Re-Accredited by NAAC with 'A' Grade
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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ક્રમાંકઃએકે/પરિપત્ર/૫૮૨૨ /૨૦૨૦
તા.૧૬/૦૭/૨૦૨૦

પ્રતિ,
વડાશ્રી,
રસાયણશાસ્ત્ર વિભાગ,
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી,
સુરત.

વિષયઃ– M.Sc. Pharmaceutical Chemistry Course ના સિલેબસ અંગે.

સુજ્ઞશ્રી,

સવિનય જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૦–૨૧ થી અમલમાં આવનાર M.Sc. Pharmaceutical Chemistry Course ના સિલેબસ અંગે રસાયણશાસ્ત્ર વિષયની અભ્યાસસમિતિની તા.૩૦/૧૨/૨૦૧૯ નાં ઠરાવ ક્રમાંકઃ ૩ અન્વયે નીચે મુજબ કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખાવતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલે તેની તા.૩૦/૦૬/૨૦૨૦ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨૯ અન્વયે સ્વીકારી મંજૂર કરેલ છે. તેની જાણ સંબંધકર્તા શિક્ષકો અને વિદ્યાર્થીઓને કરવી, તદ્ઉપરાંત તેનો અમલ કરવો.

<u>રસાયણશાસ્ત્ર વિષયની અભ્યાસસમિતિની તા.૩૦/૧૨/૨૦૧૯ નાં ઠરાવ ક્રમાંકઃ ૩</u>

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ–૨૦૨૦–૨૧ થી અમલમાં આવનાર M.Sc.પાર્ટ–૧ (સેમેસ્ટર–૧ અને ૨)Pharmaceutical Chemistry નો અભ્યાસક્રમ સર્વાનુમતે મંજુર કરી તે મંજુર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૩૦/૦૬/૨૦૨૦ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨૯

:: આથી ઠરાવવામાં આવે છે કે, રસાયણશાસ્ત્ર વિષયની અભ્યાસસમિતિએ તેની તા.૩૦/૧૨/૨૦૧૯ ની સભાના ઠરાવ ક્રમાંક : ૩ અન્વયે ભલામણ કરેલ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ મંજૂર કરેલ શૈક્ષણિક વર્ષ–૨૦૨૦–૨૧ થી અમલમાં આવનાર M.Sc.પાર્ટ–૧ (સેમેસ્ટર–૧ અને ૨)Pharmaceutical Chemistry નો અભ્યાસક્રમમંજૂર કરવામાં આવે છે.

બિડાણઃ ઉપર મુજબ

ઈ.ચા. કુલસચિવ

પ્રતિ,
૧) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૨) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
૩) પી.જી. વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

VEERNARMADSOUTHGUJARATUNIVERSITY

DEPARTMENT OF CHEMISTRY

M.SC. SEMESTER: 1 & 2

SYLLABUS

FOR

PHARMACEUTICAL CHEMISTRY

JUNE -2020

Structure of M. Sc, Syllabus

Semester-I

M. Sc. (PHARMACEUTICALCHEMISTRY)

Sr. No.	Course Code	Course Title	L	T/C/S	Credit
1	CHI 101	Inorganic Chem	4	1	4
2	CHO 102	Organic	4	1	4
3	CHP 103	Physical	4	1	4
4	CHM 104	Instrumental methods	4	1	4
5	CHPR 105	Practicals	12	4	8
			28	4	24

Faculty Code: Science Subject code: Level code:

Name of program: M. Sc. Subject: Pharmaceutical Chemistry

External Examination Time Duration: 03 hrs

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	I	CHI 101	Core	04	30	70	100
		CHO 102	Core	04	30	70	100
		CHP 103	Core	04	30	70	100
		CHM 104	Core	04	30	70	100
		CHPR 105	Practical	08	60	140	200
			Total	24	180	420	600

Structure of M. Sc, Syllabus

Semester-II

M. Sc. (PHARMACEUTICALCHEMISTRYy)

Sr. No.	Course Code	Course Title	L	T/C/S	Credit
1	CHI 201	Inorganic Chem	4	1	4
2	CHO 202	Organic	4	1	4
3	CHP 203	Physical	4	1	4
4	CHM 204	Instrumental methods	4	1	4
5	CHPR 205	Practicals	12	4	8
			28	4	24

Faculty Code: Science Subject code: Level code:

Name of program: M. Sc. Subject: Pharmaceutical Chemistry

External Examination Time Duration: 03 hrs

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	II	CHI 201	Core	04	30	70	100
		CHO 202	Core	04	30	70	100
		CHP 203	Core	04	30	70	100
		CHM 204	Core	04	30	70	100
		CHPR 205	Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
(PHARMACEUTICAL CHEMISTRY)

TO BE EFFECTIVE FROM JUNE 2020

PAPER-I (Inorganic Chemistry)

Max. Marks: 100 (External – 70 + Internal – 30) **Total Periods: 45**

SEMESTER-I

UNIT-1: Symmetry and Group Theory In Chemistry and Its applications: 12 Periods

Representation of Groups: Prepration of matrices and vectors matrix notations for geometrical transformations, orthogonality theorem and its consequences, reducible and irreducible representations and their relation, preparation of character table for C_{2v} and C_{3v} point groups, Application of group theory to- Transformation properties of atomic crystals.

UNIT-2 :Quantum Mechanics: 11 Periods

Discussion of solution of schrodinger equation to same model system e.g. the one dimensional harmonic oscillator, two particale rigid rotator. Ordinary angular momentum , generalized angular momentum, Eigen functions of aungular momentum, Eigen values of angular momentum, different types of operators and their uses, addition of angular momentum, spin, Russel-Saunders terms and coupling scheme, term separation energies of the p^n and d^n configuration, magnetic effect:spin orbit coupling and Zeeman effect (splitting).

