,1,2; 1,3 and 1,4 diaoxazines and thiazines: pyrazole pyrazolines and imidazoles, imidazolines. Synthesis of chloroquine, Papavarine, Amlodipine, Bromouidine, Ranitidine, Vit-B6, Tryptophan, Thiamine, Histidine, Heterocyclic chemistry carbenes and their applications in the synthesis.	**[15]** **[10]** **[15]** **[20]**

Books/References:

1. Carey and Sundberg. (Ed. IV), Part B – Adv. Organic Chemistry.
2. H.O. House, Synthetic Organic Chemistry.
3. Norman R.O.C. Organic Chemistry.
4. Advanced Organic Chemistry by J. March 6thEdition
5. Silversteine and Basser, Spectrometric Identification of Organic Compounds.
6. P.S. Kalsi, Organic Spectroscopy.
7. J. Bellamy, Infrared spectra of Complex molecules.
8. I Fleming, Organic Spectroscopy.
9. J. Clayden, N.Greeves et. al Organic Chemistry
10. Pavia Spectroscopy of Organic Compounds

11. Heterocyclic Chemistry – J. A. Joule, K. Mills and G. F. Smith

Course code	Course/Unit Title- Chemical Bonding and Molecular Spectroscopy	Credits: 04/60 lectures
DPC-240	**Chemical Bonding** **[02/30]** 1. Recapitulation, quantization, Postulates of Quantum mechanics, Schrödinger equation, particle in a box, , particle in 3-D box, degeneracy, hydrogen-like atoms (no derivation), atomic orbitals. (12L) 2. Variational method, many electron atoms, orbital angular momentum, electron spin, wave functions of many electron atoms, Pauli exclusion principle, spin-orbit interaction, fine structure, vector atom model, spectral terms. (5L) 3. Molecular orbital theory (MOT), Born-Oppenheimer approximation, H_2 molecule, MO diagrams of simple homo- and heteronuclear diatomic molecules. (5L) 4. Valence bond theory of simple molecules, quantitative treatment of hydrogen molecule and related systems, hybridization, comparison of VBT and MOT. (4L) 5. Hückel theory of conjugated hydrocarbons, Electron densities, Bond orders and free valence indices, Illustrations (4L) **Molecular Spectroscopy** **[02/30]** 1. Recapitulation, regions of electromagnetic spectrum, width and intensity of spectral lines. (2L) 2. Rotational spectra: classification of molecules based on the moment of inertia, Schrodinger equation of rigid rotor, diatomic molecules, effect of isotopic substitution, centrifugal distortion, linear triatomic molecules, symmetric top molecules, stark effect. (6L) 3. Infrared spectra: quantum mechanical harmonic oscillator, diatomic molecule, Morse potential, overtone and hot bands, polyatomic molecules, skeletal and normal vibrations (6L) 4. Vibrational rotational spectra, fine structure in diatomic molecules, breakdown of the Born-Oppenheimer approximation, effect due to nuclear spin, parallel and perpendicular vibrations. (5L)	

	5. Raman Spectra: classical and quantum theory of Raman effect, stokes and antistokes lines, polarizability ellipsoid, rotational Raman spectra, selection rule, vibrational raman spectra, rule of mutual exclusion, elucidating structure from the combined infrared and Raman spectra, rule of mutual exclusion (6L) 6. Electronic spectra: Born-Oppenheimer approximation, molecular progression, term symbols, Franck-Condon principle, dissociation energies, oscillator strength, rotational fine structure, fortrat parabola, predissociation, photoelectron spectroscopy (5L)	

Books/References:

Text Books:

1. Quantum Chemistry, I. Levine, 5th Edition, Prentice Hall (1999).
2. Quantum Chemistry, D. A. McQuarrie, Viva Books Private Ltd. (2007).
3. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, Tata McGraw Hill, 4th Edition (1994)

Reference Books:

1. Valence, C. A. Coulson, ELBS (1974).
2. Introduction to Quantum Mechanics- with Applications to Quantum Chemistry, L. Pauling and E. B. Wilson, Dover Publishers (1999).
3. Orbitals in Chemistry, V. Gil, Cambridge University Press (2000).
4. Molecular Spectroscopy, J. Machale, Prentice Hall, NJ, USA (1999).
5. Vibrating Molecules, P. Gans, Chapman and Hall, UK (1971).

