First year of Five Years Integrated M. Sc. (Common to Physics / Mathematics / Chemistry)

Teaching Scheme :

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)
M.Sc - I, Semester-I

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Chemistry-I	MC101	3	1	2	5	100	25	50	175
2	Physics-I	MP101	3	1	2	5	100	25	50	175
3	Mathematics-I	MM101	3	2	0	5	100	50	00	150
4	Environmental Science	MN101	2	1	0	3	100	25	00	125
5	English-I	MG101	2	1	0	3	100	25	00	125
			13	6	4		500	150	100	750
Total Contact hrs per week = 23				**Total Credit = 21**					**Total Marks = 750**	

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)
M.Sc - I, Semester-II

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Chemistry-II	MC102	3	1	2	5	100	25	50	175
2	Physics-II	MP102	3	1	2	5	100	25	50	175
3	Mathematics-II	MM102	3	2	0	5	100	50	00	150
4	Introduction to Computers	MM104	2	1	0	3	100	25	00	125
5	English-II	MG102	2	1	0	3	100	25	00	125
			13	6	4		500	150	100	750
Total Contact hrs per week = 23				**Total Credit = 21**					**Total Marks = 750**	

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. - I, Semester – I	**L**	**T**	**P**	**C**
MC 101 : Chemistry – I	**3**	**1**	**2**	**5**

- **ATOMIC STRUCTURE AND CHEMICAL BONDING** **(13 Hours)**

  Heisenberg's Uncertainity principle, postulates of quantum mechanics, Schrödinger wave equation: Derivation, significance of and ψ^2, Schrödinger wave equation for H - atom and particle in 1-D box, angular and radical wave function, atomic orbitals and shape of s and p orbitals, Valence bond theory, Hybridization, Resonance, VSEPR, Molecular orbital theory, molecular orbitals, bonding and energy level diagram for homonuclear and heteronuclear diatomic molecules, ionic solids, Born-Haber cycle, covalent bonds, coordinate bond, hydrogen bond, dipole moment, geometry and shape of simple molecules, Molecular structure and different kind of intermolecular forces and interactions like hydrogen bonding, hydrophobicity, π–π interaction, π–cation interaction, and properties such as melting and boiling points, dipole moment, acidity and basicity.

- **PERIODIC TABLE AND ATOMIC PROPERTIES** **(03 Hours)**

  Electronic configuration, periodicity in properties: ionization potential, electron affinity, ionic radii and electronegativity

- **CHEMICAL KINETICS** **(04 Hours)**

  Rate of reaction, order of reaction, enzyme catalyzed reaction, fast reactions, homogeneous and heterogeneous catalysis, general characteristics of catalytic reactions.

- **THERMODYNAMICS** **(07 Hours)**

  First law of thermodynamics, entropy, second and third laws of thermodynamics, Gibbs free energy, Helmholtz energy, chemical equilibria, Clausius Clapeyron equation

- **ELECTROCHEMISTRY** **(08 Hours)**

  Single electrode potential, Hydrogen electrode, Galvanic cell, EMF series, Nernst equation, Reversible electrodes, metal-metal ion electrodes, Calomel electrode, Oxidation-Reduction electrodes, Potentiometric titration, Application of electrochemistry in Corrosion control by cathodic protection, batteries, and related devices.

- **CHEMISTRY OF WATER** (**07 Hours)**

  Structure of water, properties, types of water (raw water, cooling water, boiler water), role of water in life sciences, Water-treatment- primary treatment and secondary treatment, types of water treatment for use in industries.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Atkins P. W. and Paula D**., *Atkin's Physical Chemistry*, Oxford University Press/Gopsons Paper Ltd, Noida, 8th Edn., 2006.
2. **Alberty R. A. and Silbey R. J.**, *Physical Chemistry*, 1st Edn., John Wiley & Sons (Asia), Singapore, 1995.
3. **Levine I. R.**, *Quantum Chemistry*, Prentice Hall India (Ltd), 1995.
4. **Lee J. D.,** *Concise Inorganic Chemistry*, 4th Edn., ELBS, 1991.
5. **Cotton F. A., Wilkinson G., Gans P. G.**, *Basic Inorganic Chemistry*', 2nd Edn., John Wiley & Sons, 1987.

