પરિપત્ર:

ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટીની સાયન્સ વિદ્યાશાખાનાં અભ્યાસક્રમ ચલાવતી તમામ સંલગ્ન કોલેજોનાં આચાર્યશ્રીઓને સવિનય જણાવવાનું કે સાયન્સ વિદ્યાશાખા હેઠળનો કેમેસ્ટ્રી (ઓર્ગેનિક) વિષયનો (એમ.એસસી. કેમેસ્ટ્રી (ઓર્ગેનિક)) પ્રોગ્રામનો સેમેસ્ટર-૧ થી સેમેસ્ટર-૪ નો અભ્યાસક્રમ આ સાથે સામેલ છે.

માનનીય કુલપતિશ્રીની મંજુરી અનુસાર સદર અભ્યાસક્રમ શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલવારી કરવાની રહે છે. સાયન્સ વિદ્યાશાખાનાં કેમેસ્ટ્રી વિષયનાં પી.જી.નો અભ્યાસક્રમ ચલાવતી તમામ સંલગ્ન કોલેજોનાં પી.જી.સેન્ટર અને અનુસ્નાતક ભવનો ધ્વારા તેની અમલવારી કરવા જણાવવામાં આવે છે.

06/07/2024

ખાસ ફરજ પરના અધિકારી
(એકેડેમિક)

ક્રમાંક/બીકેએનએમયુ/એકેડેમિક/૯૦૩/૨૦૨૪
ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી,
સરકારી પોલીટેકનિક કેમ્પસ,
ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી રોડ,
ખડીયા, જૂનાગઢ-૩૬૨૨૬૩
તા.૦૬/૦૭/૨૦૨૪

પ્રતિ,

- ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી સંલગ્ન સાયન્સ વિદ્યાશાખાનાં પી.જી.(કેમેસ્ટ્રી)નાં અભ્યાસક્રમો ચલાવતી તમામ કોલેજોના આચાર્યશ્રીઓ તેમજ સંલગ્ન ભવનનોનાં અધ્યક્ષશ્રીઓ તરફ....

નકલ સાદર રવાનાઃ-

- માન.કુલપતિશ્રી/કુલસચિવશ્રીનાં અંગત સચિવશ્રી.
- પરીક્ષા નિયામકશ્રી, ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી, જુનાગઢ

નકલ રવાના જાણ તથા યોગ્ય કાર્યવાહી અર્થેઃ

- સીસ્ટમ મેનેજરશ્રી, આઇ.ટી.સેલ વિભાગ (વેબસાઇટ ઉપર પ્રસિદ્ધ થવા અર્થે.)

BHAKTA KAVI NARSINH MEHTA UNIVERSITY
JUNAGADH

BOARD OF CHEMISTRY STUDIES

FACULTY OF SCIENCE

SYLLABUS FOR

M.Sc. CHEMISTRY (ORGANIC) PROGRAMME

(SEMESTER- I - IV)

EFFECTIVE FROM A.Y. 2023-24

Bhakta Kavi Narsinh Mehta University
Scheme of Instruction and Examinations
M. Sc. Chemistry
SEMESTER -I

Sr. No.	Level	SEM	Course Group	Course (Paper) Title	Paper No.	Credit	Teaching Hours/ Week	Internal Marks	External Marks	Practical Internal Marks	Practical External Marks	Total Marks/ Passing
								Total/ Passing	Total /Passing	Total/ Passing	Total/ Passing	
1	PG	1	Core	Inorganic Chemistry	CC-101	4	4	30/12	70/28	--	-	100/40
2	PG	1	Core	Organic Chemistry	CC-102	4	4	30/12	70/28	-	-	100/40
3	PG	1	Core	Physical Chemistry	CC-103	4	4	30/12	70/28	-	-	100/40
4	PG	1	Core	Analytical Chemistry	CC-104	4	4	30/12	70/28	-	-	100/40
5	PG	1	Practical	Practical*	CP-105	6	12	-	-	-	100/40	100/40
6	PG	1	Practical	Practical Viva Voce	CP-106	1	-	-	-	-	50/20	50/20
7	PG	1	Skill Enhancement Course	Chemoinformatic Tools	CP-107	1	2	-	-	50/20	-	50/20
Total						**24**	**30**					**600**

***Practicals of SEM-1 includes Inorganic and physical chemistry.**

Bhakta Kavi Narsinh Mehta University
Scheme of Instruction and Examinations
M. Sc. Chemistry
SEMESTER -II

Sr. No.	Level	SEM	Course Group	Course (Paper) Title	Paper No.	Credit	Teaching Hours/ Week	Internal Marks	External Marks	Practical Internal Marks	Practical External Marks	Total Marks/ Passing
								Total/ Passing	Total /Passing	Total/ Passing	Total/ Passing	
1	PG	2	Core	Inorganic Chemistry	CC-201	4	4	30/12	70/28	--	-	100/40
2	PG	2	Core	Organic Chemistry	CC-202	4	4	30/12	70/28	-	-	100/40
3	PG	2	Core	Physical Chemistry	CC-203	4	4	30/12	70/28	-	-	100/40
4	PG	2	Core	Analytical Chemistry	CC-204	4	4	30/12	70/28	-	-	100/40
5	PG	2	Practical	Practical*	CP-205	6	12	-	-	-	100/40	100/40
6	PG	2	Practical Viva Voce	Practical Viva Voce	CP-206	1	-	-	-	-	50/20	50/20
7	PG	2	Skill Enhancement Course	Research Writing	CP-207	1	2	-	-	50/20	-	50/20
Total						**24**	**30**					**600**

***Practicals of SEM-2 includes Organic and Analytical chemistry.**

Bhakta Kavi Narsinh Mehta University

Scheme of Instruction and Examinations
M. Sc. Chemistry (Organic Chemistry)
SEMESTER -III

Sr. No.	Level	SEM	Course Group	Course (Paper) Title	Paper No.	Credit	Teaching Hours/ Week	Internal Marks	External Marks	Practical Internal Marks	Practical External Marks	Total Marks/ Passing
								Total/ Passing	Total /Passing	Total/ Passing	Total/ Passing	
1	PG	3	Core	Stereochemistry and Asymmetric Synthesis	OC-301	4	4	30/12	70/28	--	-	100/40
2	PG	3	Core	Heterocyclic Chemistry and Pericyclic Reactions	OC-302	4	4	30/12	70/28	-	-	100/40
3	PG	3	Core	Medicinal Chemistry	OC-303	4	4	30/12	70/28	-	-	100/40
4	PG	3	Core	Modern Spectroscopy	OC-304	4	4	30/12	70/28	-	-	100/40
5	PG	3	Practical	Practical & Viva Voce	OP-305	6	12	-	-	-	100/40	100/40
6	PG	3	Skill Enhancement Course	Research Project Proposal &Viva Voce	OP-306	2	4	-	-	-	100/40	100/40
Total						**24**	**32**					**600**

Bhakta Kavi Narsinh Mehta University
Scheme of Instruction and Examinations
M. Sc. Chemistry (Organic Chemistry)
SEMESTER -IV

Sr. No.	Level	SEM	Course Group	Course (Paper) Title	Paper No.	Credit	Teaching Hours/ Week	Internal Marks	External Marks	Practical Internal Marks	Practical External Marks	Total Marks/ Passing
								Total/ Passing	Total/ Passing	Total/ Passing	Total/ Passing	
1	PG	4	Core	Organic Synthesis: A Disconnection Approach	OC-401	4	4	30/12	70/28	-	-	100/40
2	PG	4	Core	Separation Techniques	OC-402	4	4	30/12	70/28	-	-	100/40
3	PG	4	Dissertation/ Practical	Dissertation/ Project **or** Practical	OP-403	12	24	-	-	-	200/80	200/80
4	PG	4	Self-study	Dissertation/ Project Viva Voce **or** Practical Viva Voce	OP-404	4	-	-	-	-	100/40	100/40
Total						**24**	**32**					**500**

Program Outcomes (POs): M.Sc. Chemistry with Specialization in Organic/Analytical/Inorganic/Physical Chemistry

PO no.	PO detail
PO_1	**Depth and breadth of knowledge**: To produce efficient chemistry graduates with strong fundamental knowledge to cater the global needs related to chemical sciences.
PO_2	**Research and scholarship**: To develop research proficiency among graduates for the effective & practical solutions of industrial and societal issues.
PO_3	**Practice and usage of modern technology**: To inculcate technical skills in the chemistry graduates towards the use of modern & sophisticated instruments, equipments & cheminformatic tools.
PO_4	**Professional capacity and passion of learning**: To empower graduates for skilful utilization of the chemical literature to identify and address various problems by complying with environmental, ethical, and safety aspects.
PO_5	**Moral and aesthetic sustainability**: To enrich graduates with contemporary training in professional responsibility, ethics, lifelong learning to secure placement.

Program Specific Outcomes (PSOs): M.Sc. Chemistry with Specialization in Organic/Analytical/Inorganic/Physical Chemistry

PSO No.	PSO Statement
PSO_1	To understand the core chemistry and apply subjective knowledge for the qualitative or quantitative behaviour of compounds.
PSO_2	To demonstrate practical aspects in specialized area comprising Organic / Analytical / Inorganic/Physical chemistry.
PSO_3	To design and perform a broad variety of experiments related to chemistry.
PSO_4	To communicate scientific information orally and in writing.
PSO_5	To acquire ability towards usage of the techniques, skills, and modern tools necessary for chemistry domain.
PSO_6	To comprehend and apply chemical literature for research and effective problem solving.
PSO_7	To create advance skill for the evaluation of experimental results and extend the knowledge to develop competency.
PSO_8	To develop adaptability towards inter & multidisciplinary areas of chemical science.
PSO_9	To apply critical thinking for the environmental issues & sustainable development through chemistry research.
PSO_{10}	To inculcate the ability involving independent and life- long learning in context to societal needs.
PSO_{11}	To empower professional and ethical responsibility.

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-101	Inorganic Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Predict bonding & shapes of covalent compounds using MO & VB theories.
2	Understand and predict the chemical and physical properties of S- block elements.
3	Classify coordination compounds & predict isomerism, coordination number, shapes and spectral term symbol for coordination compounds.
4	Explain labile and inert metal complexes with its mechanism.
5	Outline theoretical and practical aspects of nano materials.