UNIT-3:Inorganic Reaction Mechanism: 11 Periods

Labile ana inert complexes, factors responsible for lability and inertness of complexes.

Reactivity of metal complexes, ligand replacement reaction:classification of mechanism and energy profile of reaction. Inert and Iabile complexes, interpretation of liability and inertness of transition metal complexes on the basis of reaction rate, VBT and CFT.

Transition state or activated complex, substrate, attacking reagents electrophilic and nucleophilic, Nature of central atom. Kinetic application of CFT.

Kinetics of octahedral substitution, acid hydrolysis, factor affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism.

UNIT-4:Metal Clusters: 11 Periods

Introduction , Classification, Carbonyl clusters, Low nuclearity carbonyl clusters, High nuclearity carbonyl clusters, Electron conuting scheme for HNCCS, Wade's rules.

Halides type clusters:Dinuclear clusters, Trinuclear clusters, Tetranuclear clusters, Hexanuclear cluster.

Chevrel phases and Zintl Ions, Carboranes, Metalloboranes, Metallocarboranes, Higher

boranes(Hexaborane-10, Decaborane-14) , Number and types of bonds present in higher boranes .

Reference books:

1. Quantum Chemistry by Ira N. Levine, Prentice-Hall of India Pvt. Ltd., New Delhi, 1994.

2. Introductory Quantum Chemistry (Third edition) by N. W. Hanna, Benjamin,Menlo Park, Cailf, 1988.

3. Quantum Chemistry and Spectroscopy by M. S. Pathania, Vishal Publications, India, 1981.

4. Chemical applications of group theory by F. A. Cotton (Second edition),Wiley Eastern Limited, 1976 New Delhi.

5. Group theory and its applications by P. K. Bhattacharya, Himalaya Publishing Hours, Mumbai, 1986.

6. Group theory and symmetry by L. R. Hall, McGraw Hill, New York, 1989.

7. 'Kinetic and Mechanism' by A. A. Frost and R. G. Pearson, Wiley, New York, 1953, 1961.

8. Mechanism of Inorganic Reactions by F. Basolo and R. G. Pearson, Second Edition, Wiley Eastern Limited, New Delhi, 1977.

9. Advnced Inorganic Chemistry by F. A. Cotton and R. G. Wilkinson, John Wiley & Sons, N. Y.

10. Principales of Inorganic Chemistry, by Puri. Sharma and Kalia, 33rd Edition, Vishal publishing Co. Jalandhar, Dehli, 2017.

11. Advanced Inorganic Chemistry by S.K.Agarwala and Keemtilal, Pragati Prakashan, Meerut.

12. Advanced Inorganic Chemistry, Volume-II by Gurdeep Raj, Krishna Prakashan Media Ltd., Meerut.

13. Inorganic Chemistry by Gary L. Miessler and Donald A. Tarr, Pearson Education International

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
(PHARMACEUTICAL CHEMISTRY)

TO BE EFFECTIVE FROM JUNE 2020

PAPER-I (Inorganic Chemistry)

Max. Marks: 100 (External – 70 + Internal – 30) Total Periods: 45

SEMESTER-II

UNIT-1 ELEMENTS OF MAGNETOCHEMISTRY: 12 Periods

Definitions of magnetic properties, type of magnetic bodies, the source of paramagnetism, diamagnetism and pascal's constant, Example of pascals constant.

Curie and Curie-Weiss law, Magnetic Properties of transition elements.

Determination of magnetic susceptibility:

(a) Gouy method (b) Faraday method (c) Null deflection method.

Application of magnetic susceptibility measurements, Temperature independent paramagnetism (TIP), Orbital contribution to magnetic moment.

UNIT-II: METAL π -COMPLEXES 11 Periods

Metal carbonyls: Introduction, classification of metal carbonyls, structure and bonding, vibrational spectra studies for bonding and structure elucidation. Preparation of metal carbonyls by (1) Direct synthesis and (2) From metal compounds.

preparation Properties and structure of $Ni(CO)_4$, $Fe_2(CO)_9$ and $Co_2(CO)_8$, 18-electron rule and EAN of metal carbonyls.

Metal Nitrosyls: Introduction, coordination compounds of metal nitrosyls, preparation properties of nitrosyl compounds like nitrosyl halides, nitrosyl cyanides, hydroxides and nitrosyl aquo compounds Complex of NO^+ iron, EAN and structures of nitrosyls.

UNIT-III: Inorganic polymers 11Periods

Definition of polymers and their depiction. Characteristic of inorganic polymer.

Characterization of inorganic polymers (physical properties) by molecular weight,

number average and weight average.

Structural features of polymers: (1) Backbone bonding (2) Branching and cross-linking (3) Chemical and stereochemical variability

Classification of inorganic polymer, synthesis, properties, structures uses and application of polyphosphazenes and ploysiloxanes.

UNIT- IV: COORDINATION COMPOUNDS 11 PERIODS

Classification of coordination compounds, Werner's theory of coordination,

Electronic interpretation of coordination compounds, Factors effecting the formation of complex ions, Detection of complex ion in solution,

Chelation, Factors influencing the stability of metal chelates, Importance of chelates, Role of metal chelates in living system

Inner complexes and polynuclear complexes, Determination of composition of complex ions.

Reference Books: (For semester –II)

(1) Magneto chemistry by R. L. Carlin.

(2) Elements of Magnetochemistry by A. Syamal and R. L. Dutta, Affileted East-West press, New Delhi,1993.