First year of Five Years integrated M.Sc. (Physics / Chemistry / Mathematics) M.Sc. - I, Semester – I	L	T	P	C
MP 101 : Physics – I	**3**	**1**	**2**	**5**

- **VECTORS FUNDAMENTALS AND DIFFERENT CO-ORDINATE SYSTEM** **(08 Hours)**
  Unit Vectors, Vector Operations, Tripple Products, Vector Algebra in component form, Differential Calculus, Cartesian Coordinate System, Spherical Coordinate System, Cylindrical Coordinate System.
- **NEWTON'S LAWS OF MOTION, CONSERVATION LAWS, MOMENTS OF INERTIA.** **(10 Hours)**
  Mechanics of the particle, Equation of motion, Different conservation laws, Moments of inertia, Motion in central force field.
- **RIGID BODY MOTION** **(06 Hours)**
  Euler's theorem, Angular momentum and kinetic energy, Euler's equation of motion, Euler's angles.
- **ELASTICITY & HYDRODYNAMICS** **(08 Hours)**
  Stress and Strain, Young's modulus, Shear modulus and Bulk Modulus, Buoyancy, Types of fluid flow, Bernoulli's equations.
  Viscocity, Terminal Velocity,
- **SIMPLE HARMONIC MOTION** **(04 Hours)**
  Restoring force, Elastic potential energy, Period and frequency, Energy, Pendulums, Applications of SHM.
- **OSCILLATIONS** (**08 Hours)**
  Damped oscillations, forced oscillations, coupled oscillations & resonance.

(Total Contact Time (Theory) : 44 Hours)

BOOKS RECOMMENDED :

1. **Mathur D. S.,** *Mechanics* , S. Chand & Company, 2000.
2. **Takwale R. G. & Puranik P.S.** *Introduction to Classical Mechanics*, TMH., 1997.
3. **Feymann R. P., Lighton R. B. and Sands M.**: *The Feymann Lectures in Physics Vol. 1* Narosa Publishers, 2008.
4. **Verma H. C**., *Concepts of Physics, Vol. 1 & 2*, Bharati Bhavan, 2007.
5. **Landau L. D. & Lifshitz E M**, *Course on Theoretical Physics, Vol. 1: Mechanics*, Addison-Wesley, 2002

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. - I, Semester – I	**L**	**T**	**P**	**C**
MM 101 : Mathematics – I	**3**	**2**	**0**	**5**

- **CALCULUS** **(07 Hours)**
  Reorientation of calculus. Differentiation of Hyperbolic and Inverse Hyperbolic functions. Successive Differentiation, standard forms, Leibnitz's theorem and applications, Power series, Expansion of functions, Taylor's and Maclaurin's series.
- **APPLICATIONS OF DERIVATIVES** **(08 Hours)**
  Curvature, Radius of curvature, Cartesian, polar parametric curve with application in Engineering problems. Indeterminate forms, L'Hospital's rules.
- **ORDINARY DIFFERENTIAL EQUATION** **(08 Hours)**
  Reorientation of differential equation, Exact differential equation and Integrating factors, First order and higher degree ode, solvable for p, y and x, Modeling of Real world problems particularly Engg. System, spread of epidemic, spread of new technological innovations, RC and RL network.
- **CURVE TRACING** **(05 Hours)**
  Cartesian, polar and parametric form of standard curves.
- **BETA AND GAMMA FUNCTION** **(04 Hours)**
  Beta and Gamma function with their properties and duplications formula without proof
- **APPLICATION OF DEFINITE INTEGRATION** (**05 Hours)**
  Area, arc length, surface area by revolving curve, volume by revolving area bounded by curve for Cartesian, polar and parametric curves
- **MATRICES** **(07 Hours)**
  Elementary row and column transformation, rank of matrix, Linear dependence, consistency of linear system of equations, characteristic equation, Caley-Hemilton theorem, Eigen value, Eigen vector.

(Total Contact Time (Theory) : 44 Hours)

BOOKS RECOMMENDED :

1. **Steward James De,** *Calculas,* Thomson Asia, Singapore, 2003.
2. **Bali and Iyengar**., *Engg. Mathematics*, Laxmi Publications, New Delhi, 1997.
3. **Peter O'Neil**., *Advanced Engg. Mathematic*', Thompson, Singapore, Ind. Ed. 2002.
4. **Kapur J. N.** , *Mathematical Models in Biology and Medicine,* East west Press, New Delhi 1985.
5. **Hilderband F. B.**, *Methods of Applied Mathematics*, McGraw Hill, New York, 1968.