SEMESTER-I			
CC-101	**Inorganic Chemistry**	**4 hrs./Wk**	**4 Credits**

Sr. No.	Course Detail	Inst. Hrs.
Unit.1	**Atomic Model & Bonding** **Atomic Model, Structure & Bonding, Bond Parameters,** Molecular orbital theory, Homonuclear diatomic molecules, Heteronuclear diatomic molecules, Valance bond theory, Types of overlapping, Shapes of covalent compounds, VSEPR, Shapes of molecules having regular & irregular geometry, bent's rule.	**12**
Unit.2	**Main Group (S-Block)** **Chemistry of Main group Elements of S-Block,** General Trends, Physical and Chemical Properties and selected Applications.	**10**
Unit.3	**Coordination Compounds** Classification of Coordination compounds, Werner's theory, Nomenclature, Isomerism, Coordination number, structures, shapes and Hybridisation, electronic spectra, spectroscopic terms, term symbols, calculation of spectroscopic terms.	**14**
Unit.4	**Reaction Mechanism of Coordination Compounds** Synthesis and reactions of coordination compounds, Labile and inert complexes, Types of reactions in metal complexes, Substitution in square planar complexes, Substitution reactions & mechanism in octahedral complexes, Trans effect.	**12**
Unit.5	**Nanomaterial** Definition and Introduction of nanomaterial, Size effects, Importance of nanomaterials, Classification of nanomaterials, Properties of nanomaterial, Synthesis techniques of nanomaterials, Inorganic Nanoparticles and Nano porous Materials: Oxide, catalysis. Techniques for characterisation of nanoscale materials: SEM, TEM, XRD, AFM.	**12**

Reference Books

1. Miessler, G. L; Fischer, P. J.; Tarr, D. A.; (2014, sixth edition) Inorganic Chemistry, (ISBN: 978-0-321-81105-9).
2. Agarwala S. K.; Lal K.; (2009), Advanced Inorganic Chemistry, (ISBN: 978-81-8398-773-8).

3. Singh, A.; Singh, R.; (2005) Textbook of Inorganic Chemistry Vol. I & II. New Delhi: Campus Books International, (ISBN: 8180300714).
4. Housecroft C. E; Sharpe A. G.; (2005, 2nd edition) Inorganic Chemistry, (ISBN: 0130-39913-2).
5. House J. E; House K. A.; (2016, 3rd edition) Descriptive Inorganic Chemistry, (ISBN: 978-0-12-804697-5).
6. Rao C. N. R; Muller A.; Cheetam A. K.; (2004) The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH.
7. Poole C. P.; Owens Jr. F. J.; (2003) Introduction to Nanotechnology Wiley Interscience.
8. Kenneth J. K. (2001) Nanoscale materials in Chemistry, Wiley Interscience.
9. Pradeep T.; (2007) Nano: The Essentials in understanding nanoscience and nanotechnology, Tata McGraw Hill.
10. Ajaikumar; (2016 2nd edition) Organometallic & Bloinorganic Chemistry, Aaryush Education, (ISBN:978-81-930437-1)
11. Strohfeldt K. A., (2015) Essentials of inorganic chemistry: for students of pharmacy, pharmaceutical sciences and medicinal chemistry, (ISBN: 9780470665589)

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-102	Organic Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand the concept of various electronic effect and its applications.
2	Calculate aromaticity and differentiate between aromatic, anti-aromatic and non-aromatic compounds.
3	Understand concept and types of reaction mechanism, draw arrow notation, categorize bond cleavages, and generation of reactive intermediates.
4	Explain reaction mechanism and identify the reagent for the C-C bond forming reactions.
5	Illustrate preparation of organic reagents and recognize appropriate reagent for particular reaction.

SEMESTER-I			
CC-102	**Organic Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Reactive Organic Intermediates** Inductive effect, Resonance effect, Hyperconjugation effect and its applications (Stability, Acidity, Basicity, Nucleophilicity, Aromatic character), Homolytic and Heterolytic fission, Different types of arrow notation, concept and Examples of Electrophiles and Nucleophiles. Hybridization, Structure, Generation, Stability, Reactivity & Applications of Carbocation, Carbanion, Free radicals, Carbenes, Nitrenes, Ylides, Benzyne and Enamines. Applications and related reactions **Aromaticity** Introduction, Criteria of aromaticity, Hückel's rule, Examples of aromatic, anti-aromatic and non-aromatic compounds. Aromatic character for Annulenes, Azulenes & Heterocycles.	**14**
Unit.2	**Organic Reactions** Principal, mechanism and applications of: Appel reaction, Benzoin condensation, Nef reaction, Prins reaction, Mitsunobu reaction, Vilsmeier-Haack reaction, Blanc Reaction, Riemer-Tiemann, Michael addition, Dieckmann condensation, Robinson annulations, Arndt-Eistert, Corey-Fuchs alkyne synthesis, Nazarov cyclization.	**10**
Unit.3	**Rearrangements** Principal, mechanism and applications of: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Beckmann, Schmidt, Baeyer-Villiger, Lossen rearrangement, Neber rearrangement, Baker-Venkataraman rearrangement	**10**
Unit.4	**Conjugate addition & C-C Bond Forming Reactions** Enolate, Enamine and Imine chemistry, Grignard reagents, Cuprates and other conjugate reactions. Olefination reaction: Wittig, Horner–Wadsworth–Emmons, Mc-Murry reaction. Cyclopropanation reaction (Simons-smith), Bayliss Hillman reaction, Organocatalyzed C-C bond forming reactions: Aldol reaction, Mannich reaction and	**14**

	Stork enamine synthesis.	
Unit.5	**Organic Reagents** General mechanism, selectivity, and important applications of the following reagents: (a) Oxidative Reagents: $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-pyridine (Collin's reagent), hypervalent iodine reagents (Dess-Martin), Swern reagent, SeO_2, HIO_4, $NaIO_4$ (b) Metal hydride reduction: Boron reagents ($NaBH_4$, 9-BBN), aluminium reagents ($LiAlH_4$, DIBAL-H), Li/Na-liquid NH_3 mediated reduction (Birch reduction) of aromatic compounds and acetylenes.	**12**

Reference Books

1. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.
3. László Kürtip; Barbara Czakó (2004, First edition) Strategic Applications of Named Reaction in Organic Synthesis. Philadelphia: Elsevier Publishing company (ISBN: 9780124297852).
4. M.B. Smith & J. March, March's Advanced Organic Chemistry, 6thEd., John Wiley & Sons, New York, 2007.
5. F.A. Carey and R.A. Sundberg, Advanced Organic Chemistry, Part A and Part B, 5th Ed.,
6. McMurry, John E. (2011, Eight edition) *Organic Chemistry*. Boston: Cengage Learning (ISBN: 0840054440).
7. Smith, Michael B.; March, Jerry (2013, Seventh edition) *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*. Hoboken: Wiley-Blackwell (ISBN: 978-0-470-46259-1).
8. Bansal, Raj K. (2009, Fifth) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).
9. T. W. Graham Solomons (2011, 10th edition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-103	Physical Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand thermodynamics of particle by statistical approach, derive and calculate thermodynamic properties of mono and diatomic molecules
2	Understand the theories of electrochemical properties with numerical problems
3	Justify ideal & non-ideal solutions and determination of properties of solutions
4	Distinguish Free energy change and its applications in chemical reactions
5	Classify the types, characteristics and mechanism of homogeneous & heterogeneous catalysis.

SEMESTER-I			
CC-103	**Physical Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Statistical Thermodynamics:** The concepts of Ensemble, Thermodynamic probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Partition function, Molar partition function, Thermodynamic properties in term of molecular partition function for diatomic molecules, Monoatomic gases, Rotational, Translational, Vibrational and Electronic partition functions for diatomic molecules. Problems.	**14**
Unit.2	**Electrochemical cells** Introduction, Ostwald dilution law, Debye-Huckel theory of mean ionic activity co-efficients, Decomposition potential and its determination, over voltage, hydrogen over voltage, factors affecting over voltage, importance of hydrogen over voltage, Tafel equation. numerical problems. **Commercial cells:** Fuel cell, lead accumulator, nickel iron accumulator, zinc silver accumulator.	**10**
Unit.3	**The Properties of Solutions** **Ideal solutions**: Properties, the Duhem-Margules equation, vapour pressure curves. Composition of liquid and vapour in equilibrium influence of temperature on gas solubility and solid-liquid equillibria. **Non ideal solutions**: Deviation from ideal behavior, vapour pressure curves, liquid and vapour compositions. General equations for liquid mixtures, **Dilute solutions:** Henry's law. Determination of molecular weights from freezing and boiling points. Problems.	**12**
Unit.4	**Free Energy and Chemical Reactions** Chemical equilibrium and the equilibrium constant: Equilibrium in homogeneous gaseous systems. Homogeneous reactions in liquid solutions. Homogeneous reactions in dilute solutions. Chemical equilibria in heterogeneous systems. Free energy change in chemical reactions: The reaction isotherm, standard free energy of reaction, the direction of chemical variation of equilibrium constant with pressure and temperature. Influence of temperature on heterogeneous reactions. Integration of the Van't Hoff equation. Variation of standard free energy with temperature, problems.	**14**

Unit.5	**Catalysis** • Introduction, Types of catalysis (Homogeneous & heterogeneous), comparison between them, general characteristics of catalytic reaction. • Heterogeneous catalysis: kinetics of unimolecular and bimolecular surface reaction. • Homogeneous catalysis: types of acid base catalysis, Mechanism and kinetics of acid-base catalysis • Enzyme catalysis- Mechanism and kinetics of enzyme catalysed reaction. • Nanocatalysis, types, applications.	**10**

Reference Books

1. Glasstone, Samuel. (2007) Textbook of Physical Chemistry: MCMILAN India Press (SBN: 033391-876-2).
2. Peter Atkins, Julio de Paula (2015) Physical chemistry: Thomson Press (ISBN: 019872872-7).
3. Gurdeep Raj (2014, Third edition) *Thermodynamics*. Meerut: GOEL publishing House (ISBN: 8187224886).
4. Gurtu, J. N. Gurtu,A. (2014, Twelfth edition) *Advanced Physical Chemistry*. Meerut: Pragati Prakashan (ISBN: 9350060191).
5. Barrow, Gordon M. (1996, Sixth edition) *Physical Chemistry*. New York: McGraw-Hill International. (ISBN: 0070051119).
6. V R Gowariker, (2012) Polymer *Chemistry*. New age International P limited. (ISBN: 978-0-85226-307-5).
7. Puri, Sharma, Pathamia, (2018, 47th edition) Principles of Physical Chemistry. Vishal Publishing Co. (ISBN: 978-93-82956-78-5).
8. B. S. Bahl, Arun Bhahl,G. D. Tuli, (2005) Essetials of Physical Chemistry. S. Chand & Company LTP. (ISBN: 81-219-0546-X).
9. Physical Chemistry, Ira N Levine (Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition).
10. Physical Chemistry, Alberty and Stilby, (John Wiley & Sons, New York).
11. D.K. Chakrabarty and B. Viswanathan, Heterogeneous Catalysis, New Age, 2008.
12. Introduction to the principles of heterogeneous catalysis. J.M.Thomas and W.J.Thomas, Acad.press, London, 1967.
13. Chemical kinetics and catalysis G.M.Panchenkov and V.P.Lebedev., Mir publication, 1976.