(3) Introduction to metal pi-complex chemistry by M. Tsusui, M. Ichikwa, K. Mori, Plenum press, New york.

(4) Introductory polymer chemistry by G. S. Mishra, Wiley Eastern Ltd.,1993.

(5) Phosphorous-Nitrogen Compounds, H. R. Allock, Academic, New York,1972.

(6) Advanced in Inorganic Chemistry by S. K. Agarwal, Keemtilal, Pragati prakashan, Meerut.

(7) Coordination Chemistry by Ajaykumar, Aaryush Education publication, Third publication.

(8) Principles of inorganic chemistry by Puri, Sharma and Kalia, Vishal publication Co. Jalandhar, Delhi.

(9) Coordination Chemistry by Gurdeep Chatwal, M. S. Yadav, Himalaya Publishing House.

(10) Inorganic Polymers by Prof. G. R. Chatwal, Himalaya Publishing House.

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
(PHARMACEUTICALCHEMISTRY)

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PAPER-II (Organic Chemistry)

Max. Marks: 100 (External – 70 + Internal – 30) **Total Periods: 45**

SEMESTER-I

UNIT-I: REACTION MECHANISM & REACTIVE INTERMEDIATES

Detailed study of organic reaction intermediates. Generation, structure, stability and reactions of –

Carbocations (Classical and non-classical): Phenonium ion, norbornyl system, common carbocation rearrangements- Demjanov, Pinacole-Pinacolone, Rupe.

Carbanions: Mechanism of condensation involving enolates - Aldol, Claisen, Mannich, Dieckmann, Michael and Shapiro reactions.

Carbenes: Mechanism of Arndt-Eistert reaction, Reimer-Tiemann reaction and Bamford Steven's rearrangement reaction.

Free Radicals: Allylic halogenation (NBS), coupling of alkenes and arylation of aromatic compounds by diazonium salts. Sandmeyer reactions. Free radical rearrangements, Hunsdiecker reaction.

Reference book:

1. Carbenes, Benzynes and Nitrenes by Gilchrist, T. L. and Rees.
2. Advanced Organic Chemistry-Reactions, Mechanism and Strucuture, Jerry March, John Wiley.
3. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
4. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. &Kogekusha Co. Ltd., 1970).
5. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
6. Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
7. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
8. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
9. Organic chemistry 2nd ed. Jonathan clayden, Nick greeves, Stuart Warren.
10. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).

UNIT-II: PERICYCLIC REACTIONS

Introduction - Definition, Characteristics and Classification
Molecular orbitals and symmetry propertiesofethylene, 1,3- butadiene, 1,3,5- hexatriene and allylsystems.
Electrocyclic Reactions: Woodward-Hoffman Correlation diagram and derivation of selectionrules,Conrotatory and disrotatory motions, FMO and PMO approach for 4n and (4n+2)∏electron system and allyl systems.
Cycloaddition Reactions: Antarafacial and suprafacial additions. FMOand PMO approach for 4n and (4n+2)∏electron Systems(No correlation diagram),Diels-Alder reaction, stereoselectivity,Effect of substituents.
Sigmatropicrearrangements: Suprafacial and antarafacialshifts involving H & C moieties, retention and inversion of configurations.
The Cope and Claisen rearrangements, Ene reaction, 1, 3- dipolar cydoadditions.
Examples of electrocyclic, cycloaddition and sigmatropic rearrangements.

Reference book:

1. March's Advanced Organic Chemistry Reactions, Mechanisms, And Structure 7th ed. 2013 Michael B. Smith. Wiley.
2. Mechanism AndTheoryIn Organic Chemistry-2007 by Thomas H. Lowry, Kathleen S. Richardson, Forbes.Harper& Row, Publishers. New York, Hagerstown, San Francisco, London.
3. Advanced Organic Chemistry Part A: Structure and Mechanisms by Carey &Sundberg (5th edition),2000, Springer.
4. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
5. Photochemistry AndPericyclic Reactions 3rd ed. by Jagdamba Singh 2010. New Age International Publishers Ltd. New Delhi.
6. Pericyclic Reactions A mechanistic and problem solving approach Sunil Kumar, Vinod Kumar, S.P.Singh Academic Press 2015

UNIT-III; SUBSTITUTION AND ELIMINATION REACTIONS

A: Aliphatic Nucleophilic Substitution: The SN^1 , SN^2 , SN^i mechanisms. Reactions of Allylic halides, neighbouring group participation by -OH, -NH_2, -COO- , -RS, - halogen, aromatic ring.
B: Aromatic Nucleophilic Substitution: The SN^2 , SN^1 and benzyne mechanisms, Reactivity - effect of substrate structure, leaving group and attaching nucleophile, The Von Richter rearrangement.
C: Elimination reaction: Hoffmann and Zaitsev's rule of elimination, E1, E2 and E1CB Reaction mechanism and orientation.

Reference book:

1. Advanced Organic Chemistry-Reactions, Mechanism and Strucuture, Jerry March, John Wiley.
2. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
3. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. &Kogekusha Co. Ltd., 1970).
4. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5. Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Physical organic chemistry by Jack Hyne
8. Reaction mechanism by Jagdambasingh.
9. organic chemistry - Reaction mechanism, by P.S. Kalsi, New age international publishers.

UNIT-IV: Stereochemistry

A. Stereo chemical principles; Enantiomeric relationships; Distereomeric relationship; R-S and E-Z nomenclature; Dynamic stereochemistry; Chiral-Prochiral relationships; Stereo selective and Stereo specific reactions; Racemates and racemic modification, Resolution of racemic modification, Optical activity in the absence of chiral carbons biphenyl, allenes, spiranes.