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics) M.Sc. - I, Semester – I	L	T	P	C
MN 101 : Environmental Science	**2**	**1**	**0**	**3**

- **FUNDAMENTAL OF ENVIRONMENTAL SCIENCE** **(05 Hours)**
  Definition
  Principle and scope of environmental science
  Composition and structure of atmosphere
- **NATURAL RESOURCES** **(05 Hours)**
  Water
  Land
  Minerals
  Forests
- **ENVIRONMENTAL POLLUTION** **(05 Hours)**
  Water pollution
  Air pollution
  Land pollution
  Sources, effects & control of pollution.
- **ENERGY RESOURCES** **(05 Hours)**
  Solar energy
  Nuclear energy
  Wind energy
  Hydro energy
  Wave energy
- **RADIATION POLLUTION** **(05 Hours)**
  Sources
  Effects
  Control
- **THERMAL AND NOISE POLLUTION** (**05 Hours)**
  Sources
  Effects
  Control of thermal and noise pollution

(Total Contact Time (Theory) : 30 Hours)

BOOKS RECOMMENDED:

1. **Wright R.T.**, *Environment Science, 9th edition*, Prentree – Hall of India Private Limited, New Delhi 2007.
2. **Cunningham W. P. & Cunningham M. A.**, *Principles of Environment Science, Inquiry and Application*, Tata McGraw Hill, 1999.
3. **Bharucha E.**, *Textbook of Environmental Studies for Undergraduate Course,* University Grant Commission, University Press,2001.
4. **Anandan P., Kumararelan R.**, *Environment Science & Engineering*, Scitech Publications (India) Pvt. Ltd. Fourth Reprint – July 2007.
5. **Dhaueja S. K.**, *Environmental Engineering and Management*, S. K. Kataria & Sons Publishers & Distributors, 2004 .

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. - I, Semester – I	**L**	**T**	**P**	**C**
MG 101 : English-I	**2**	**1**	**0**	**3**

- **BASIC** **(12 Hours)**
  Articles, Prepositions, Degrees of comparison, Tenses; Kinds and Uses, Active and Passive Voice, Phrases Clauses and Sentences, Kinds of sentences, Reported Speech.
- **BASIC COMPOSITION** **(07 Hours)**
  Paragraph Writing,, Business Correspondence, Official Reports
- **BASIC PHONETICS** **(08 Hours)**
  The Production of Speech, The Sounds of English, Phonetic Transcription, Syllable and Stress, Intonation
- **BASIC CONVERSATION** **(03 Hours)**
  English in use, English for routine communicative functions, Speech practice

(Total Contact Time (Theory) : 30 Hours)

BOOKS RECOMMENDED:

1. **Murphy R.,** *Intermediate English Grammar*: *Reference and Practice for South Asian Students*, Cambridge University Press, 2001.
2. **Thaker P.K., Desai S. and Purani T.J.** (eds), *Developing English Skills : A Composite Course for Intermediate Students,* Oxford University Press, 1997.
3. **Mohan K. and Banerji M.,** *Developing Communication Skills*, Mc.Millan Co. Publication 1990.
4. **Krishnaswami N and Sriram T.,** *Creative English for Communication*, Mc.Millan Co.Publication 1992.
5. **Board of Editors**, *Written and Spoken Communication in English*, University Press Private Limited,2007.

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M. Sc - I, Semester – II	**L**	**T**	**P**	**C**
MC 102: Chemistry – II	**3**	**1**	**2**	**5**