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-104	Analytical Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand basic concepts of analytical techniques
2	Apply various traditional analytical methods for chemical analysis.
3	Identify principles and applications of green chemistry
4	Discuss optical methods and apply for chemical analysis
5	Explain thermal methods and apply for thermal analysis

SEMESTER-I			
CC-104	**Analytical Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Fundamentals of Analytical Chemistry & Chemical Calculations** Analytical chemistry, its functions and applications, Analytical problems and procedures, Analytical techniques and methods, Concentration units (Molarities, Normality, Formality, ppb, ppm, mole calculation, Empirical Formulas, % composition, Determination of molecular weight, theoretical yield, Percent Yield, Problems	**12**
Unit.2	**Analytical Methods** Solution equilibria, Electrochemical reactions, Potentiometry, pH and its control, Titrimetry I: acid–base titrations, Complexation, solubility and redox equilibria, Titrimetry II: complexation, precipitation and redox, titrations, Gravimetry, Voltammetry and amperometry, Conductimetry	**10**
Unit.3	**Green Chemistry** Introduction, importance and twelve principles of Green Chemistry. Designing a green synthesis using these principles. Green Chemistry in day to day life. Green solvents (alternatives of organic solvents). Ionic liquids, supercritical fluids, CO_2 and H_2O and aqueous phase organic synthesis. Non-traditional greener alternative approaches: green reagents, catalysis, biocatalysis. Applications of non-conventional energy sources: Microwave, ultrasonic assisted synthesis, electro-synthesis and sunlight (UV), radiation assisted synthesis.	**14**
Unit.4	**Optical Methods** **Refractive index:** Introduction, Principle, Instrumentation, Measurement of refractive index, abbe refractometer, immersion refractometer, application. **Polarimetry:** Introduction, Principle, Instrumentation, optical purity, calculations.	**12**
Unit.5	**Thermal Methods of Analysis** Principle, theory and instrumentation of TGA, DTA and DSC. Factors affecting thermal analysis. Applications of thermal methods in various field of science. Various theories of thermal analysis for evaluation of kinetic parameters and analysis of simple and polymeric compounds.	**12**

Reference Books

1. Fundamentals of Analytical Chemistry by Skoog Douglas A.

2. Analytical Chemistry by D. Kealey & P. J. Haines, BIOS Scientific Publishers Limited, 2002 First published 2002 (ISBN 1-85996-189- 4)
3. Instrumental Methods of Analysis by B. Sivasankar,
4. B. K. Sharma. "Instrumental method of chemical analysis" **24th** edition**,** GOEL publishing house Meerut .2005
5. Gary D. Christian. "Analytical chemistry" **6th** edition John Wiley & sons, Inc. 2004
6. Skoog, Holler, Niemon, "principles of instrumental analysis" **5th** edition, Saunders college publisher.
7. Analytical Chemistry by Chatwal G. R.
8. Indian Pharmacopoeia Commission (IPC) Ghaziabad, www.ipc.gov.in
9. Green Chemistry by V. K. Ahluwalia, Ane Books Pvt. Ltd.
10. Green Chemistry by K. R. Desai, Himalia Publishing House.Instrumental Methods of Analysis by B. Sivasankar,
11. B. K. Sharma. "Instrumental method of chemical analysis" **24th** edition**,** GOEL publishing house Meerut .2005
12. Gary D. Christian. "Analytical chemistry" **6th** edition John Wiley & sons, Inc. 2004
13. Skoog, Holler, Niemon, "Principles of instrumental analysis" **5th** edition, Saunders college publisher.
14. Analytical Chemistry by Chatwal G. R.
15. Analytical Chemistry: Theory and Practice by Verma R. M.

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CP-105	Practical	6 credits & 12 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Perform qualitative analysis of an inorganic mixture containing six radicals.
2	Perform inorganic complex synthesis and its characterization.
3	Utilize Conductivity meter, pH & Potentiometer, Refractometer and Polarimeter for physicochemical analysis.
4	Perform experiments on Partition Co-efficient, First and second order reactions-order determination, energy of activation, Heat of vaporization.
5	To examine adsorption isotherms.

SEMESTER-I			
CP-105	**Practical**	**12 hrs./Wk**	**6 Credits**

SR. No.	Practical Detail	Lab Hours
1	**Inorganic Chemistry Practical (50 Marks)** **1. Inorganic Qualitative Analysis (25 Marks)** Analysis of a mixture containing six radicals including one less common metal ion: W, Tl, Ti, Mo, Se, Zr, Th, Ce, V and Li. (Minimum 10 mixtures) **2. Preparation and Characterisation of metal complexes (25 Marks):** 1. Preparation and Characterisation of $[VO(AcAc)_2]$. 2. Preparation of cis & trans $[Cr(Ox)_2(H_2O)]$. 3. Preparation and Characterisation of $[Co(Py)_2Cl_2]$. 4. Preparation of $[Cu(gly)_2]$ & $[Cu(acac)_2]$. 5. Preparation and Characterisation of $[Cu(NH_3)_4]SO_4.H_2O$ 6. Preparation and Characterisation of $[Ni(NH_3)_6]Cl_2$ compare with $[Ni(H_2O)_6]Cl_2$. 7. Preparation and Titrimetric Estimation of $[Fe(HCO_2)_2].2H_2O$. 8. Preparation and Characterisation of $[Ni(en)_3]Cl_2.2H_2O$ 9. Synthesis of bis(salicylidene)ethylene diamine cobalt (II) complex. 10. Synthesis of bis(8-quinolinol) bis(benzylidene)ethane-1,2-diamine Ni(II) complex.	6
	Physical Chemistry Practicals (50 Marks)	

2	**Group-A (25Marks):** **Conductometry:** 1. To determine concentration of mixture HCl+CH_3COOH + $CuSO_4$ / HCl + Oxalic acidvs. NH_4Cl/ NaOH by conductometricaly. 2. To determine the equivalent conductance of a strong electrolyte and to verify the Onsager's equation. 3. To determine the degree of hydrolysis and hydrolysis constant. 4. Determine the CMC of a surfactant by conductivity measurements. 5. To determine the Equivalence conductance and dissociation constant of strong electrolytes and weak electrolytes and hence to verify ostwald's distribution law. **pH metry**: 1. To determine normality and dissociation constant of tribasic acids using 0.1N NaOH by PHMetricaly 2. To determine the Hammett constant for p-amino/ nitro benzoic acid using 0.1N NaOH by PH-Metry. 3. To determine the standard oxidation potential of the Quinhydrone electrode. 4. To determine the acidic and basic dissociation constants of amino acid and its isoelectric point by pH-metry. 5. Determine the dissociation constant and strength of borax solution pH-metrically. **Potentiometry**: 1. Determination of dissociation constant of dibasic acids. 2. Determination of activity and activity coefficient of ions. 3. Redox titration- Fe2+ vs Ce4+, I- vs KMnO4. 4. Determine the amount of ferrous sulphate / ferrous ammonium sulphate in given flask potentiometrically using cerric salt solution. 5. Determine the pseudo first order rate constant for bromination of N, N – dimethylaniline/phenol. **Refractometry**: 1. To study the variation of refractive index with composition of given liquid and to determine the % composition of unknown mixture. 2. Determine parachor/density/refractive index of binary solutions. 3. To determine the molar refractive index of a given salt. 4. To determine the electron polarization and electron polarizability of a given salt. 5. To determine refraction equivalents of carbon, hydrogen and chlorine atoms.	**6**
	Group-B (25 Marks) **Partition Co-efficient**: 1. To study the distribution of benzoic acid between toluene & water at room temperature and hence to prove the dimerization of benzoic acid in benzene / toluene. 2. To determine equilibrium constant for the reaction between potassium iodide& iodine by the method of distribution. 3. Determine the formula of a complex between Cu^{+2} and NH_3 by distribution	

method.

4. Determine the equilibrium constant of the reaction $I^- + I_2 = I_3^-$ by the distribution method.
5. To study the distribution co-efficient of succinic acid between ether and water.

Reaction Kinetics:

1. To determine the order of the reaction by a fractional change method.
2. To determine the temperature coefficient and the energy of activation of the reaction between $KBrO_3$ and KI.
3. Autocatalytic reaction between KMnO4 and oxalic acid
4. To determine the reaction velocity constant for the reaction between acetone & iodine
5. To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate catalyzed by HCl + KI by fractional change method.

Adsorption:

1. To study the adsorption of aqueous oxalic acid solution by activated charcoal and examine the validity of Freundlich and Langmuir's adsorption isotherms.
2. To study the adsorption of I_2 from alcoholic solution by charcoal.

Polarimetry:

1. To determine the specific & molecular rotation of glucose/ sucrose & hence intrinsic rotation and concentration of an unknown solution of optically active compound.
2. To determine the rate constant for the inversion of cane sugar.
3. To determine % composition of D-sucrose and tartaric acid in a given mixture.

Thermodynamics

1. Heat of vaporization: To determine heat & entropy of vaporization of a given liquid by a kinetic approach.

Reference Books

1. Svehla, G. (1996, Seventh edition) Vogel's Qualitative Inorganic Analysis. New Jersey: Pearson Education. (ISBN: 0582218667).
2. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) Vogel's Textbook of Quantitative Chemical Analysis. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
3. Pass G., Sutcliffe H., (1974 2nd edition) Practical Inorganic Chemistry: Preparations, Reactions, and Instrumental Methods. (ISBN: 9789401727440)
4. Marusak R. A., Doan K., Cummings S. D., (2007) Integrated approach to coordination chemistry an inorganic laboratory guide, (ISBN: 9780471464839)
5. Woollins D. (2006, 2nd edition) Inorganic Experiments, (ISBN: 978352730510)
6. Parsania P. H (2005, 1st edition) Experiments in Physical Chemistry, Granth Nirman Board.
7. Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London).
8. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, (New Age International Publishers, New Delhi).
9. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut).
10. Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London).
11. Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler,

(McGraw Hill International Edition, London
12. A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London) .
13. Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
14. Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi).
15. W. J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London, 1970

M.Sc. Chemistry SEMESTER-I			
CP-106	**Viva Voce**	**-**	**1 Credits**
• Comprehensive viva voce based on practical and core courses.			

SEMESTER-I		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CP-107	Chemoinformatic Tools	1 credits & 2 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Draw structures, chemical reaction, mechanism & experimental assemblies.
2	Generate IUPAC nomenclature from structures & vice versa
3	Use MS Excell for data analysis and graphical representation
4	Search & retrieve authenticated scientific reference materials.

SEMESTER-I			
CP-107	**Chemoinformatic Tools**	**2 hrs./Wk**	**1 Credits**

1. **Chemical Drawing**
   - Drawing chemical reaction, Structure drawing using templates, Structure to name and name to structure.
   - Drawing mechanism of reaction, Diagram of Assembly, Chiral Structure.
   - Reproducing reaction scheme from given research paper, 3D Chemdraw ultra.
   - Use of MS Excel for plotting and statistical analysis.
2. **Web & Tools for Literature Search**
   - Research Journals & publications.
3. **Citation & Referencing**

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-201	Inorganic Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Classify organometallic compounds using ligands, calculate oxidation state and determine hapticity.
2	Categorize organometallic reaction mechanism and discuss catalytical cycles.
3	Understand and predict the chemical and physical properties of P- block elements
4	Discuss the classification and role of metal ions in function of biomolecules.
5	Outline applications of various metal and radioactive isotopes in pharmaceutical chemistry.