B. Confirmational Analysis: Interconversion of Fischer, Newman and Sawhorse projections. Newer method of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereo selective synthesis.Simple acyclic and cyclic (chair and boat cyclohexanes, Decalins, Perhydrophenanthrene)systems.Effects of conformation on reactivity in acyclic compounds and substituted cyclohexanes.

Reference book:

1. Advanced Organic Chemistry: Part A: Structure and Mechanisms; By Francis A. Carey, Richard J. Sundberg, fifth edition, Published by Springer.
2. Advanced Organic Chemistry: Part B: Reaction and Synthesis; By Francis A. Carey, Richard J. Sundberg, fifth edition, Published by Springer.
3. Stereochemistry of Carbon Compounds; By Ernest L. Eliel, Published by Tata McGraw-Hill Publishing Company Ltd.
4. Basic organic stereochemistry; By Ernest Ludwig Eliel, Samuel H. Wilen, Michael P. Doyle, Published by Wiley-Interscience.
5. Introduction to Stereochemistry; By Kurt Martin Mislow, Dover Publication INC.
6. Stereochemistry of Organic Compounds: Principles and Applications; By D. Nasipuri, New Age International (P) Ltd. Publisher.
7. Stereochemistry Conformation and Mechanism; By P.S. Kalsi, New Age International (P) Ltd. Publisher.
8. Basic Stereochemistry of Organic; By SubrataSen Gupta, First edition, Published by Oxford University Press.

M.Sc. Semester – I (PRACTICALS)

1.Mixture analysis: ternary mixture to be given. (S+S+S), Semisolids or (L+L+L). Type determination.Separation by physical and chemical methods. (both permitted in case of liquids)
2.Paper Chromatography

References:

1. A text book of practical organic chemistry – A. I. Vogel
2. Practical organic Chemistry – Mann and Saunders
3. A handbook of quantitative and qualitative analysis – H. T. Clarke
4. Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia& S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
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TO BE EFFECTIVE FROM JUNE 2020
PAPER-II (Organic Chemistry)
Max. Marks: 100 (External – 70 + Internal – 30) Total Periods: 45

SEMESTER-II

UNIT-I: Organic Name Reactions

General nature, method, mechanism and synthetic applications of the following reactions:

(i) Heck reaction
(ii) Dakin reaction
(iii) Darzen'sglycidic ester synthesis
(iv) Leuckart reaction
(v) Suzuki reaction
(vi) Willgerodt reaction
(vii) Buchwald-Hartwig reaction
(viii) H. V. 2 reaction
(ix) Vilsmeyer-Hack reaction
(x) Mitsunobu reaction
(xi) Sonagashira reaction
(xii) Dickmann reaction.

UNIT-II: AROMATICITY (11 Periods)

A. Aromaticity and Aromatic character; structure and stability of benzene, Frost circle diagram, concept of aromaticity; Resonance and chemical stabilization; criteria to checkaromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method
B. Antiaromaticity, homoaromaticity, nonaromaticity; aromaticity in benzanoid compounds: naphthalene, pyrene, acepleialdelene.
C. Aromaticity non-benzenoid compounds: azulene, tropolones, charged rings,annulenes, fullerenes, and hmesoionic compounds.

UNIT-III: ORGANIC TRANSFORMATION AND REAGENTS

I. Sharplessepoxidation
II. Umpolung reagent (1,3-dithiane)
III. Dess martin periodinane
IV. DDQ
V. Tri-n-butyltinhydride $(C_4H_9)_3SnH$
VI. Diisobutyl aluminum hybride (DIDAL-H)
VII. Lithium disoprpyl amide (LDA)
VIII. OZONE /

IX. $K_3Fe(CN)_6$and DMSO
X. Merrifield Peptide Synthesis\
XI. Crown ethers
XII. Wilkinson's Catalyst

UNIT-IV: (11 Periods)

PHOTO CHEMISTRY

A. Energy of molecules, photochemical energy, electronic excitation, Jablonski diagram, laws of photochemistry, quantum efficiency.
B. Photochemistry of carbonyl compounds- α- cleavage of acyclic, cyclicand α-β unsaturated cleavage of carbonyl compounds, β- cleavage of, inter and intramolecularhydrogen abstraction, addition to carbon- carbon doublr bond, photo reduction of carbonylcompounds.
C. Photo induce rearrangement of enones, dienones and alkenes. Photochemistry of alkenesand aromatic compounds- isomerization, dimerization and addition reactions
D. Photochemistry of visiob, singletoxygenoxygenations,solar energy conversion and storage

Reference books:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
3. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. &Kogekusha Co. Ltd., 1970).
4. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5. Advanced Organic Chemistry by Carey &Sundberg (3^{rd}edition).
6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Name Reactions by A. R. Parikh &H.A.Parikh
8. Name reaction: A collection of detailed reaction machanisms by Jie Jack Li
9. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
10. Organic Chemistry-Reactions and Mechanism by P S Kalsi
11. Advanced Organic Chemistry : Reactions and Mechanisms byM.S. Singh
12. Organic chemistrybyCram, Hammond, Pine and Handrickson
13. Photochemistry and Pericyclic Reactions by Jagdamba Singh
14. Pericyclic reactions: A text book by S. Sankararaman
15. Excited states in Organic Chemistry by J. D. Coyle and J. A. Barltrop
16. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure by Michael B. Smith
17. Advanced Organic Chemistry: Part B: Reaction and Synthesis byCarey & Francis
18. Organic Chemistry byJonathanClayden

M.Sc. - Semester – II (PRACTICALS)

Preparation of organic compounds :

i) Nitration
ii) Bromination
iii) Acylation
iv) Reduction
v) Oxidation
vi) Condensation reaction
vii) Diazotization reaction
viii) Friedl-Craft's reaction
ix) Cannizzaro reaction
x) Aldol condensation