- **SURFACE CHEMISTRY** **(05 Hours)**
  Types of adsorption, adsorption isotherms-Freundlich and Langmuir; Colloids and colloids state, application of colloids, surfactants, micelles, critical micelle concentration, Basics of surface characterization by X-Ray and DLS.
- **POLYMERS** **(04 Hours)**
  Methods of polymerization, Characterization by TGA, DTA, Molecular weight and its determination, amorphous and crystalline polymers, biopolymers, structure-property relation in polymers.
- **CARBOHYDRATES** **(04 Hours)**
  Introduction, Basic structural features and types of carbohydrates, Reactions and conversions, role in biological systems.
- **METALLURGY** **(03 Hours)**
  Basic principles and applications; purification of elements and metals, metallurgical aspects of corrosion and its control.
- **INORGANIC CHEMISTRY** **(08 Hours)**
  Transition metal ions and complexes; coordination chemistry, magneto chemistry, organometallic compounds, catalysis, some relevant uses of transition elements, role of metal ions in biological process; trends in properties of s-and p-block elements, silicones; silicates; zeolites; alkoxides, sol-gel process, O_2 activation; N_2 fixation
- **ORGANIC MOLECULES** **(08 Hours)**
  Structure, properties and mechanism of organic reactions: Relationship between shapes and properties of organic molecules. Electrophiles and nucleophiles, reactive intermediates-free radical, carbonium ion and carbanion, carbine, arynes. Types of organic reactions- Stepwise, ionic and free radical mechanisms, single step concerted mechanism, addition, substitution, elimination and rearrangement, emphasizing mechanisms, basic features of pericyclic reactions. Linear free energy relationships, Hammett equation.
- **STEREOCHEMISTRY OF ORGANIC COMPOUNDS** **(08 Hours)**
  Conformations of alkanes and cycloalkanes; configurations, Enantiomers, molecular chirality, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, retention and racemization. Relative and absolute configuration, sequence rules, D and L systems of nomenclature and R and S systems of nomenclature. Geometric isomerism **–** determination of configuration of geometric isomers E and Z systems of nomenclature, geometric isomers of oximes and alicylic compounds. Linear and cyclic conjugation, benzene, aromaticity, properties of conjugated systems.
- **NEW DEVELOPMENTS IN CHEMICAL SCIENCES** **(02 Hours)**
  Environmentally benign chemistry, nanochemistry, smart materials, and their applications. Interface of chemical sciences with other disciplines, particularly in technology and medical sciences and engineering.

(Total Contact Time (Theory) : 42 Hours)

BOOKS RECOMMENDED:

1. **Chawla S**..,*Text Book of Engg. Chemistry*, Dhanpat Rai & Co. Pvt. Ltd., Delhi, 2003.
2. **Adamson A. W**., *Physical Chemistry of Surfaces*, 3rd Edn., John Wiley, 1976.
3. **Morrison R. T. and Boyd R.N.,** *Organic Chemistry', 6th Edn*., Prentice Hall, 1992.
4. **Solomons T. W. G.,** *Fundamentals of Organic Chemistry, 5th Edn*., John Wiley, 1992.
5. **Streitwieser, Jr. A. and Heathcock C. H**., *Introduction to organic chemistry* 2nd Edn, MacMillan, New York , 1998

First year of Five Years integrated M.Sc. (Physics / Chemistry / Mathematics)

M.Sc. – I, Semester – II		**L**	**T**	**P**	**C**
MP 102 : Physics – II	**Kinetic theory, Thermodynamics & Statistical Physics**	**3**	**1**	**2**	**5**

- **KINETIC THEORY OF GASES** **(04 Hours)**
  Postulates of kinetic theory of gases, velocity of gas molecules, Molecular energy, Kinetic-molecular model of an ideal-gas, kinetic interpretation of temperature, Degree of freedom of gas molecules, Maxwell's law of equipartition of energy.

- **INTERMOLECULAR FORCES & TRANSPORT PHENOMENA** **(04 Hours)**
  Viscosity of a gas, Thermal conductivity of gases, Van der wall's equation of state, Brownion motion

- **LAWS OF THERMODYNAMICS,** **(12 Hours)**
  Zeroth law of Thermodynamics , I st and II nd laws of Thermodynamics, concepts of Temperature, internal energy and entropy, calculations of change of internal energy, and Entropy in various thermodynamic processes

- **THERMODYNAMICS POTENTIALS, HELMOLTZ & GIBBS FUNCTIONS, MAXWELL RELATIONS** **(12 Hours)**
  Giibs and Helmholtz energy, Gibbs paradox, Enthalpy, and Maxwell's thermodynamic relations

- **ELEMENTS OF STATISTICAL PHYSICS** **(08 Hours)**
  Fermi Dirac, Maxwell Boltzmann, & Bose Einstein distributions

- **THERMODYNAMICS OF BLACK BODIES** **(04 Hours)**
  Black body and characteristics, radiation principles like Rayleigh Jeans, Weins and Planck's law of black body radiation

(Total Contact Time (Theory) : 44 Hours)

BOOKS RECOMMENDED :

1. **Sears F.W. & Salingar,** *Thermodynamics, Kinetic theory and Statical Thermodynamics* 3rd Ed. Addison-Wesley/Pearson, 1975.
2. **Young & Freedman,** *Sears and Zemansky's University Physics* : Pearson Education, Singapore. 2004.
3. **Feymann R. P., Leighton R. B. and Sands M**.: *The Feymann Lectures in Physics* Vol. 1 Narosa Publishers, 2008.
4. **Zemanasky M. W.,** *Heat and Thermodynamics* (McGraw Hill), 1957
5. **Carter A.**, *Classical and Statistical Thermodynamics*, Pearson Education, 1999.