SEMESTER-II			
CC-202	**Inorganic Chemistry**	**4 hrs./Wk**	**4 Credits**

Sr. No.	Course Detail	Inst. hrs.
Unit.1	**Structure and Bonding in Organometallic Compounds** Introduction, Structure & Classification, 18 Electron rule, Hepticity, Ligands in organometallic chemistry: carbonyls, nitrosyls, hydride and dihydrogen, phosphine, ethylene, and related ligands, cyclopentadiene and related ligands, alkyl, aryl, carbenes, carbynes, carbides.	**14**
Unit.2	**Reaction Mechanism and catalytic process of organometallic complex** Reactions involving gain or loss of ligands, Ligand dissociation and substitution, Oxidative addition and C-H bond activation, Reductive elimination, and Pd-Catalyzed cross-coupling, Sigma bond metathesis, Organometallic catalysts: Catalytic deuteration, Hydroformylation, Monsanto acetic acid process, Tennessee–Eastman acetic anhydride process, Wacker (Smidt) process, Hydrogenation by Wilkinson's catalyst, Olefin metathesis, Fischer–Tropsch carbon chain growth, Ziegler–Natta polymerizations.	**12**
Unit.3	**Main Group (P-Block)** **Chemistry of Main group Elements** General Trends in Main Group Chemistry, Physical Properties, Electronegativity, Ionization Energy, Chemical Properties. selected Applications (Inorganic Polymers).	**14**
Unit.4	**Bioinorganic Chemistry** Bio-Inorganic Chemistry Introduction, classification of elements according to their action in the biological system, deficiency, and toxicity, metalloenzymes: classification of biomolecules containing metal ions, metalloporphyrin: introduction, characterization of porphyrins, oxygen carrier and storage, hemoglobin (Hb) and myoglobin (Mb) in oxygen transfer mechanism & functions, biological electron transport proteins: iron-sulfur protein and cytochromes	**10**
Unit.5	**Selected Topics Inorganic Pharmaceutical Chemistry** Introduction, Alkali and Alkaline earth metals as drug, pharmaceutical	**10**

	application of boron and aluminium compounds, transition metal complexes as potential medicinal agent, Radioactive compounds and their clinical applications, Chelation therapy.	

Reference Books

1. Miessler, G. L; Fischer, P. J.; Tarr, D. A.; (2014, sixth edition) Inorganic Chemistry, (ISBN: 978-0-321-81105-9).
2. Agarwala S. K.; Lal K.; (2009), Advanced Inorganic Chemistry, (ISBN: 978-81-8398-773-8).
3. Singh, A.; Singh, R.; (2005) Textbook of Inorganic Chemistry Vol. I & II. New Delhi: Campus Books International, (ISBN: 8180300714).
4. Housecroft C. E; Sharpe A. G.; (2005, 2nd edition) Inorganic Chemistry, (ISBN: 0130-39913-2).
5. House J. E; House K. A.; (2016, 3rd edition) Descriptive Inorganic Chemistry, (ISBN: 978-0-12-804697-5).
6. Rao C. N. R; Muller A.; Cheetam A. K.; (2004) The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH.
7. Poole C. P.; Owens Jr. F. J.; (2003) Introduction to Nanotechnology Wiley Interscience.
8. Kenneth J. K. (2001) Nanoscale materials in Chemistry, Wiley Interscience.
9. Pradeep T.; (2007) Nano: The Essentials in understanding nanoscience and nanotechnology, Tata McGraw Hill.
10. Ajaikumar; (2016 2nd edition) Organometallic & Bloinorganic Chemistry, Aaryush Education, (ISBN:978-81-930437-1)
11. Strohfeldt K. A., (2015) Essentials of inorganic chemistry: for students of pharmacy, pharmaceutical sciences and medicinal chemistry, (ISBN: 9780470665589)

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-202	Organic Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand concept, types and mechanism of multicomponent reaction with applications
2	Apply C-C bond forming reactions using Pd- catalysis and Illustrate its mechanism.
3	Explain concept of organic photochemistry, properties of photochemical reactions and differentiate photo-induced cleavages.
4	Understand fundamentals of stereochemistry and distinguish types of isomerism.
5	Illustrate preparation of organic reagents and recognize appropriate reagent for particular reaction.

SEMESTER-II			
CC-202	**Organic Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Multicomponent Reactions** Principle, mechanism and applications of: Biginelli, Hantzsch dihydropyridine, Mannich reaction, Doebner Quinoline Synthesis, Passerini reaction, Ugi, Malononitrile & 1,3-dicarbonyl based multicomponent reactions (chromenes and pyridine synthesis).	**12**
Unit.2	**Pd-catalyzed Cross-Coupling Reactions** Introduction, Pd-catalysis, Various ligands, General mechanism of Cross-coupling. Principle, reaction mechanism and application of: Suzuki, Sonogashira, Heck, Negashi, Kumada, Stille, Buchwald-hartwig cross-coupling reactions.	**12**
Unit.3	**Photochemical Reactions** Absorption of light by organic molecules, Jablonski diagram, properties of excited states, mechanism of excited state processes and methods of preparative photochemistry. (a) Photochemistry of alkenes and related compounds: Isomerization, Di-π-methane rearrangement and Cycloaddition (b) Photochemistry of carbonyl compounds: Norrish type-I cleavage of acyclic, cyclic, and unsaturated carbonyl compounds, Norrish type-II cleavage (c) Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, Barton reaction, Photodimerisation of□□□□□unsaturated ketones, Rearrangement of enones and dienones, Photo-Fries rearrangement.	**14**
Unit.4	**Fundamentals of Stereochemistry** Isomerism, tetrahedron geometry and concept of chirality, Isomers, Classification of stereoisomerism, Optical isomerism due to tetrahedron carbon, Wedge-dash and Fisher Projections and their interconversion. Concept of enantiomers, diastereomers and meso compound. Various types of configurational nomenclature	**10**

	of stereocenters (one, two similar and two dissimilar stereocenters). Ring and □ and diastereoisomerism-Various methods of nomenclature for acyclic and cyclic systems-cis-trans, E-Z, syn and anti.	
Unit.5	**Important Organic Reagents:** General mechanism, selectivity, and important applications of the following reagents: TEMPO, NBS, n-Bu_3SnH(TBTH), DDQ, TBAB, DCC, Wilkinson catalyst, Azobisisobutyronitrile(AIBN), Organosilicon reagents (TMSCl, TMSCN, Arylsilanes, Hydrosilation).	**12**

Reference Books

1. László Kürtip; Barbara Czakó (2004, First edition) Strategic Applications of Named Reaction in Organic Synthesis. Philadelphia: Elsevier Publishing company (ISBN: 9780124297852).
2. Kalsi, P. S. (2012, Fourth edition) Organic Reactions Stereochemistry and Mechanism (Through Solved Problems). New Delhi: New Age International (P) Limited. (ISBN: 9788122417661).
3. Pericyclic reaction and organic photochemistry. V.P sharma and Rakesh Kumar (ISBN No. : 978-81-8398-632-8)
4. Organic Chemistry (VI edition) - R.T Morrison- Boyd. Prentice Hall of India (2003)
5. Organic Chemistry- (V edition) - John McMurry), Asian Book Pvt Ltd, New Delhi
6. Advanced organic chemistry (IV edition) - Jerry March
7. Basic stereochemistry of organic molecules by Subrata Sen Gupta, Oxford University press, (ISBN-10:0-19-945163-X)
8. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-203	Physical Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Outline polymers and explain various polymerization reactions
2	Differentiate chain polymerization reactions and calculate polymer properties.
3	Discuss types of crystals and point defects
4	Explain adsorption isotherms and factors affecting it. Discuss properties of colloidal system and factor affecting it.
5	Describe kinetics of complex reaction of unimolecular and photochemical reactions.

SEMESTER-II			
CC-203	**Physical Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Polymer Chemistry** Introduction, addition and substitution reaction, Cyclization reaction, cross linking reaction, reactions leading to graft and block copolymers, miscellaneous reactions. Stereo regular polymers. Polymer nomenclature. **Polycondensation** Reaction route of poly functional compounds. Kinetics of polycondensation reaction. Molecular weight control in polycondensation. Statistics of linear polycondensation. Effect of monomer concentration and temperature on direction of polycondensation reaction.	**12**
Unit.2	**Chain Polymerization** **(a)Free Radical Polymerization:** Methods of initiating free radical polymerization. Chain transfer reactions. Kinetics of free radical polymerization and chain transfer reactions. **(b)Ionic (Catalytic) Polymerization:** Kinetics of cationic and anionic polymerization. Coordination polymerization. Copolymerization and its kinetics. Evaluation of reactivity ratios. **(c)Polymer molecular weight**; number average molecular weight, the weight everage molecular weight. Problems	**12**
Unit.3	**Solid state** Introduction: symmetry of crystal, miller indices, Types of crystals:- molecular, Network covalent, ionic, metallic , band theory, energy band theory of conductors, semiconductors and insulators, imperfections in crystal-point defect, Schottky defect, Frenkel defect, metal excess defect, line defects, quasicrystals.	**10**
Unit.4	**Surface Chemistry** Introduction, Adsorption isotherm: Freundlich, Langmuir, Gibbs and BET of multilayer adsorption, Surface area determination, Electrokinetic (Zeta) potential and its determination by electrophoresis, factor affecting zeta potential.	**12**

	Colloidal state: General properties of colloidal system, Lyophobic sols and lyophilic sols, Surface active agent, Micellization: mechanism, Critical Micellar Concentration (CMC) factors affecting the CMC of surfactants.	
Unit.5	**Chemical Kinetics:** Introduction, activated complex theory in terms of thermodynamic, influence of ionic strength and solvent properties on rate, Complex reactions: Opposing reactions, Consecutive reactions, kinetics of fast reaction, Ionic reactions, and salt effect. Unimolecular reactions: Lindemann-Christiansen hypothesis, Hinshelwood. Photochemical reactions: introduction, rate law, kinetics of photochemical reactions-kinetics of hydrogen-bromine, decomposition of HI and Anthracene reaction.	**14**

Reference Books

1. Textbook of polymer science-third edition by Fred.W. Billmeyer Jr., a Willey Inter-science publications, ISBN-9971-51-141-X.
2. Polymer Science by V. R. Govariker, New age international publisher, ISBN:978-0-85226-307-5.
3. Glasstone, Samuel. (2007) *Thermodynamics for Chemists*: Narahari Press (ISBN: 1406773220).
4. Peter Atkins, Julio de Paula (2015) Physical chemistry: Thomson Press (ISBN: 019872872-7).
5. Gurdeep Raj (2014, Third edition) *Thermodynamics*. Meerut: GOEL publishing House (ISBN: 8187224886).
6. Gurtu, J. N. Gurtu,A. (2014, Twelfth edition) *Advanced Physical Chemistry*. Meerut: Pragati Prakashan (ISBN: 9350060191).
7. Chemical Kinetics, K. J. Laidler, (McGrraw Hill Publication).
8. Advanced Practical Physical Chemistry by J. B. Yadav, (Goel Publishing House, Meerut).
9. Chemical Kinetics and Dynamics; Jeffrey I Steinfeld, Joseph S. Francisco and William L. Hase. Prentice Hall, 2nd edition, 1998.
10. Laidler, K. J.; “Chemical Kinetics", 3rd Edition 1997 , Benjamin-Cummings. Indian reprint - Pearson 2009.
11. R.G.Frost and Pearson, Kinetics and Mechanism, Wiley, New York,1961.
12. G.A. Somorjai, Y. Li , Introduction to Surface Chemistry and Catalysis (2n ed.), 2010. Surface Chemistry: Theory and Applications by J.J Bikertman, Academic Press, New York (1972).
13. Physics at surfaces, A Zangwill, Cambridge university Press (1988). 12. Surface crystallography, L J Clarke, Wiley-Interscience (1985).
14. A.W. Adamson, A.P. Gast, Physical chemistry of surfaces, Wiley, 1997.
15. Surface crystallography, L J Clarke, Wiley-Interscience (1985)

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CC-204	Analytical Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Justify method validation parameters and statistical significance of test
2	Understand the different criteria of Intellectual Property rights and its legislations
3	Illustrate pharmacopeial analysis and apply for various qualitative and quantitative assessments.
4	Discuss methods for petrochemical analysis
5	Apply experimental methods for soil analysis and water sample testing.