Course Outcome : After undergoing the course, the student should acquire the following skills:

1. Understand the concept quantization and setup the Schrödinger equation and its application to one-dimensional problems.
2. Solution of exactly solvable two- and three-dimensional problems.
3. Understand the basics of MOT and the difference between MOT and VBT.
4. Apply Hückel theory to problems of conjugated molecules.
5. Impart qualitative and quantitative knowledge about principles and applications of different spectroscopic techniques
6. Understand the applications of spectroscopic techniques in the structure determination of molecules

Major Elective

Course code-	Course/Unit Title- Bioinorganic Chemistry	Credits: 02/30 lectures
DIC-221	1.Overviews of Bioinorganic Chemistry. (2L) 2. Principles of coordination Chemistry related to Bioinorganic–Proteins, nucleic acids and other metal binding biomolecules (6L) 8. Choice, uptake and assembly of metal containing units in Biology (6L) 3. Control and utilization of metal ion concentration in cells. (6L10. Metal ion folding and cross –linking of biomolecules. (6L) 4. Binding of metal ions and complexes to biomolecular active Centers (4L)	**[30]**

Course code-	Course/Unit Title : **Physical Methods in Inorganic Chemistry**	Credits: 02/30 lectures
DIC-225	1. Crystal Structure and Crystal geometry (08) Space Lattice and basic unit cells, Crystal systems and Bravais Lattices, Classification of space lattice by crystal systems and their structures, the relation between interatomic distance (d) and atomic radius(R) of cubic unit cells. The Atomic Packing factor of BCC, FCC and HCP unit cell and their examples, Atomic positions in cubic unit cells with origin at eight corners of the cube, directions in Cubic Unit Cells, Direction Indices in cubic unit cells, Miller indices for crystallographic planes in Cubic unit cells, Crystallographic planes in Hexagonal unit cell, Miller-Bravais indices. Volume, planar and linear density calculations of cubic unit cells, application of Miller indices in solving crystal structures, problems of all the topics. 2. NMR of Inorganic Compounds (10) Concept of nuclear spin and resonance, fundamentals of coupling (homonuclear heteronuclear) and decoupling, coupling constants. Predicting Intensity of NMR lines by binomial, trinomial, tetranomial etc Pascal triangles Examples of 11B and 10B NMR, 1H and 11B NMR spectra of of BH4 - , Me4 11B2H2, Me2B(μ-H)2BH2, second order coupling in diborane, Effect of natural abundance. Structure elucidation by 19F and 31P NMR spectroscopy. Examples: 19F NMR spectra of interhalogen compounds, 19F and 31P NMR to deduce structures of PF3R2 type compounds, 31P NMR of Wilkinson catalyst, geometrical isomers of platinum compounds, trans effect and meridonial, facial isomers of rhodium compounds. General trends in chemical shifts, factors influencing chemical shift-geometry, electronegativity, charge and oxidation state, coordination number, effect of ligands, coordination effect on transition metal. General trends in coupling constant, factors influencing coupling constant-gyromagnetic ratio, periodicity, ‘s’ character in the bond, hybridization, coordination number, electronegativity, trans effect, inter bond angles lone pairs and oxidation state. 3. Mössbauer spectroscopy (12) Basic principles of 57Fe Mössbauer spectroscopy, instrumentation, spectral parameters a) Mössbauer Parameters- Isomer Shifts, quadrupole splitting, Magnetic hyperfine interaction. b) Application of Mössbauer spectroscopy with respect to i) Oxidation states of metal ion in compounds ii) Structural elucidation iii) Covalent and ionic compounds iv) High spin low spin behavior v) Magnetically ordered compounds	**[30]**

Books: 1. Advanced Inorganic Chemistry: F. A. Cotton, G. Wilkinson,C. A. Murollo, M. Bochmann, 6th edn. (2003).
2. Inorganic Chemistry: D. F. Shriver and P.W. Atkins, 4th edn. Oxford (2003).
3. Concise inorganic Chemistry, J.D.Lee 4Th edition (Chapman and Hall)
4. Physical Methods in Chemistry, R. S. Drago, Saunders, Harcourt Brac Javanovich College Publishers, (1992).
5. NMR spectroscopy in Inorganic Chemistry, J. A. Iggo, Oxford University press (2001).
6. Mössbauer Spectroscopy and Transition Metal Chemistry, P. Gütlich,R. Link, A. Trautwien, Springer-Verlag (1978).
7. Mössbauer Spectroscopy, N.N. Greenwood, T.C. Gibb, Chapman and Hall Ltd. (1971).
8. Instrumental method of analysis (7th edition) By- H.H. Willard , L.L. Merritt. Jr. J.A. Dean and F.A. Settle,Jr (Publisher: CBS Publishers and distributors Pvt .Ltd. (Copyright – wardsworth publishing copy USA .2000).