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. –I, Semester.-II	**L**	**T**	**P**	**C**
MM 102: Mathematics II	**3**	**2**	**0**	**5**

- **DIFFERENTIAL CALCULUS** **(07 Hours)**
  Partial differentiation, Euler's theorem for homogeneous function, Modified Euler's theorem, Taylor's and Maclaurins series for two variables.
- **APPLICATIONS OF PARTIAL DIFFRENTATION** **(08 Hours)**
  Tangent plane and Normal line Error and Approximation, Jacobians with properties, Extreme values of function of two variables, Lagrange's methods of undetermined multipliers.
- **DIFFERENTIAL EQUATION OF HIGHER ORDER** **(08 Hours)**
  Solution of homogenous equations, complementary functions, Particular Integrals, Linear differential equation with variable coefficient, Cauchy's Euler and Legendre's equation with variable coefficient, Method of variation of parameters.
- **MATHEMATICAL MODELS** **(07 Hours)**
  Electrical network models, Detection of diabetes model and Bending beam models.
- **SERIES SOLUTION AND SPECIAL FUNCTIONS** **(07 Hours)**
  Regular point , Singular point, series solution of ODE of 2^{nd} order with variable coefficient with special emphasis to differential equation of Legendre's and Bessel's for different cases of roots of indicial equations.
- **LAPLACE TRANSFORM** **(07 Hours)**
  Laplace transform, Existance theorem, Laplace transform of derivatives and integrals, Inverse Laplace transform, Unit step functions, Dirac – delta functions , Laplace transform of periodic functions, Convolutions theorem, Application to solve simple linear andsimultaneous differential equations.

(Total Contact Time (Theory): 44 Hours)

BOOKS RECOMMENDED :

1. **Kreyszig E.** : *Advanced Engg. Mathematics*. 8^{th} Ed, John Wiley & Sons., New York, 1995.
2. **Jain and Iyenger** , *Advanced Engg. Mathematics*, Narosa Publications, New Delhi, 1997.
3. **De J. S.,** *Calculas*, Thomson Asia, Singapore, 2003.
4. **Kapur J. N.** , *Mathematical Models in Biology and Medicine*, East west press, 1998.
5. **Hilderbrand F. B.,** *Methods of Applied Mathematics*, McGraw Hill, New York, 1968.

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. –I, Semester.-II	**L**	**T**	**P**	**C**
MM 104: Introduction to Computers	**2**	**1**	**0**	**3**

- **Introduction to Computer** **(09 Hours)**
  Introduction to computer, History of computer, Parts of computer, Computer Terminology, Start up of a computer, Disc drives, Disc utilities, Starting and stopping computer, use of the mouse, Installing and uninstalling software, Maintenance of computer, Purchasing a computer, Types of computers.

- **Hardware of computer** **(08 Hours)**
  Input and output devices, Central processing unit (CPU), Keyboard, Monitor, Mouse, Printers, Modems, Scanners, Digital cameras, Different cards (sound, colour and video), Different drives (floppy, hard, CD, DVD).

- **System Software and Programming** **(08 Hours)**
  System software-Function, Types and Utilities.
  Computer Programming-Languages-Machine and assembly languages, Fortran, Cobol, Basic, C, C^{++}, Java etc.

- **Applications of Computer** **(07 Hours)**
  Desktop publishing, Spread sheet, Database, Graphics, Presentation, Communication, Browser, Web pages, Email, Project management, Integrated and suits.

(Total Contact Time (Theory): 32 Hours)

BOOKS RECOMMENDED:

1. **Kingsley Idiagbor**, *Basic Computer Science for Beginners*, 2002.
2. **Walton**, **S.**, *Computer Fundamentals,* 1997.
3. **Horowitz P. and Hill W**., *The Art of Electronics*, Cambridge University Press, 1989.
4. **Shelly C. V**., *Discovering Computers*, Web Enhanced, Complete Edition, 2005.
5. **Marjorie H. and Michael H**., *Microsoft Office 2003*, Brief Edition

First year of Five Years integrated M. Sc. (Physics / Chemistry / Mathematics)

M.Sc. - I, Semester – II	**L**	**T**	**P**	**C**
MG 102 : English-II	**2**	**1**	**0**	**3**

- **Grammar in Use** **(10 Hours)**

  The Verb Phrase; Be, have and do; Modal Verbs; Infinite Gerund and Participles.