Quantitative Estimations

a. Estimation of ester + acid
b. Estimation of formaldehyde
c. Estimation of glycine
d. Estimation of amide + acid

References:

1. A text book of practical organic chemistry – A. I. Vogel
2. Practical organic Chemistry – Mann and Saunders
3. A handbook of quantitative and qualitative analysis – H. T. Clarke
4. Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia& S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I

(PHARMACEUTICALCHEMISTRY)

TO BE EFFECTIVE FROM JUNE 2020

PAPER-III (PHYSICAL CHEMISTRY)

Max. Marks: 100 (External – 70 + Internal – 30) **Total Periods: 45**

SEMESTER-I

UNIT-I: CHEMICAL KINETICS (12 Periods)

Theories of Unimolecular gas reactions: Lindemann theory, Kinetics of some complex reactions (i)Reversible reactions(only first order opposed by first order) (ii)Consecutive reactions(A→B→C); Steady state treatment or approximation, Enzyme catalysed reactions, Kinetics of general Chain reaction, Kinetics of photochemical reactions(H_2-$Cl_2$and H_2-Br_2) , Kinetics , Mechanism ,determination of activation energy and chain length of some organic decomposition (i) decomposition of ethane (ii) decomposition of acetaldehyde, Effect of Ionic strength on rates of ionic reactions (Primary and secondary salt effect)
Numerical.

UNIT- II: THERMODYNAMICS (11 Periods)
Introduction to Laws of thermodynamics, state and path functions and their applications, thermodynamic description of various types of processes,Maxwell's relations, Partial molar quantities, Calculation of partial molar quantities, determination of partial molar volume and partial molar enthalpy, Ideal and non-ideal liquid mixtures,Thermodynamics functions of mixing of non-ideal solutions (i) free energy of mixing (ii) entropy of mixing (iii) volume of mixing and (iv) enthalpy of mixing ,Excess functions(μ^E ,G^E , S^E ,H^E and V^E) for non ideal solutions and expression for excess thermodynamic functions.
Numerical

UNIT –III STATISTICAL THERMODYNAMICS (11 Periods)
Basics of Statistical thermodynamics(Assembly ,Canonical ensemble, occupation numberstatistical weight factor, probability),Thermodynamic probability,Probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Lagrange's methods of multipliers, Partition function,Thermodynamic properties in term of partition functions(i) Internal energy (ii) Heat Capacity (iii) Third law of thermodynamics(iv) Helmholtz free energy (v) Enthalpy (vi) Gibb's free energy(vii) Chemical potential (viii) Equilibrium constant Molecular partition functions for an ideal gas , Derivation for Translational, Rotationaland Vibrational partition functions
Numerical.

UNIT-IV: POLYMER CHEMISTRY (11 Periods)
Types of polymers, Stereochemistry of polymers, Kinetics of polymerization (Addition and Condensation),Thermodynamics of polymerization, Phase techniques of polymerization (Bulk, solution, suspension and emulsion), Number &Mass average Molecular mass,Polydispersity Index(P.D.I) Molecular mass determination by Viscometry and Osmometry, Thermal transitions in polymer: glass transition temperature and its significance,
Numerical

BOOKS:

1. **Physical Chemistry, Atkins, P.W., W.H. Freeman (2017) 10 thediton**
2. **Thermodynamics for chemist Samuel Glasstone, East-West Press Pvt. Ltd. (2008)**
3. Principles of Physical Chemistry**Puri B.R., Sharma L.R. and Pathania, M.S.,** Vishal Publishing Co. 41th ed. (Kinetics of some complex reactions (i) Reversible reactions(only first order opposed by first order), Consecutive reactions page no. 700-704) Kinetics of general Chain reaction page no. 706-708 Kinetics of photochemical reactions(H_2-Br_2) page no. 351-352Maxwell's relations page no. 565 Number &Mass average Molecular mass,Polydispersity Index(P.D.I) Molecular mass determination by Viscometry and Osmometry page no. 1036 -1042
   Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Lagrange's methods of multipliers, page no. 629-635
   Molecular partition function for an ideal gas , Derivation for Translational, Rotational andVibrational partition functions page no. 636-641

4. **Chemical KineticsLaidlerK.J.TATAMcGRAW-HILL PUBLISHING COMPANY LTD.,** (Theories of unimolecular gas reactions: Lindemann theory Page No. 143-147)Steady state treatment or approximation page no. 327-328Enzyme catalysed reactions page no. 474-477 Kinetics of photochemical reactions(H_2-$Cl_2$and H_2-Br_2) page no. 360-364 ,327-328 ,358-359 Kinetics, Mechanismand determination of activation energy and chain length of some organic decomposition (i) decomposition of ethane (ii) decomposition of acetaldehyde page no. 386-390
5. **Principles of Chemical Kinetics, James E. House, Elsevier Publication**

6. **Kinetics and Mechanism of Chemical Transformations,Rajaraman, J. and Kuriacose, J., McMillan (2008).**

7. **Kinetics of chemical reactionsS.K. Jain , Vishal Publications**
   Mechanismand determination of activation energy and chain length of some organic decomposition (i) decomposition of ethane (ii) decomposition of acetaldehyde page no. 141-143 , 144-145Effect of Ionic strength on rates of ionic reactions (Primary and Secondary Salt Effect) page no. 160-162 Kinetics of polymerization (Addition and Condensation) page no. 192-195