SEMESTER-II			
CC-204	**Analytical Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Analytical Chemometrics** Propagation of measurement of uncertainties, useful statistical tests: Test of significance, F- test, t-test, chi-square-test, correlation coefficient, confidence limits of mean, comparison of mean with true values. Regression analysis (least square method for linear and nonlinear plots). Statistics of sampling and detection limit evaluation. Specific study for analytical method radiation by using validation parameters: (1) accuracy, (2) precision (repeatability and reproducibility), (3) linearity and range, (4) Limit of Detection (LOD) and Limit of quantification (LOQ), (5) selectivity/specificity, and (6) Robustness and Ruggedness. Problems.	**14**
Unit.2	**Intellectual Property Rights (IPR)** Introduction, various Technical Terms, Legislation, IPA in India, Criteria for Patent, Patent for Polymorph, case studies.	**10**
Unit.3	**Pharmaceutical Analysis** Introduction to Pharmacopeia and Pharmacopeial analysis: Physical and chemical tests: Physical verification and colour test, Loss on drying, loss on ignition, Tape and Bulk Density, Determination of moisture, limit test for heavy metals, Limit test for Halogens, Purity and assay determination by classical methods, Concept for Potency determination. Introduction of Disintegration and Dissolution tests, types of Dissolution apparatus, Types of Dissolution media, Application.	**12**
Unit.4	**Analysis of Petrochemical Products** **Petroleum:** Introduction, Definition, Composition, Test methods for following: **Naphtha:** Aniline and Mixed Aniline point, Composition, Density, Evaporation rate, Flash point, Velocity, Volatility, Appearance, Kauri-Butanol value. **Gasoline:** Additives, Composition, Corrosiveness, Density, Flash and Fire point, Volatility, Water and Sediments **Kerosene:** Acidity, Composition, Flash and Fire point, Pour point, Density, Viscosity, Water and Sediments	**12**

	Diesel: Acidity, Composition, Flash and Fire point, Pour point, Density, Viscosity, Water and Sediments Distillate **Fuel oil and Mineral oil:** Acidity, Composition, Flash and Fire point, Pour point, Density, Viscosity, Water and Sediments	
Unit.5	**Analysis of Soil and Water** **Soil:** Introduction, Importance of soil testing, Types of soils and analysis of soil for following: pH, Electrical Conductance, Organic Carbon, Determination of Sodium, Potassium, Boron, Phosphorous. **Water:** Introduction, Sampling techniques, Preservation and Pre-concentration methods, Determination of following: Total Acidity, Alkalinity, Free Carbon Dioxide, Chloride, Calcium, Magnesium, Iron, Silver, Heavy Metals, DO, COD, BOD, National and International standards for drinking water.	**12**

Reference Books

1. Modern Analytical Chemistry by Alka L. Gupta, Pragati Prakashan, 2nd Edition (ISBN:978-93-5140-571-9)
2. Practical Statistics (Vol 1 and 2) by Singh, Atlantic Publishers.2003.
3. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions. CRC, 2008.
4. Spectroscopy 14th edition -2018 by H. Kaur, Pragati Prakashan, Meerut. Environmental Chemistry by V. K. Ahluwalia Ane Books India First Edition.
5. Environmental Chemistry by B.K. Sharma, Gole Publishing House
6. Methods for Analysis of Petroleum Products by ASTM, International USA
7. Indian Pharmacopeia, 2022, 9th Edition, Government of India, Ministry of Health and Welfare, Published by IPC, Ghaziabad.

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CP-205	Practical	6 credits & 12 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Perform qualitative analysis of a multifunctional organic compounds
2	Perform synthesis of organic compounds and demonstrate its mechanism.
3	Demonstrate and Calibration of glassware & apparatus.
4	Prepare and standardize the solutions.
5	Measure the % Assay and % Purity of fine chemicals.

SEMESTER-II			
CP-205	**Practical**	**12 hrs./Wk**	**6 Credits**

SR. No.	Practical Detail	Lab Hours
1	**Organic Chemistry Practicals (50 Marks)** **Group-A: Qualitative Analysis of Bi-functional organic compounds (Minimum 10 Compounds) (25 Marks):** • Anthranilic acid • p-Aminobenzoic acid • o-Chlorobenzoic acid • m-Nitrobenzoic acid • o/m/p-Nitroaniline • Bi-phenyl amine • N, N-Dimethyl aniline • Resorcinol • Ethyl acetoacetate • P-Dichlorobenzene • o/p-Cresol • o/m/p-Toluidine • Benzanilide • Acetamide • α/β-Naphthole NOTE: Other bifunctional compounds may be asked in examination. **Group-B: Single Step Synthesis (25 Marks):** 1. Phenyl urea from aniline 2. m-diNitro benzene aniline from nitrobenzene. 3. Hydro quinone diacetate from hydroquinone. 4. 1,2,3,4-Tetrahydrocarbazole from Cyclohexanone 5. p-Nitroacetanilide from aniline. 6. 7-Hydroxycoumarine from resorcinol. 7. Hippuric acid from glycine.	**6**

	8. Benzilic acid from Benzil 9. Phthalamide from phthlic anhydride. 10. Resacetophenone from resorcinol.	
2	**Analytical Chemistry Practicals (50 Marks)** **Group-A: Analytical estimation (25 Marks)** 1 Preparation and Standardization of solutions. 2 Calibration of glassware and apparatus. 3 To determine the % purity of Aspirin. 4 To determine the % of Zinc Oxide by reduce titration method. 5 To determine the amount of Calcium and Zinc in given sample. 6 To determine the volume strength of H_2O_2. 7 To determine the % purity of given Phthalic anhydride. 8 To determine the % purity of given Malic anhydride. 9 Estimation of Calcium and Magnesium in given sample. 10 To determine the amount of tin from solder wire. **Group-B: Analysis of Food and Drug (25 Marks):** 1. % purity of Aspirin, Paracetamol, Valproic acid, Ascorbic acid etc. 2. Total protein content in milk. 3. Peroxide value of oil sample. 4. Saponification value of oil sample. 5. Percentage of starch content in turmeric powder. 6. Amount of iodine in the given iodized salt. 7. The percentage of reducing sugars in honey sample.	**6**

Reference Books

1 Brian S. Furniss (1989, Fifth edition) Vogel's Textbook of Practical Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 0-582-462363).

2 Svehla, G. (1996, Seventh edition) *Vogel's Qualitative Inorganic Analysis*. New Jersey: Pearson Education. (ISBN: 0582218667).

3 Parsania P. H (2005, 1st edition) Experiments in Physical Chemistry, Granth Nirman Board

4 Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) Vogel's Textbook of Quantitative Chemical Analysis. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).

M.Sc. Chemistry SEMESTER-II			
CC-206	**Viva Voce**	**-**	**1 Credits**
• Comprehensive viva voce based on practical and core courses			

SEMESTER-II		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
CP-207	Research Writing	1 credits & 2 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand research journal, citations, impact factors and publication processes.
2	Comprehend literature from research journals
3	Prepare review articles using literature survey
4	Justify research objective and methodology

SEMESTER-II			
CC-207	**Research Writing**	**2 hrs./Wk**	**1 Credits**

- Various journals, data mining
- Article formats, various literature search options
- Recent publication, citation index
- Impact factor
- Review article writing preparation and submission in the given format:
  - Title, abstract, introduction, literature survey, summary, references

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-301	Stereochemistry and Asymmetric Synthesis	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Express projections, discuss stereoisomerism without chiral carbon, examine chirality and calculate enantiomeric excess.
2	Differentiate topicity of ligands and faces and demonstrate conformational analysis with stability.
3	Understand and identify the types of Nucleophilic substitution and Elimination reaction and predict stereoselectivity/specificity of the concerned reaction with mechanism
4	Analyse and write the stereochemistry of Addition Reactions to Carbon-Hetero multiple bond.
5	Apply various methods of asymmetric induction and predict the outcome of asymmetric synthesis.

M.Sc. (Organic Chemistry) SEMESTER-III			
OC-301	**Stereochemistry and Asymmetric Synthesis**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	(**a**)**Projections**: Wedge-dash, Fischer, Newman, Sawhorse, Zigzag projections and their interconversions for compounds having two or more stereocenter. **(b) Stereoisomerism without a stereogenic carbon**. Axial chirality (bi-phenyl, allenes, spiranes), planar chirality (ansa compounds, paracyclophanes, trans-cyclooctene), helicity (hexahelicene). **(c) Racemic mixtures and modification** Theories of racemization, resolution of racemic mixtures, optical purity & enantiomeric excess.	**12**
Unit.2	**(a) Prochirality, pro-stereoisomerism** Pro-stereoisomerism and prochirality-introduction Topicity: Examples of homotopic & heterotopic ligands, pro-R and pro-S nomenclature. Examples of Homotopic & Heterotopic faces, Re-Si nomenclature system. **(b)Conformational analysis and reactivity:** • Conformations, klyne-prelog terminology for tortional angle, conformation analysis and reactivity of acyclic molecules like butane, n-pentane, halogeno alkanes, acetaldehyde, propionaldehyde 1,3-butadiene and C-Hetero bond. • Conformations of cyclohexane, mono and di-substituted cyclohexane ring	**12**

	systems. Effect of conformation on reactivity of cyclohexanes. • Conformations of fused ring systems-decalin and decalones and its diastereomerism. • Conformation of bridge systems-Bicyclo[2,2,1] heptane and Bicyclo[2,2,2]octane. Exo. Endo nomenclature, bredt's rule. • Conformation of sugar (Fisher, haworth and chair), epimers, anomers, Epimerization, anomeric effect and mutarotation.	
Unit.3	**Stereospecific and Stereoselective reactions-I** Stereospecific and stereoselective reactions, general methods of synthesis and asymmetric induction. **(a) Aliphatic nucleophilic substitution reactions** Introduction, Stereochemistry of S_N1 & S_N2 reaction mechanism, The S_Ni mechanism, Mixed S_N1 & S_N2 reaction, ambient nucleophile, Regioselectivity, Neighboring group participation. **(b) Elimination Reactions** • Introduction, Mechanism E1, E2 and E1cB, Stereochemistry of E2-anti-ellimination reaction, E2-syn-elimination.	**12**
Unit.4	**Stereospecific and Stereoselective reactions-II** **(a) Addition Reaction of Carbonyl** Stereochemistry addition of carbonyl compounds (Cram's rule and Felkin Anh models), Stereochemistry of metal hydride reduction of carbonyl. Stereoselective aldol reactions. **(b) Addition Reaction of Olefins** Stereochemistry of addition of olefins: dihydroxylatioin (manganese, osmium based), Hydroboration & oxymercuration, Woodward & Prevost reagent.	**12**
Unit.5	**Asymmetric synthesis** Methods of asymmetric induction, substrate, reagent and catalyst-controlled reaction: • Asymmetric oxidation from: mCPBA & Henbest effect, halo-hydrine, Sharpless, and Shi reagents. • Asymmetric ring opening of expoxide from: Grignard reagent, super-Grignard reagent, dialkylcuprates, LAH, $NaBH_4$, DIBAL, OH^-/H_2O and HBr. • Chiral-auxiliary controlled stereoselection: Evans oxazolidinones, asymmetric synthesis of amino acids from chiral auxillary.	**12**