- **Concepts in Grammar** **(10 Hours)**

  Questions and Auxiliary Verbs; Conditionals and 'wish'; ' – ing' and the infinite; Articles and Nouns; Pronouns and Determiners; Adjectives and Adverbs; Conjunctions and Preposition.

- **A Course in Listening and Speaking** **(10 Hours)**

  Pronunciation and Neutralization of Accent

(Total Contact Time (Theory): 30 Hours)

BOOKS RECOMMENDED :

1. **Murphy, Raymond**, *Intermediate English Grammar,* 2nd edition, Cambridge University Press, New Delhi,2007.
2. **Murthy, J. D.,** *Contemporary English Grammar,* Book Palace Publication 1998.
3. **Sasikumar, V., Dutt, P. K. & Rajeevan, G**., *A Course in Listening and Speaking-I*, Foundation Books, Cambridge Uni. Press India Pvt.Ltd.,2005.
4. **Monippally, M. M**, *Business Communication Strategies*, Tata McGraw-Hill Publishing Com. Ltd., New Delhi Publication, 2001
5. **Eastwood, J.,** *Oxford Guide to English Grammar*, Oxford Uni. Press, New Delhi, 2008.

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc.-II, Semester-III

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW/ Viva/ Pract.	
1	Physical Chemistry-I	MC 201	3	1	2	5	100	25	50	175
2	Inorganic Chemistry-I	MC 203	3	1	2	5	100	25	50	175
3	Modern Physics and Physical Optics	MP 203	3	1	2	5	100	25	50	175
4	Communication Skills-I	MG 201	2	1	0	3	100	25	00	125
5	Basic Science Elective (BSE)*	MS 2XX	3	0	0	3	100	00	00	100
			14	4	6		500	100	150	750
Total Contact hrs per week=24					**Total Credit=21**					**Total Marks=750**

*MS 201, 203, 205, 213, 215, 217.

*List of Basic Science Elective:

Sr. No.	Code	Subject Name
1	MS 201	Fundamentals of Classical Mechanics
2	MS 203	Modern Physics
3	MS 205	Basics of Astronomy and Astrophysics
4	MS 213	Numerical Analysis
5	MS 215	Introduction to Linear Algebra
6	MS 217	Statistics & Probability

Second year of Five years Integrated M. Sc.(Chemistry)
M. Sc.-II, Semester-IV

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW/ Viva/ Pract.	
1	Organic Chemistry-I	MC 202	3	1	2	5	100	25	50	175
2	Introduction to Chemical Engineering-I	CH 206	3	1	2	5	100	25	50	175
3	Fundamentals of Computer Programming	MM 210	3	1	2	5	100	25	50	175
4	Communication Skills-II	MG 202	2	1	0	3	100	25	00	125
5*	Engineering Science Elective (ESE)*	*ES 2XX	3	0	0	3	100	00	00	100
			14	4	6		500	100	150	750
Total Contact hrs per week=24					**Total Credit=21**					**Total Marks=750**

*** ES 202, ES 208.**

Sr.	Code	Course
1	ES 202	**Industrial Engineering (Mech. Engg. Dept)**
2	ES 208	**Applied Mechanics (Appl. Mech. Dept)**

Third year of Five Years integrated M. Sc.(Chemistry)
M. Sc.-III, Semester-V

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW/ Viva/ Pract.	
1	Physical Chemistry-II	MC 301	3	2	0	5	100	50	00	150
2	Organic Chemistry-II	MC 303	3	0	0	3	100	00	00	100
3	Inorganic Chemistry-II	MC 305	3	0	0	3	100	00	00	100
4	Computers in Chemistry	MC 307	3	1	2	5	100	25	50	175
5	Chemistry Lab. – I	MC 309	0	0	10	5	00	00	250	250
			12	3	12		400	75	300	775
Total Contact hrs per week=27						**Total Credit=21**				**Total Marks=775**

Third year of Five Years integrated M. Sc.(Chemistry)
M. Sc.-III, Semester-VI

Sr. No.	Course	Code	Teaching Scheme Hours per Week			Credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW/ Viva/ Pract.	
1	Physical Chemistry-III	MC 302	3	0	0	3	100	00	00	100
2	Organic Chemistry-III	MC 304	3	1	0	4	100	25	00	125
3	Inorganic Chemistry-III	MC 306	3	1	0	4	100	25	00	125
4	Economics & Business Management	MH 352	3	1	0	4	100	25	00	125
5	Chemistry Lab. – II	MC 308	0	0	12	6	00	00	300	300
			12	3	12		400	75	300	775
Total Contact hrs per week=27						**Total Credit=21**				**Total Marks=775**