8. **A Text Book of PHYSICAL CHEMISTRYK.L.Kapoor**
   VOL-5Macillan India Ltd. 2007
   Effect of Ionic strength on rates of ionic reactions (Primary and Secondary Salt Effect) page no. 164-167
9. **An Introduction to Chemical Thermodynamics R P Rastogi and R R Mishra**
   VIKASH PUBLISHING HOUSE PVT LTD. 6th edition Introduction to Laws of thermodynamics, state and path functions and their applications, thermodynamic description of various types of processes page no. 1-15 , 42-47 Maxwell's relations page no. 254-258Partial molar quantities(Partial molar volume ,Internal energy, enthalpy, entropy ,Gibb,s free energy and Work function) page no. 318-325 Thermodynamics functions of mixing of non-ideal solutions (i) free energy of mixing

(ii) entropy of mixing (iii) volume of mixing and (iv) enthalpy of mixing page no. 396- 397 Calculation of partial molar quantities determination of partial molar volume and partial molar enthalpy page no. 402-413

Excess functions(μ^E ,G^E , S^E ,H^E and V^E) for non ideal solutions and expression for excess thermodynamic function. Page no. 397-398

(Assembly,Canonicalensemble,occupation number , statistical weight factor, probability page no. 269-273Thermodynamic probability ,Probability and entropy page no. 274-278Partition functionpage no. 284Thermodynamic properties in term of partition functions(i) Internal energy (ii) Heat Capacity (iii) Third law of thermodynamics(iv) Helmholtz free energy (v) Enthalpy (vi) Gibb's free energy(vii) Chemical potential (viii) Equilibrium constant page no. 286- 291

10. **Advanced Physical Chemistry D.N.BajpaiS.CHAND& COMPANY LTD. 2nd edition**

Effect of Ionic strength on rates of ionic reactions (Primary and secondary salt effect) Page no. 508-512Partition function page no. 275-276 Derivation for Translational, Rotationaland Vibrational partition functions page no. 278-282

SEMESTER -I

GROUP-C (PHYSICAL) Any Six

1.Determine the dissociation constants of a given dibasic acid pH-metrically.

2. Determine the amount of ferrous sulphate / ferrous ammonium sulphate in given flask potentiometrically using cerric salt solution.
3. Verification of Onsager's equation and determination of equivalent conductance at infinite dilution of strong electrolytes
4. Determine the CMC of a surfactant by conductivity measurements.
5. Calculate the molar absorptivity of each of the given two solutions (A) and (B) and also find out concentration of supplied unknown solution colorimetrically.
6. Investigation the reaction between $K_2S_2O_8$ and KI at two different temperatures and calculate the energy of activation for the reaction.
7. To study the phase diagram of a three component system Water – acetic acid – chloroform.
8. Determination of CMC and area per molecule of a surfactant by surface tension measurement.
9. Determine the molecular weight of a given polymer from viscosity measurement.

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I

(PHARMACEUTICALCHEMISTRY)

TO BE EFFECTIVE FROM DECEMBER-2020

PAPER-III (PHYSICAL CHEMISTRY)

Max. Marks: 100 (External – 70 + Internal – 30) **Total Periods: 45**

SEMESTER-II

UNIT-I:THEORIES OF ELECTROLYTIC CONDUCTANCE AND OVER VOLATEGE (11 Periods)

Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoretic effect, Debye Falkenhagen effect, Weineffect.Ionic strength and its determination ,Debye-Huckel limiting law. Activity and activity coefficient, determination of activity coefficient by (i) solubility (solubility product principle) (ii) EMF method (cell without transference), Determination of dissociation constant of monobasic acid by conductance method and approximate EMF method, Electrolytic polarization, Dissolution and Decomposition potential, Concentration polarization, Decomposition potential and its determination, over voltage, determination of over voltage,theories of over voltage:combination of atom as slow process (Tafel theory)

Numerical.

UNIT-II: SURFACE CHEMISTRY (11 Periods)

Adsorption Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation.Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Change in enthalpy ,entropy and free energy of adsorption, Adsorption at the surface of liquid : Gibbs adsorption isotherms (derivation).Thermodynamic treatment of adsorption,Surface –Active substances, orientations of surfactants on the surface of solution , surface inactive substances, surface pressure,Insoluble surface films on liquid

Numerical

UNIT-III: COLLOIDS: (11 Periods)

Types of colloidal systems, preparation of lyophobic colloidal, Properties of Colloidal systems: (i) electrical properties origin of charges on colloidal, electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, explanation on DLVO theory of colloid stability (ii) Electrokinetic properties: Electrophoresis, elecroosmosis.

Surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model, solubilisation, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.

UNIT IV: MOLECULAR SPECTROSCOPY (12 Periods)

Molecular spectra, **Microwave spectroscopy** (Rotational spectroscopy): The Rotation of molecules, Linear molecule, Symmetric tops ,Spherical tops, Asymmetric tops, Rotational spectra of rigid diatomic molecule ,Intensities of spectral lines , Effect of isotopic substitution, Techniques and instrumentation of rotational spectrum,

IR Spectroscopy: Classical frequency of harmonic oscillator,The classical potential energy of harmonic vibration of a diatomic molecule, Quantum expression of potential energy, energy level diagram, Relative population of energy levels ,Mechanism of interaction with radiation, selection rule, determination of force constant, Amplitude of vibration, The anharmonicvibrationor oscillator , Morse potential , Vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions.