Reference Books

1. Kalsi, P. S. (2012, Fourth edition) Organic Reactions Stereochemistry and Mechanism (Through Solved Problems). New Delhi: New Age International (P) Limited. (ISBN: 9788122417661).
2. Subrata Sen Gupta (2014), Basic Stereochemistry of organic molecules. New Delhi: Oxford University press. (ISBN: 978-0-19-945163-0).
3. Modern Methods Of Organic Synthesis By W. Carruthers. Cambridge university press.(ISBN: 0521-77097-1)
4. Aziridines and Epoxides in Organic Synthesis Edited by Andrei K. Yudin, Wiley-VCH (ISBN-13 978-3-527-31213-9)
5. Finar, I. L. (1989, Fifth edition) Organic Chemistry: Vol -2: Stereochemistry and the Chemistry

of Natural Products. Harlow: Longman. (ISBN: 0-582-05916-X).
6. Clayden Jonathan; Greeves Nick, Warren Stuart (2012, Second edition) Organic Chemistry. Oxford: Oxford University Press (ISBN: 0199270295).
7. Eliel, Ernest L., Wilen, Samuel H. (1994) Stereochemistry of Organic Compounds. Hoboken: Wiley-Blackwell (ISBN: 0471016705).
8. Nogradi, M. (2008, Second revised and updated edition) Stereoselective synthesis: A practical approach. Weinheim: Wiley VCH. (ISBN: 978-3-527-61568-1).

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-302	Heterocyclic Chemistry and Pericyclic Reactions	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Generate IUPAC nomenclature for heterocyclic systems and vice versa.
2	Analyse and predict the chemical reactivity of various heterocyclic compounds.
3	Identify and apply suitable starting material, reagent and reaction condition to synthesize given heterocyclic compounds.
4	Understand pericyclic reactions
5	Apply FMO, PMO and Woodward rule for writing mechanism and respective products of cycloaddition and sigmatropic reactions

M.Sc. (Organic Chemistry) SEMESTER-III			
OC-302	**Heterocyclic Chemistry and Pericyclic Reactions**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**(a) Nomenclature of heterocyclic compounds** **(b) Heterocyclic analogues of cyclopentane and its fused ring system** 1. Preparation and properties of pyrrole, furan, thiophene. Preparation and properties of indole, benzofuran, benzothiophene.	**12**
Unit.2	**(a) Heterocyclic analogues of benzene and its fused ring system** 1. Preparation and properties of pyridine and pyran. 2. Preparation and properties of quinoline, isoquinoline, acridine. 3. Preparation of benzopyran, benzopyran-2-one and benzopyran-4-one. **(b) Compounds with two heteroatoms in a six membered ring** Preparation of pyridazine, pyrimidine, pyrazine, dioxane, Morpholine, phthalazine, quinazoline, quinaxoline, phenothiazine.	**12**
Unit.3	**(a)Compounds with two heteroatoms in a five membered ring** 1. Preparation & properties of pyrazole, oxazole, thiazole. 2. Preparation of imidazole, isoxazole, isothiazole. **(b) Compounds containing more than two heteroatoms** 2. Preparation of triazole, oxadiazole, thiadiazole, triazenes.	**12**

Unit.4	**Pericyclic reactions and concerted mechanism-I** • General introduction and classification of pericyclic reaction, symmetry properties of molecular orbitals - ethylene, 1,3 – butadiene, 1,3,5–hexatriene and allylic systems. Concept of frontier molecular orbital (HOMO and LUMO) under thermal and photochemical conditional. • **Electrocyclic reaction**: Conrotatory and disrotatory motions of orbitals, prediction about feasibility of electrocyclic reaction: FMO approach, conservation of orbital symmetry-correlation diagram approach and perturbational molecular orbital (PMO) or Huckel-Mobius (H-M) approach. • Selection rule for electrocyclic ring-closing & ring-opening reaction (thermal or photochemical) for 4nπ system and (4n+2)π system. Examples of different electrocyclic reactions and their stereochemistry.	**12**
Unit.5	**Pericyclic Reactions and Concerted Mechanism-II** • **Cycloaddition reactions**: (2+2) cycloaddition through antarafacial and suprafacial modes, selection rules for cycloaddition by FMO & correlation diagram approach Diels-alder reaction: (4+2) exo and endo-addition, reactivity and regioselectivity. 1,3-Dipolar cycloaddition reactions, cheletropic reactions & selection rule for thermal condition. • **Sigmatropic rearrangements**: Suprafacial and Antarafacial shifts of hydrogen, selection rule for thermal and photochemical conditions, [1,3] & 1,5-sigmatropic shift of Hydrogen, [3,3] and [5,5] sigmatropic rearrangements, Claisen and Cope rearrangements, aza-Cope rearrangements, Sommelet–Hauser rearrangement.	**12**

Reference Books

1. Vinay P. Sharma & Rakesh Kumar. Pericylic reactions and organic photochemistry, Pragati Prakashan, 2008, Meerut- (ISBN-978-81-8398-632-8)
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford
3. University Press, 2001.
4. Heterocyclic Chemistry by R.K. Bansal, New age international (ISBN-13: 978-8122412123)
5. Heterocyclic chemistry by J.A. Joule, K. Mills (2010, First ediction) John Wiley & Sons, Inc., Hoboken, New Jersey, (ISBN 978-1-405-13300-5).
6. Modern Heterocyclic Chemistry by Julio Alvarez-Builla, Juan Jose Vaquero, and Jose´ Barluenga, Wiley-VCH publication (ISBN 978-3-527-33201-4)
7. Name reaction in Heterocyclic chemistry by Jie Jack Li, Willey-interscience (ISBN 0-471-30215-5).
8. The Chemistry of Heterocycles by Theophil Eicher and Siegfried Hauptmann, Wiley-VCH publication (ISBN 3-527-30720-6).
9. Handbook of Heterocyclic chemistry by A. R. Katritzky, Pergamon-Elsevier (ISBN 0-08-042998-2)

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-303	Medicinal Chemistry	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand the chemistry of drugs with respect to their pharmacological activity.
2	Demonstrate an understanding of the steps involved in the drug discovery and design process
3	Critically analyse biological pathways for their potential as drug targets for a given disease.
4	Employ the core subject knowledge of anticancer and anti-infectious, Cardiovascular and the drugs affecting on metabolic disease.
5	Well acquainted with the synthesis of some important class of drugs.

M.Sc. (Organic Chemistry) SEMESTER-III			
OC-303	**Medicinal Chemistry**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs
Unit.1	**Drug design and development** History and development of medicinal chemistry, drugs and their important, drug discovery, clinical trials, lead discovery, lead discovery from natural sources, lead discovery through: Random screening, non-random (or targeted or focused) screening, drug metabolism studies, clinical observations, rational approaches to drug discovery. **(a) Lead modification** Identification of the active part: The pharmacophore, functional group modification. structure–activity relationships, privileged structures and drug-like molecules, structure modifications to increase potency and the therapeutic index, homologation, chain branching, ring-chain transformations and bioisosterism. **(b) QSAR** Introduction to quantitative structure–activity relationships (QSARs), lipophilicity, partition coefficients (P), lipophilic substitution constants (p), electronic effects, the hammett constant (s), steric effects, the taft steric parameter (Es), molar refractivity (MR), other parameters. hansch analysis, craig plots, the topliss decision tree.	**12**
Unit.2	**(a)Prodrug** Concept, structure and classification of prodrug. Use of prodrugs: Masking taste or odour, minimizing pain at site of injection, alteration of drug solubility, overcome absorption problems, prevention of pre-systemic metabolism, longer duration of action diminish local and systemic toxicity. **(b) Combinatorial chemistry** The Principle and design of combinatorial chemistry, Pool and split method for peptide synthesis, Parallel synthesis, Furka's mix and split technique, Solid support	**12**

	method.	
Unit.3	**(a)Drugs acting on cancer** Introduction to diseases, classification of anticancer drugs and synthesis of the following classes of the drugs: (1) DNA alkylating agents: Estramustine, Cisplatin (2) Enzyme Inhibitors: Anastrozole, Sorafenib, sunitinib **(b)Drugs acting on infectious diseases** Introduction to diseases, classification of acting on infectious diseases and synthesis of the following classes of the drugs: (1) Quinolone Antibiotics: Levofloxacin, Moxifloxacin. (2) Triazole Antifungals: Itraconazole, Fluconazole. (3) Non-Nucleoside HIV Reverse Transcriptase Inhibitors: Nevirapine, Delavirdine Mesylate. (4) Neuraminidase Inhibitors For Influenza: Oseltamivir Phosphate (Tamiflu), Zanamivir. (5) Antimycobacterial (TB)drugs: Isoniazid, Ethambutol	**12**
Unit.4	**(a)Drugs acting on cardiovascular disorder** Introduction to diseases, classification of drugs acting on Cardiovascular disorder and synthesis of the following classes of the drugs: (1) Hypertension: Losartan Potassium, Telmisartan. (2) Calcium Channel Blockers For Hypertension: Nifedipine, Amlodipine (3) Second-Generation Hmg-Coa Reductase Inhibitors: Rosuvastatin, Atorvastatin. **(b)Analgesic and Non-steroidal anti-Inflammatory dugs (NSAIDs):** Introduction to diseases, classification of anti-inflammatory drugs and synthesis of the following classes of the drugs: (1) Heteroarylacetic acid analogues: Indomethacin, Sulindac, (2) Arylacetic acid analogues: Ibuprofen, Diclofenac sodium. (3) Arylpropionic acid analogues: Ketoprofen, Indoprofen. (4) Naphthalene acetic acid analogues: Naproxen. (5) Salicylic acid analogues: Aspirin, Benorilate. Pyrazolones and pyrazolodiones: Phenazone (Antipyrine), Phenylbutazone.	**12**
Unit.5	**(a)Drugs acting central nervous system** Introduction to diseases, classification of drugs acting on Central Nervous System, synthesis of the following classes of the drugs: (1) Antidepressant: Venlafaxine, Duloxetine. (2) Insomnia: Zolpidem, Zaleplon, Indiplon. (3) Antiepileptic: Gabapentin. (4) Attention Deficit Hyperactivity Disorder: Amphetamine. **(b)Non-sedating antihistamines** Histamine blocker: Citrizine, fexofenadine **(c)Anti-diabetic drugs:** Introduction to diseases, classification of hypoglycemic drugs acting and synthesis of the following class of the drugs: (1) Type 2 Diabetes: Rosiglitazone, Pioglitazone	**12**

	(2) Sulphonamide-Hypoglycemic agents: Tolbutamide, Glyburide, (3) Guanidine: Metformin	

Reference Books

1. Fundamentals of Medicinal Chemistry by Gareth Thomus, Wiley-VCH- 2003, (ISBN 0-470-84306-3)
2. The practice of Medicinal Chemistry by Camille G. Wermurth, Third edition-Academic Press-(ISBN-0-12-744481-5).
3. Medicinal Chemistry by Ashutosh Kar, New age international-4th edition (ISBN:978-81-224-2305-7).
4. Principles of Medicinal Chemistry by S. S. Kadam, Mahadik, Bothera, Nirali Publication, 11th edition.
5. Drugs from Discovery to approval by Rick N.G., Wiley-Blackwell-second edition.
6. An Introduction to Drug Design, S. S. Pandey and J.R. Dimmock, New Age International.
7. Burger's Medicinal Chemistry and Drug Discovery, Sixth Edition, Ed.M.E.vWolff, John Wiley.
8. The Art of Drug Synthesis by Douglas S. Johnson and Jie Jack Li, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN 978-0-471-75215-8.
9. Synthesis of Essential Drugs by R.S. Vardanyan and V.J. Hruby, Elsevier, ISBN: 978-0-444-52166-8.