Course code-	**Course/Unit Title- Stereochemistry of addition to Carbonyl**	Credits: 02/30 lectures
DOC-235	Reactivity trends, C=X stereo electronic effects, Crams model, The Chelation, Crams, Felkin-Anh-Eisenstein model for C=O Addition, Diastereoselective Ketone Reduction, Breakdown in the Felkin-Anh model, Zimmerman Traxelar model for Aldol reaction, Prelog model, reduction of prochiral ketone by boranes and CBS catalyst, Diastereoselective additions to cyclic ketones, Chelate controlled carbonyl additions.	**[30]**

Books/References:

1. Carey and Sundberg. (Ed. IV), Part B – Adv. Organic Chemistry.
2. H.O. House, Synthetic Organic Chemistry.
3. Norman R.O.C. Organic Chemistry.
4. Advanced Organic Chemistry by J. March 6thEdition
5. Silversteine and Basser, Spectrometric Identification of Organic Compounds.
6. P.S. Kalsi, Organic Spectroscopy.
7. J. Bellamy, Infrared spectra of Complex molecules.
8. I Fleming, Organic Spectroscopy.
9. J. Clayden, N.Greeves et. al Organic Chemistry
10. Pavia Spectroscopy of Organic Compounds
11. Heterocyclic Chemistry – J. A. Joule, K. Mills and G. F. Smith

Course code-	**Course Title- Bio-Physical Chemistry**	Credits: 02/30 lectures
DPC-245	1 Equilibria and reactions involving protons-Response of the equilibrium constant to conditional changes, Acid base equilibria, protonated states of amino acids residues, Buffers, Buffering in the cardiovascular systems, proton coupled electron transfer and pathways (4 L) (Chapter 5, ref. 1)	**[30]**

	2 Oxidation/reduction methods and bioenergetics Recapitulation of Nernst equation – mid-point potentials – Gibbs energy of formation and activity- ionic strength- Adenosine triphosphate- Chemiosmotic hypothesis- respiratory chain and ATP synthase (4 L) (Chapter 6, ref. 1) 3 Kinetics and enzymes- Energetics accompanying electron transfer reactions- Marcus relationships- Structure and function of proteins and enzymes- Enzyme catalysis -Michaelis Menten mechanism- Lineweaver-Burk equation- enzyme activity (4 L) (Chapter 7, ref. 1) 4 statistical thermodynamics – Chain configuration and conformation pf macromolecules, Statistical distribution, end to end dimensions and Biopolymer structure, average dimensions and different chain structures, protein folding and prions (5 L) (Chapter 8, ref. 1) 5 Biological systems- Signal transduction- biochemical pathway for visual response- spectroscopic studies – Comparison of rhodopsins from different organisms- Rhodopsin proteins in visual response (3 L) (Chapter 17, ref. 1) 6 Membrane potentials, transporters and channels – membrane potentials, Energetics of transport across membranes- transporters- Ion Channels (4 L) (Chapter 18, ref 1) 7 Photosynthesis- Energy transfer and light harvesting complexes- Electron transfer, Bacterial reaction centers and photosystem 1, Water oxidation (3 L) (Chapter 20, ref. 1) 8 Molecular Imaging- Imaging in cells and bodies, Green fluorescent protein- mechanism of chromophore formation, fluorescent resonance energy transfer, Imaging in organisms-Radioactive decay-PET-Parkinson disease (3 L) (Chapter 19, ref. 1)	

Text books

(1) Biophysical Chemistry by James Allen, Wiley-Blackwell (2008).
(2) Physical Chemistry for the biological sciences by Gordon Hammes, Wiley Interscience (2007)

Course Outcome :

(3) After studying these topics, students will realize how physical chemistry can be explored in biological systems to understand protein folding and underlying pathways of proton coupled electron transfer or enzyme catalysis reactions, which are central to life sciences.

Practical :

Course code	Course/Unit Title- Inorganic Chemistry Practicals (Part B)	Credits 02/60 hours
DIC-228	**Instrumental methods of analysis** a. Colorimetry. 1. Simultaneous determination of Cr & Mn. 2. Determination of Keq of M-L Systems such as , Fe (III) - salicylic acid, Fe (III)-Sulphosalicylic acid Fe (III) - b -resorcilic acid by Job's & Mole- ratio method. b. Determination of iron by solvent extraction technique in a mixture of Fe3+ + Al 3+ & Fe3+ + Ni2+ using 8- hydroxyquinoline reagent. c. Study of aquation of [Fe(o-phen)3] in acid solution by spectrophotometry. d. Conductometry (Ref.- 5) i.Verification of Debye Hückle theory of ionic conductance for strong electrolytes KCl,BaCl2.K2SO4, K3[Fe(CN)6] ii.Structural determination of metal complexes by conductometric measurement iii. To study complex formation between Fe(III) with sulfosalicylic acid by conductometry e New Experiments : (any one) i. Data analysis, error analysis, least squares method. Plot of Born Maeyer to determine for 1:1 type molecule to determine internuclear separation. Characterization of metal ligand bonding using IR spectroscopy. ii. Computer Applications: (1) Electronic structure, vibrational characteristics and charge distributions in first row transition metal complexes. (2) Visualizing frontier MO's. iii. Analysis of Electronic spectra of transition metal complexes at least for one system (dn Oh or Td) and calculation of Crystal Field parameters, inter electronic repulsion parameter and bonding parameter.	