Vibrational –Rotational spectra of diatomic molecule(CO molecule) Application of Vibrational rotational spectra

Numerical

BOOKS

1. Atkins, P.W., Physical Chemistry, W.H. Freeman (2017) 10 thediton
2. Samuel Glsstone, Introduction to Electro chemistry, East-West Press Pvt. Ltd. (2008)
3. Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, Vishal Publishing Co. (2017-18) 45th ed. Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoretic effect, Debye Falkenhagen effect, Wein effect. Ionic strength and its determination ,Debye-Huckel limiting law page 866-874Insoluble surface films on liquid page no.1025

Types of colloidal systems, preparation of lyophobic colloidal, Properties of Colloidal systems: (i) electrical properties origin of charges on colloidal, electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, explanation on DLVO theory of colloid stability (ii) Electrokinetic properties: Electrophoresis, elecroosmosis. Page no. 989-1001

4. Fundamentals of Molecular Spectroscopy C N Banwell TATA McGRAW-HILL 15th edition

Molecular spectra page no.-1Microwave spectroscopy (Rotational spectroscopy): The Rotation of molecules Linear molecule, Symmetric tops ,Spherical tops Asymmetric tops, Rotational spectra of rigid diatomic molecule ,Intensities of spectral lines , Effect of isotopic substitution page no. 40-53Techniques and instrumentation of rotational spectrum page no. 66 –67Quantum expression of potential energy, energy level diagram, Relative population of energy levels ,Mechanism of interaction with radiation, selection rule, determination of force constant, The anharmonic vibration or oscillator , Morse potential, Vibrational energy of diatomic molecule following the Morsepotential, energy level diagram, vibrational transitions.Vibrational –Rotational spectra of CO molecule Application of Vibrational rotational spectrapage no. 72-88

5.**A Text Book of PHYSICAL CHEMISTRY K. L. Kapoor**

VOL-4Macillan India Ltd. 3rd edition

Classical frequency of harmonic oscillator ,The classical potential energy of harmonic vibration of a diatomic molecule, Quantum expression of potential energy, energy level diagram, Relative population of energy levels ,Mechanism of interaction with radiation, selection rule, determination of force constant, Amplitude of vibration, The anharmonic vibration or oscillator , Morse potential , Vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions page no. 460-471Vibrational –Rotational spectra of diatomic molecule Application of Vibrational rotational spectra page no. 480-484

Raman Spectrum in detail page no. 488-500

6**A Text Book of PHYSICAL CHEMISTRY K. L. Kapoor**

VOL-5Macillan India Ltd. 3rd edition

Adsorption Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation. Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Change in enthalpy ,entropy and free energy of adsorption, Adsorption at the surface of liquid : Gibbs adsorption isotherms (derivation).Thermodynamic treatment of adsorption, Surface –Active substances, orientations of surfactants on the surface of solution , surface inactive substances, surface pressure page no. 11-22 , 24-26 , 30-32 ,34-38

7. **Advanced Physical Chemistry D.N.BajpaiS.CHAND& COMPANY LTD. 2nd edition** Activity and activity coefficient, determination of activity coefficient by (i) solubility (solubility product principle) (ii) EMF method (cell without transference), page no. 623-626

SEMESTER -II

GROUP – C (PHYSICAL) Any Six

1. Determine the dissociation constant and strength of borax solution pH-metrically.
2. Determine the velocity constant of the hydrolysis of ethyl acetate with sodium hydroxide at room temperature by conductance measurements.
3. Determine the solubility of silver chloride in water potentiometrically.
4. To determine the concentration of given components in a mixture colorimetrically.
5. Determine the equilibrium constant of the reaction $I^- + I_2 = I_3^-$ by distribution method.
6. Investigation the reaction between H_2O_2 and HI at two different temperatures and calculate the energy of activation for the reaction
7. Determine the formula of a complex between Cu^{+2} and NH_3 by distribution method.
8. Determine CST of Phenol -Water system
9. Determine CST of Phenol –NaCl system

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
(PHARMACEUTICALCHEMISTRY)
PROPOSED SYLLABUS
TO BE EFFECTIVE FROM DECEMBER-2020
PAPER-IV (I*nstrumental Mathods-I*)

Max. Marks: 100(External –70 + Internal – 30) **Total Periods: 45**

SEMESTER-I

UNIT-I: UV-VisibleSpectrophotometry (12 Periods)

Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypso chromic effect, Hyper chromic effect, Hypo chromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect , Woodward's rules for α,β-unsaturatedketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.

UNIT-II: CHROMATOGRAPHY (11 Periods)

Thin-Layer Chromatography: Selection ofstationaryandmobilephase, Detection techniques –Elementary idea of HPTLC

Gas Chromatography: Selection of mobile phase – Selection of stationary phase in GLC and GSC – Detectors: FID (with modifications), TCD and ECD, Their comparison, Packed column, WCOT,SCOT(advantagesanddisadvantages)–Temperatureprogramming– Derivatisation in GC – Quantitative Analysis.

UNIT-III: CHEMICAL MATHEMATICS (11 Periods)

Errors inChemicalanalysis,classificationoferrors,natureand originoferrors, Propagationoferror, Accuracyandprecision, Averagedeviation andstandarddeviationandits physicalsignificance,NormalDistributioncurveanditsproperties. Confidencelimitand probability, Statisticaltreatmentforerroranalysis,student't'test,rejectioncriteriaand Q-test, method of least square

UNIT-IV: THERMAL METHODS OF ANALYSIS (11 Periods)

(A) THERMOGRAVIMETRY

Thermogravimetry, Instruments for TGA- thermobalace and furnace, Calibration of temperature scale, Factorsaffecting TGA results instrumental and experimental, Applications.

(B) THERMOMETRIC TITRATION:

Thermometric Titration (TT),Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometry Titration and Redox Titration.