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc II, Semester – III	**L**	**T**	**P**	**C**
MC 201: PHYSICAL CHEMISTRY – I	**3**	**1**	**2**	**5**

- **SOLID STATE** **(06 Hours)**
  Laws of crystallography: (i) constancy of interfacial angles (ii) rationality of indices (iii) symmetry, miller indices, space lattice, unit cell, types of solids, ionic structures, ratio effect and coordination numbers, limitation of radius ration rule, lattice defects, Born Haber cycle, metallic bond, VBT and MOT (band theory), X-ray diffraction, derivation of Bragg's equation, determination of crystal structure (NaCl, KCl and CsCl).

- **THERMOCHEMISTRY** **(06Hours)**
  Standard state, standard enthalpy of formation, Hess's law and its applications, heat of reaction at constant pressure and at constant volume, enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, Kirchoff's equation, Joule Thomson effect, inversion temperature. Nernst's distribution law: Derivation, application and limitations, distribution coefficient, Henry's law, solvent extraction.

- **CHEMICAL KINETICS** **(05Hours)**
  Collision theory, transition state theory, equilibrium approximation, steady state approximation, parallel and consecutive reactions, reversible reactions.

- **IONIC EQUILIBRIA** **(06Hours)**
  Arhenius theory of electrolytic dissociation, ionic product of water, pH scale, measurement of pH, common ion effect, buffer capacity, buffer in biological systems, Henderson'sequations, hydrolysis of salts, hydrolysis constant, relation between K_h, K_a, K_b, $K_{w,}$ degree of hydrolysis, acid base indicators, concept of solubility product.

- **COPOLYMER** **(07Hours)**
  Copolymerization, kinetics, determination of reactivity ratio, reactivity ratio and behavior of copolymer, industrial polymers, polymer processing.

- **ACIDS AND BASES** **(07Hours)**
  Bronsted and Lowry, Lux-flood, Lewis concept of acids and bases, relative strengths of acids and bases, solvent effects on strengths of acids and bases, hard and soft acids and bases, Pearson's HSAB concept, theoretical bases of hardness and softness, electronegativity and softness and hardness.

- **NON AQUEOUS SOLVENTS** **(05Hours)**
  Physical properties of solvent, types of solvent and their general characteristics, reaction in non aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Total Contact Time (Theory): 42Hours)

BOOKS RECOMMENDED:

1.**Chakrabarty D. K.,** '*Solid state chemistry'*, New Age International, 1996.
2. **Barrow G. M**.,' *Physical Chemistry*' 5th Edn, Tata McGraw-Hill, New Delhi, 1992.
3.**Chanda Manas**, '*Advanced Polymer Chemistry: A Problem Solving Guide'*, New York: Marcel Dekker, 2000.
4. **Bahl A. and Tuli**, '*Advanmced Physical Chemistry*', S. Chand & Co., New Delhi, 2005.
5.**Gowarikar V. R, '***Polymer Science'*, Wiley Eastern Ltd, New Delhi 1990.

Second year of Five years Integrated M. Sc.(Chemistry)
M. Sc II, Semester – III

	L	T	P	C
MC 203: INORGANIC CHEMISTRY – I	**3**	**1**	**2**	**5**

- **GRAVIMETRIC AND VOLUMETRIC METHODS OF ANALYSIS (06Hours)**
  Gravimetric analysis: Precipitation methods, mechanism of precipitation, desirable properties of gravimetric precipitate, adverse ion effect, co-precipitation, post-precipitation, digestion, drying, ignition, errors in gravimetric analysis, inorganic and organic precipitating agents, organic reagents in inorganic reactions. Volumetric analysis : Primary standards, acid base titrations, theory of acid base indicators, redox titration, complexometric and precipitation titrations, caution in volumetric titrimetry, correction for unavoidable error.

- **BIO- INORGANIC MOLECULES (05Hours)**
  Introduction, role of metal ions in different biological processes, essential, beneficial and toxic metals, etallo-porphyrins, hemoglobin as a carrier of O_2 and CO_2, myoglobin, chlorophyll and vitamin B-12.

- **LANTHANIDES AND ACTINIDES (06Hours)**
  Electronic configuration and general properties of lanthanides and actinides, extraction and separation of lanthanides and actinides.