References:

1. Textbook of Quantitative Analysis, A. I. Vogel. 4th edn (1992).
2. Inorganic Electronic spectroscopy: A. B. P. Lever, 2nd edn Elsevier Science Publishers, New York, (1984).
3. Inorganic Synthesis (Vol. Series)

4. Practical Manual made By Department of Chemistry, University of Pune
5. Experiments in Chemistry, D.V. Jahagirdhar, Himalaya Publishing House

Course code-	Course/Unit Title- Organic Preparations	Credits 02/60 hours
DOC-238	Single-stage preparations (6 preparations) based on regio-selective and chemo selective principals Bromobenzene to p-nitrobromobenzene Anthracene to anthraquinone Benzoin to benzil Anthracene to Anthracene maleic anhydride adduct 2-Naphthol to BINOL p-Benzoquinone to 1,2,4-triacetoxybenzene Ethyl acetoacetate to 3-methyl-phenyl pyrazole-5-one *o*-Phenylenediamine to 2-methylbenzimidazole *o*-Phenylenediamine to 2,3-diphenylqunooxaline Urea and benzil to 5,5-diphenylhydantoin	
	At least two Oxidation and Reduction reactions Two stage preparations (6 preparations) **Note**-i) Preparations preferred to be clubbed with various technics and ii) Preparation preferred to be on the aromatic substitution, Nucleophilic substitution, Free radical substitution, Addition, Elimination Condensation, Rearrangements, Oxidation, Reduction etc.	

Reference/Book

1. Laboratory Safety for Chemistry Students Robert H. Hill, Jr., David C. Finster A John Wiley & Sons, Inc., Publication
2. Vogel′s Textbook of Practical Organic Chemistry, 5th Ed., A. Vogel, et al., ed., Prentice Hall
3. Chemical Laboratory Safety and Security A Guide to Developing Standard Operating Procedures, By National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies, Committee on Chemical Management Toolkit Expansion: Standard Operating Procedures, Board on Chemical Sciences and Technology · 2016

Course code	Course/Unit Title- Physical Chemistry Practical-II	Credits 02/60 hours
DPC-248	pH metry. 1. Hydrolysis of aniline hydrochloride. 2. Determination of the acid and base dissociation constants of an amino acid and hence the isoelectric point of the acid. 3. To determine the amount of aspirin in the given tablet. Colorimetry: 1. Analysis of a binary mixture. 2. Copper EDTA photometric titration.	(60)

	3. Determination of stability constant of ferricsalicylate complex by colorimetric measurements Radioactivity: 1. Determination of E_{max} of beta radiation and absorption coefficients in Al. 2. Counting errors. Chemical kinetics: 1. Bronsted primary salt effect. 2. Kinetics of the reduction of methylene blue by ascorbic acid.	

Reference/Book

3. Findlay's Practical Physical Chemistry, B. P. Levitt and J. A. Kitchener 9th Edition, Longmans, London (1972).
4. Experiments in Physical Chemistry by J. M. Newcombe, R. J. Denaro, A. R. Rickett, R.M.W Wilson, Pergamon (1962).
5. Senior Practical Physical Chemistry, 5th Edition, B. D. Khosla, V. S. Garg and A. Khosla, R. Chand (1987).
6. The Chemical Maths Book, E. Steiner, Oxford University Press (1996).

On Job Training DOJT-210 (Credit 4)

This is the most important course included in NEP-2020. After M.Sc., most of our students are expected to join industries, a teaching profession or start small scale business.

Therefore, to develop the skilled or employable students, following five options would be given:

DOJT-210	**On Job Training**	**Credits 04/ 120 hours**
	1) Hands on (25 students) a) NMR, IR, Gas Chromatography, HPLC and Computer Programming Language Python (25 students) b) Thermal Methods, Mass Spectrometry, Cyclic Voltammetry and Computer Programming Language Python c) X-ray Diffraction, Single Crystal and Computer Programming Language Python (25 students) **OR** **2) Hands on (25 students)** a) Chromatographic techniques b)Solid material analysis c)Surface analysis techniques d)Teaching Methodolog	

	e) Pharmaceutical Chemistry/ Biophysical Techniques **3) Teachers Training Course (25 students)** a) Development of MOOCS b) Development of Learning Management System (LMS) **OR** **4) To develop Entrepreneurship, production of the following items, including packaging (25 students)** a) Dye b) Acids, caustic soda c) Fire Extinguisher d) Fertilizers **OR** 5) **Internship in Industry or National Research Laboratory (25 students)**	