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-304	Modern Spectroscopy	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand Principle and theory of various spectroscopy. i.e. UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry.
2	Discuss Instrumentation of UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry.
3	Demonstrate competence in collecting and interpreting data in the laboratory.
4	Solve problems related to the saturation, functional group, molecular weight and structure of molecules
5	Analyse and interpret spectroscopic data for structure elucidation.

M.Sc. (Organic Chemistry) SEMESTER-III			
OC-304	**Modern Spectroscopy**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Introduction to spectroscopic techniques** Types of analytical techniques, introduction of instrumental methods and its classification, overview of spectroscopic methods based on wave length regions of electromagnetic radiation, properties of electromagnetic radiation. **UV Spectroscopy** Introduction, theory of ultra violate spectra, instrumentation, type of transition in organic molecules; auxochrome, chromophore; explanation of bathochromic shift and hypsochromic shift, hyper chromic effects, types of bands, effect of solvent, application of UV spectra. Calculation of λ-max (1) dienes and conjugated dienes (2) enones and dienones (i.e. unsaturated carbonyl compounds) (3) aromatic carbonyl system.	**10**
Unit.2	**Infrared Spectroscopy:** Introduction to IR and FTIR, principle & theory of Infrared absorption spectrometry, infrared sources and transducers, sample handling, instrumentation, interpretation of IR spectra, applications and limitations of IR spectroscopy.	**08**
Unit.3	**Mass Spectroscopy** Introduction, principle, theory and components of mass spectrometers, different ionization and detection techniques, recording and resolution of mass spectrometer, types of ions produced in mass spectrometer, interpretation of mass spectra of selected compounds /API, Applications of Mass spectrometry, Introduction to ICP-MS.	**08**
Unit.4	**Nuclear Magnetic Resonance Spectroscopy-I**	**14**

	Introduction, NMR active nuclei, Basic Theory, NMR Spectrometer, internal Standard & solvent. **^{1}H NMR (PMR):** Principle, Chemical shift, Magnetic anisotropy, spin-spin coupling (multiplicity), applications & problems of Nuclear magnetic resonance spectroscopy.	
Unit.5	**Nuclear Magnetic Resonance Spectroscopy-II** **^{13}C NMR**: Introduction, Principle, chemical shift, application and problems of ^{13}C – NMR. **Introduction to 2D NMR, Application of COSY, NOESY, HSQC, HMBC** **Structure Elucidation**: Structure determination and distinction of various isomeric compounds through spectroscopic techniques (UV, IR, Mass, NMR &2D-NMR)	**20**

Reference Books

1. Martin, M. L., Delpuech, J. J. and Martin, G. J. (1980) Martin *Practical* Nmr Spectroscopy. Weinheim: John Wiley & Sons Ltd. (ISBN: 0471258652).
2. Silverstein, Robert M., Webster, Francis X., Kiemle, David J., Bryce, David L. (2014, Eighth edition) Spectrometric identification of Organic Compounds. Weinheim: John Wiley & Sons Ltd. (ISBN: 978-0-470-91401-4).
3. Abraham, R. J., Fisher, J. and Loftus, P. (1988) Introduction to NMR Spectroscopy. Weinheim: John Wiley & Sons Ltd. (ISBN: 0471918946).
4. Dyer, J. R. (1965) Application of absorption Spectroscopy of Organic Compounds. Upper Saddle River: Prentice Hall.
5. Williams, D. H., Fleming, I. (2007, Sixth edition) Spectroscopic Methods in Organic Chemistry. New Delhi: Tata McGraw-Hill. (ISBN: 007711812X).
6. Kalsi, P. S. (2006, Sixth edition) Spectroscopy of Organic Compounds. New Delhi: New Age International Pvt. Ltd. (ISBN: 8122415431).
7. Breitmaier E. (2002, Third edition) Structure elucidation by NMR in Organic Chemistry-A Practical approach. Weinheim: John Wiley & Sons Ltd. (ISBN: 978-0-470-85007-7).

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OP-305	Practical & Viva Voce	6 credits & 12 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Apply understanding of reaction mechanism and reagents to perform heterocyclic preparation.
2	Analyze product formation by using TLC monitoring, physical measurement, separation and purification techniques.
3	Apply UV Viz. phenomena to find out wavelength, concentration and chemical shifts of organic molecules.
4	Interpret IR spectrum for identification of various functional group in organic molecules.
5	Operate flame, polarimeter, UV Visible and IR spectrophotometer.

M.Sc. (Organic Chemistry) SEMESTER-III			
OP-305	**Practical & Viva Voce**	**12 hrs./Wk**	**6 Credits**

SR. No.	Practical Detail	Lab Hours
Unit-1	**Organic Synthesis (50 Marks)** **Multi-step synthesis / Synthesis of Medicinally important moieties (with TLC monitoring of Reaction):** 1. Benzophenone to Benzanilide 2. 4-Bromoaniline from Acetanilide 3. 4-Iodonitrobenzene from 4-Amino-nitrobenzene 4. o-Iodobenzoic acid from Phthalic anhydride 5. Acridone from o-Chlorobenzoic acid 6. Hydantoin from Glycine 7. 5-Hydroxy-1, 3-benzoxathiol-2-one from hydroquinone 8. Benzimidazole from o-Phenylenediamine 9. Dibenzylacetone from Acetone 10. Barbituric acid from Urea 11. β-D-Glucopyranose penta-acetate from alpha-D-Glucose 12. 3-Carbethoxycoumarin from Salicyldehyde	**9**
Unit-2	**Separation Technique (50 Marks)** **Group B: Instrumentation analysis (50 Marks):** 1. Determination of λ max of given samples by visible spectrophotometer. 2. Determination of λ max of given samples by UV-Vis spectrophotometer. 3. Evaluation of effect of solvents on given sample and to identify the type of shift by UV-Vis spectrophotometer. 4. Control of absorbance and limit of stary light on UV-Vis spectrophotometer. 5. Calibration of polarimeter.	**3**

	6. Specific rotation determination by polarimeter. 7. Estimation of metal from various water samples by flame photometer. 8. Estimation of metals from various drug samples by flame photometer. 9. Estimation of metals from various soil samples by flame photometer. 10. Determination of bleachability index (DOBI) of palm oil by UV-Vis spectrophotometer. 11. Demonstrative practicals of IR and fluorescence spectroscopy.	

Reference Books

1. Brian S. Furniss (1989, Fifth edition) Vogel's Textbook of Practical Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Arthur I. Vogel. (second edition) Elementary practical organic chemistry: Small scale preparations. Pearson (ISBN: 978-81-317-5686-7).
3. V.K. Ahluwalia and Renu Aggarwal (University Press),Comprehensive practical organic chemistry: Preparations and qualitative analysis (ISBN: 978-81-7371-273-9)
4. Raj K. Bansal (new age international-5th edition). Laboratory manual of organic chemistry (ISBN:978-81-224-2930-5**)**

M.Sc. (Organic Chemistry) SEMESTER-III		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OP-306	Research Project Proposal &Viva Voce	2 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Analyse published literature
2	Perform critical analysis of literature survey and established research scope
3	Create research aims and objective
4	Identify appropriate research methodology to full fill research objective
5	Create research proposal in the prescribed format

M.Sc. (Organic Chemistry) SEMESTER-III			
OP-306	**Research Project Proposal & Viva Voce**	**4 hrs./Wk**	**2 Credits**

Research proposal Writing Guideline (Minimum 5000 words) (100 Marks):

1. Explanation of various research funding agencies (UGC, DBT, DST, CSIR, SERB, GUJCOST) & their research support schemes.
2. Training on how to write various aspects of research proposal in given format with one example. (Title, description of problem, review of related work, national & international status, rationale for taking up project, objective of proposal, methodology, references, year-wise work plan, budget estimation etc.)
3. Assign chemistry-based research problems and its literature review.
4. Preparation and submission of one research proposal for anyone funding agency.
5. Presentation (ppt) of the prepared research proposal including all aspects.
6. Viva voce will be based on the research proposal and its various aspects.

M.Sc. (Organic Chemistry) SEMESTER-IV		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-401	Organic Synthesis: A Disconnection Approach	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand concept of disconnection, synthon and synthetic equivalents and its application in disconnection analysis.
2	Understand concept of functional group interconversion strategy and its application for the aromatic compounds.
3	Recognize disconnection pattern for dicarbonyl compounds including 1-2, 1-3, 1-4, 1-5 and 1-6 dicarbonyl framework and plan synthesis thereof.
4	Apply the stepwise disconnection approach for a range of compounds having different patterns of functionalization to support selected strategic and tactical principles in retrosynthetic analysis of targeted molecules.
5	Analyze published synthetic routes in terms of retrosynthetic strategy, recognize the importance of reagent selection for common transformations and suggest reagents for such transformations in the context of such synthetic routes.