VEER NARMAD SOUTH GUJARAT UNIVERSITY M.Sc.-I
(PHARMACEUTICALCHEMISTRY)
PROPOSED SYLLABUS
TO BE EFFECTIVE FROM DECEMBER-2020
PAPER-IV (Instrumental Methods-II)

Max. Marks: 100 (External –70 + Internal – 30)Total Periods: 45

SEMESTER-II

UNIT-I: IR SPECTROPHOTOMETRY (12 Periods)

IR Spectroscopy*:* Introduction: Theory, Instrumentation: single beam, double beam spectrophotometers, FTIR: principle, instrument design, and function of beam splitter, radiation sources, sample cells, monochromators, detectors, sample handling, Resolution, wave number measurement, Advantages of FTIR vs. IR. Useful terms: IR region, types of vibrations: fundamental and overtones, linear and nonlinear molecule, equation for vibrational frequency, selection rule, coupling interactions, hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, finger print region, spectra interpretations (Amino, carboxyls, hydroxyl, ethers groups containing compounds) and structure elucidation.

UNIT-II: LIQUID CHROMATOGRAPHY (11 Periods)

Principle of Liquid – Solid chromatography, Comparison with GC, Column chromatography,Gradient elution, Displacement chromatography, Principle of HPLC, Instrument andsignificance of each component, Pumps, Guard column Criteria in selection of mobilephase, Stationary phases (solid, liquid), Bonded phase supports, Detectors: UVabsorption, RI detectors – Normal phase and Reversed phase. Method of introducing sample.

UNIT-III GREEN CHEMISTRY AND WATER ANALYSIS (11 Periods)

Green Chemistry(04 Periods)

Twelve principles,*Green solvents and their applications:* Ionic liquids, types, properties and applications, ILs as solvents, Supercritical fluids, Supercritical CO_2, its properties and applications in dry cleaning and decaffeination of coffee.

Water analysis (07Periods)

Sources of water pollution, Sewage and industrial effluents, Analysis of waterpollutants, Sampling, Preservation, Measurement of parameters such as COD, BOD, DO,TDS,suspended solids, TCC, phenols, fluoride.

UNIT-IVTITRIMETRIC METHODS AND ELEMENTAL ANALYSIS (11 Periods)

Solution and Their Concentration: (03 Periods)

Molarity, Molality, Normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, Formality, Primary and Secondary standard, Acid Value, Density and Specific Gravity, Numerical.

Non Aqueous Titration: (04 Periods)

Protic and Aprotic Solvent, Solvent system, Dielectric constant, Titrant, Titration Curve, Determination of Equivalence point, Karl Fisher Titration, Numerical.

Elemental Analysis:(04 Periods)

Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulpher Analysis, Numerical.

Reference books:

1. Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
2. Spectrometric Identification of Organic Compounds (4^{th}edition/5^{th}edition), Silverstein,Bassler&Morril,JohnWiley&Sons.
3. IntroductiontoMolecularSpectroscopy,G.M.Barrow, McGraw – Hill.
4. Modern Spectroscopy, J.M.Hollas, John Wiley.
5. Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
6. ModernMethodsofChemicalAnalysis(2^{nd}ed.),Pecsok,Shields,Cairns&McWilliom, JohnWiley&Sons.
7. Instrumental Analysis byR. D. Braun, McGraw-Hill.
8. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
9. Mathematical preparation for Physical Chemistry, F. Daniels, McGrawHill.
10. Introductionto Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
11. FundamentalsofAnalyticalChemistry:SkoogD.R.andWestD.M.(Holt,Rinehart&Winston, New York).
12. Chemical Analysis in Industry(in Gujarati) by M. N. Desai.
13. Instrumental Methods of Analysis by G. W. Ewing.
14. ModernMethodofChemicalAnalysisbyPecsok,Shield,Cairns,McWilliam,John Wiley and Sons.
15. Quantitative Analysis, 6^{th}Ed.,R.A.DayandA.L.Underwood, Prentice– Hall of India, 1993.
16. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn& Bacon Inc., NewYork, 2^{nd}edition.
17. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, NewYork), 5^{th}edition.
18. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6^{th}edition.
19. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2^{nd}edition.
20. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
21. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
22. Introduction to Modern Liquid Chromatography: L. R. Shyder& J. J. Kirkland (John Wiley & Sons, New York).
23. Treatise on Analytical Chemistry: I. M. Kohthoff& P. J. Elving (John Wiley & Sons, New York).
24. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
25. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
26. Environmental Chemistry by A.K.de
27. Spectrometric Identification of Organic Compounds; By Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, Eight edition, Published by Wiley
28. Introduction to Spectroscopy; By Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan,Fourth edition, Published by Brooks cole.
29. Spectroscopic Methods in Organic Chemistry; By D.H Williams, I. Fleming, Sixth edition, Published by Tata McGraw Hill Education.
30. Spectroscopy of Organic Compounds; By P S Kalsi, Sixth edition, Ne Age International Publisher.

31.Organic Spectroscopy: Principles and Applications; By Jag Mohan, Second edition, Published by Alpha Science International Ltd.
32.Organic Spectroscopy (NMR, IR, Mass and UV); By Dewan S.K.,First edition, CBS Publisher & Distributors Pvt Ltd.
33.Basic Principles of Spectroscopy; By Raymond Chang, Published by McGraw-Hill Inc.
34.Elementary Organic Spectroscopy; By Y R Sharma, S. Chand & Company Pvt. Ltd.
35.Organic Spectroscopy; By William Kemp, Published by Palgrave Macmillan.

36. Green chemistry by V. K. Ahluwalia, Narosa Pub New Delhi
37. Green Chemistry, Theory and Practice, P. T. Anastas and John C. Warner, Oxford University Press, 2000, New York, USA.
38. Green Chemistry: An Introductory Text, Mike Lancaster, Green Chemistry Network, University of York, RSC, 2002.