M.Sc. (Organic Chemistry) SEMESTER-IV			
OC-401	**Organic Synthesis: A Disconnection Approach**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs
Unit.1	**Retrosynthesis-A Disconnection Approach-** Introduction of disconnection analysis, Common terminology and explanation, representation of disconnection analysis, Concept of synthon (Acceptor and donor, umpolung) and synthetic equivalents (Reagent). Planning a synthesis- convergent vs linear synthesis, criteria of good disconnection. • Disconnection of aromatic compounds: Functional group based strategies- functional group addition (FGA), order of events, functional group interconversion (FGI), Functional group removal (FGR) and dummy groups.	**12**
Unit.2	**Functional groups relationships & scaffold construction** • One group C-C & C-X disconnection: Retrosynthesis of alcohols, olefins and carbonyl compounds. • Two group C-C disconnection: Disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5-dicarbonyls and application of Mannich reaction.	**12**

Unit.3	**Illogical Two Group Disconnections (Umpolung)** • Disconnection and synthesis 1-hydroxy carbonyl, 1,2-diol, 1,2-dicarbonyl, 1,4-dicarbonyl and 1,6-dicarbonyl compounds.	**12**
Unit.4	**Disconnection & Synthesis of Acyclic, Cyclic Hetero-Compounds** • Ring synthesis-application of Diels-alder cycloaddition reaction. • Synthesis of saturated oxygen and nitrogen containing ring system. • Disconnection strategies for 5 & 6 member heterocycles with two or three heteroatoms. • Synthesis of heterocycles using multicomponent reaction strategy.	**12**
Unit.5	**Chemoselectivity & Protecting Groups** Introduction, three types of control, chemoselectivity examples and rules, chemoselectivity by (i) reactivity (ii) reagent, examples of chemoselectivity in synthesis. Protection of organic functional groups, protecting reagents and removal of protecting groups.	**12**

Reference Books

1. Warren, S.; Wyatt, P. (2008, Second edition) Organic Synthesis: The Disconnection Approach. Weinheim: Wiley. (ISBN: 978-0-470-71236-8).
2. Warren, S. (1978) Designing Organic Syntheses: A Programmed Introduction to the Synthon Approach. Weinheim: Wiley. (ISBN: 978-0-471-99612-5).
3. Carruthers, W.; Coldham, Iain (2004, Fourth Edition) Modern Methods of Organic Synthesis. Cambridge: Cambridge University Press. (ISBN: 9780521778305).
4. Jurgen Fuhrhop, Gustav Penzlin (2008) Organic synthesis-concept methods-starting materials-Weinheim: Wiley. (ISBN: 3-527-29074-5).

M.Sc. (Organic Chemistry) SEMESTER-IV		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OC-402	Separation Techniques	4 credits & 4 hrs/week

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Understand the principle, fundamental theory and instrumentation of various planar and column chromatographic techniques.
2	Identify the significance, quality, and limitations of the results produced by the various separation techniques.
3	Apply theoretical knowledge to design and develop suitable extraction techniqes for separation and identification of organic/natural compounds
4	Calculate Rf values and Interpret HPLC and GC chromatograms to perform qualitative analysis of unknown
5	Differentiate various applications of separation techniques to medicinal and pharmaceutical field.

M.Sc. (Organic Chemistry) SEMESTER-IV			
OC-402	**Separation Techniques**	**4 hrs./Wk**	**4 Credits**

SR No.	Course Detail	Inst. Hrs.
Unit.1	**Adsorption and Partition Chromatography** History, introduction, classification, principles, experimental, factors affecting adsorption & partition chromatography.	**12**
Unit.2	**Planar Chromatography** Principle, basic theory, technique & applications of : Paper chromatography, thin layer chromatography and high performance thin layer chromatography.	**12**
Unit.3	**Gas Chromatography** Basic theory, instrumentation, working and applications of GC, GC-MS &HS-GC.	**12**
Unit.4	**Liquid Chromatography** Basic theory, instrumentation, working and applications of HPLC & LC-MS.	**12**
Unit.5	**Extraction Techniques** Introduction, types of extraction (LLE, SSE, LSE), extraction methods (maceration, infusion, digestion, decoction, percolation, solvent extraction, Soxhlet extraction, counter current extraction, sonication, supercritical fluid extraction, steam distillation) and application.	**12**

Reference Books

1. Sethi, P. D. (2013) Sethi HPTLC: High Performance Thin Layer Chromatography: Quantitative Analysis of Pharmaceutical Formulations 3 Volume Set. New Delhi: CBS Publishers & Distributors Pvt. Ltd. (ISBN: 9788123922799).
2. Stahl, E. (1969, Second edition) Thin-Layer Chromatography: A Laboratory Handbook. New

Berlin: Springer. (ISBN: 978-3-642-88488-7).
3. Heftmann, E. (2004, Sixth edition) Fundamentals and applications of chromatography and related differential migration methods - Part A (Journal of Chromatography Library). Philadelphia: Elsevier Publishing Company. (ISBN: 0444511075).
4. Skoog, D. A., West D. M., Holler, F. J., Crouch, Stanley R. (2013, Ninth edition) Fundamentals of Analytical Chemistry. Boston: Cengage Learning. (ISBN: 0495558281)
5. Instrumental Methods of Analysis by B. K. Sharma, Goel Publisher, Meerut.

M.Sc. (Organic Chemistry) SEMESTER-IV		
Paper No.	**Course (Paper) Title**	**Course credit & teaching hrs**
OP-403	Dissertation/Project **or** Practical	12 credits & 24 hrs/week

Dissertation/Project

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Apply critical and analytical skills in a scientific and professional manner.
2	Plan and develop research project with critically apprising and interpretative published literature
3	Synthesize knowledge and skills previously gained and applied to an in-depth study.
4	Compare and select from different research methodologies, methods and forms of analysis to produce a suitable research method.
5	Present the finding of their project in a written report.

Practical

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement
1	Demonstrate laboratory setup for various reactions conditions.
2	Apply understanding of reaction mechanism and reagents to perform heterocyclic preparation.
3	Analyze product formation by using physical measurement, separation and purification techniques.
4	Design and develop solvent system for separation/extraction and identification of organic/natural compounds from single/multi-step reactions.
5	Construct manual Thin layer chromatography and Column chromatography whenever applicable.

M.Sc. (Organic Chemistry) SEMESTER-IV			
OP-403	**Dissertation/Project or Practical**	**24**	**12 Credits**

- All the students of M.Sc. Organic Chemistry will have option to undertake a research dissertation or practical during semester- IV.
- The student shall pursue his/her dissertation/project work under **university recognized research guide** only.

Dissertation/Project Detail (200 Marks):

- The student will be given the option of selecting a research problem in a preferred area that falls within the discipline of courses undertaken.
- The dissertation/project work could be conducted at the institute or recognized research laboratory. In case the student carry out research work at other research laboratory, a NOC,

presence report and certificate of place of work from the concern laboratory should be submitted along with the thesis.

- At the end of the semester, the student is required to submit his/her results in the form of a dissertation thesis. A student must submit 3 copies of his/her dissertation at the time of evaluation duly signed by candidate, guide and head of the institution. The thesis should include plagiarism certificate duly signed by candidate, guide and head of the institution.
- The format of the Dissertation thesis/project should be as under:
    - (a)The thesis should be typewritten on A4 size paper printed on both side in Times New Roman font with 12 size.
    - (b)A margin of at least 1.5 cm must be left at the left side of each page and a margin of 1.0 cm on the top, bottom, and right side of each page.
    - (c)The dissertation thesis shall arrange in the following sequence: Title, introduction of research problem, aims and objectives of the research undertaken, result and discussion, experimental section with characterization of compounds including spectral analysis, conclusion, and latest references as per the scopus index research journal format.
- The evaluation (Thesis & Viva) of the dissertation/project work will be carried out during university practical examination by external examiner.

OR

Practical Details (200 Marks):

(a) Synthesis of Medicinally important privileged scaffolds (with TLC monitoring of Reaction) (50 Marks):

1. 2-Phenylindole from acetophenone
2. 2,3-biphenylbenzopyrine
3. 2,4,5-Triphenyl-1H-imidazole
4. Benzilidene 2-methyloxazol 5-one.
5. 3-Methyl-5-pyrazolone
6. 2-hydroxy-4-methyl quinoline
7. 7-hydroxy-2-methylchromone
8. 5,5-diphenyl hydantoin
9. 2,2'-(4-nitrophenylazanediyl)diethanol
10. Dihydropyrimidine (DHPM) derivative

(b) Synthesis of Drug(TLC monitoring of Reaction) (50 Marks):

1. Sulphanilamide
2. Benzocaine
3. Paracetamol
4. Methylsalicylate

(C) Separation Chemistry (100 Marks):

1. Organic mixture separation by column chromatography **(Minimum 3)**.
2. Inorganic mixture separation by column chromatography **(Minimum 3)**.
3. Organic mixture separation and determination of R*f* value by TLC **(Minimum 3)**.

4. Inorganic mixture separation and determination of R*f* value by TLC **(Minimum 3)**.
5. Extraction of Eugenol from clove
6. Extraction of Caffeine from Tea
7. Extraction of Cinnamaldehyde from Cinnamon
8. Extraction of Nicotine from Tobacco
9. Extraction of Curcumin from Turmeric powder
10. Extraction of Carotenoids from Tomato

Reference book

1. Brian S. Furniss (1989, Fifth edition) Vogel's Textbook of Practical Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Arthur I. Vogel. (second edition) Elementary practical organic chemistry: Small scale preparations. Pearson (ISBN: 978-81-317-5686-7).
3. V.K. Ahluwalia and Renu Aggarwal (University Press),Comprehensive practical organic chemistry: Preparations and qualitative analysis (ISBN: 978-81-7371-273-9)
4. Raj K. Bansal (new age international-5th edition). Laboratory manual of organic chemistry (ISBN:978-81-224-2930-5**)**

M.Sc. (Organic Chemistry) SEMESTER-IV			
OP-404	**Dissertation/ Project Viva Voce or Practical Viva Voce**	**-**	**4 Credits**

- Dissertation/project viva voce will be carried out in the form of a presentation of his/her dissertation thesis. The presentation should include brief introduction, objective of research, scheme of research problem, result & discussion, spectra of compounds and conclusion of the present study.

OR

- Comprehensive viva voce based on practical and core courses.

Bhakta Kavi Narsinh Mehta University Junagadh

M.Sc. Chemistry

Question Paper Pattern

(Effective from June 2023)

Unit-1 [14 marks]

Answer **ALL** questions

Q.1 (a)	**1 Question of 4 Marks OR 2 Questions of 2 Marks Each.**	**4 Marks**
Q.1 (b)	**Answer any two question out of three.**	**10 Marks**
(1)		5
(2)		5
(3)		5

Unit-2 [14 marks]

Answer **ALL** questions

Q.2 (a)	**1 Question of 4 Marks OR 2 Questions of 2 Marks Each.**	**4 Marks**
Q.2 (b)	**Answer any two question out of three.**	**10 Marks**
(1)		5
(2)		5
(3)		5

Unit-3 [14 marks]

Answer **ALL** questions

Q.3 (a)	**1Question of 4 Marks OR 2 Questions of 2 Marks Each.**	**4 Marks**
Q.3 (b)	**Answer any two question out of three.**	**10 Marks**
(1)		5
(2)		5
(3)		5

Unit-4 [14 marks]

Answer **ALL** questions

Q.4 (a)	**1 Question of 4 Marks OR 2 Questions of 2 Marks Each.**	**4 Marks**
Q.4 (b)	**Answer any two question out of three.**	**10 Marks**
(1)		5
(2)		5
(3)		5

Unit-5 [14 marks]

Answer **ALL** questions

Q.5 (a)	**1 Question of 4 Marks OR 2 Questions of 2 Marks Each.**	**4 Marks**
Q.5 (b)	**Answer any two question out of three.**	**10 Marks**
(1)		5
(2)		5
(3)		5