- **INORGANIC REACTION MECHANISM (06Hours)**
  Reaction mechanism of ligand substitution reactions in octahedral complexes: SN_1 (D-process), SN_2 (A-process), solvent intervention, ion pair formation, conjugate base formation SN_1CB. Solvolysis reactions: acid and base hydrolysis, Redox (single electrode transfer) reactions.

- **METAL CARBONYLS (04Hours)**
  Definition, classification, nature of bonding and metal carbonyl, structure and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Mn_2(CO)_{10}$.

- **COORDINATION CHEMISTRY (06Hours)**
  John Teller effect, molecular orbital theory of coordination chemistry, interpretation of electronic spectra, inducing charge transfer spectra, spectrochemical series, nephelauxetic series. Magnetism: Dia, para, ferro- and antiferro- magnetism, quenching of orbital angular momentum, spin orbit coupling, inorganic reaction mechanisms, substitution reactions and trans effect.

- **FERTILIZERS (05Hours)**
  Definition and classification of fertilizers, direct and indirect fertilizers, natural and synthetic fertilizers, symptoms and deficiency of some elements like N, P, and K, Industrial preparation of urea from natural gas, single and triple super phosphate of lime, ammonium sulphate, hazardous effects of use of fertilizers.

- **BORON AND SILICON COMPOUNDS (04Hours)**
  Hydrides of boron: Diborane and higher boranes, borazines, borohydrides, silane, silicones as examples of polymers.

(Total Contact Time (Theory): 42Hours)

BOOKS RECOMMENDED:

1. **Lee J. D**., *Concise Inorganic Chemistry*, 4th Edn., ELBS, 1991.
2. **Cotton F. A., Wilkinson G. and Gans P. G**., *Basic Inorganic Chemistry*, 2nd Edn., John Wiley & Sons, 1987.
3. **Soni P. L**., *Inorganic Chemistry*, 5th Edn., McGraw-Hill, 1985.
4. **Puri B. R. Sharma L. R. and Kalia K. C.,** *Principles of Inorganic Chemistry*, 30th Edn., S. Chand, 2001.
5. **Yawalkar K. S., Agarwal J. P. and Bokde S.** *Manures & Fertilizers*, 9th Edn., Oscar, 2000.

Second year of Five Years integrated M.Sc. (Chemistry)

M.Sc. – II, Semester – III		**L**	**T**	**P**	**C**
MP 203 :	**Modern Physics & Physical Optics**	**3**	**1**	**2**	**5**

- **SPECIAL THEORY OF RELATIVITY** **(06 Hours)**
  Frames of reference, postulates of Sp. Theory of relativity, Time dilation, length contraction, Mass-energy interrelationship

- **BLACK BODY RADIATION** **(04 Hours)**
  Black body characteristics, Ultraviolet catastrophe, Laws of black body radiations

- **PARTICLE PROPERTIES OF WAVES** **(04 Hours)**
  Electromagnetic waves, light as a wave, dual nature, photoelectric effect, Compton effect, X-ray diffraction

- **WAVE PROPERTIES OF PARTICLES** **(04 Hours)**
  De-Broglie waves, Group and phase velocities, particle in abox, uncertainty principle

- **ATOMIC STRUCTURE** **(06 Hours)**
  The Nuclear Atom, Energy orbits, atomic spectra, The Bohr Atom, Energy levels, correspondence Principle, Pauli's exclusion principle, quantum numbers

- **INTRODUCTORY QUANTUM MECHANICS** **(06 Hours)**
  Classical mechanics as an approximation of quantum mechanics, Wave equation, Time dependent Schrodinger's eqn., Linearity and Superposition, Operators

- **PHYSICAL OPTICS** **(10 Hours)**
  Wave characteristics of light, Interference of light, Diffraction of light and Polarization of light

- **LASERS** **(04 Hours)**
  Basics of Lasers, their working, types and applications of lasers

(Total Contact Time (Theory): 44 Hours)

BOOKS RECOMMENDED :

1. **Beiser, A.,** *Concept of the Modern Physics*, TMH, 2008.
2. **Ghatak, A**., Optics, Tata McGraw Hill, 2005.
3. **Wehr M. R**, **Richards J.A. and Adair T. W**. , *Physics of the Atom*, Addison – Wesley, 1984.
4. **Harris,R.,** *Modern Physics*, Addison-Wesley/ Pearson), 2/E ,2007.
5. **Born M., and Wolf, E**., *Principles of Optics*, Cambridge Uni. Press,2000.

Second year of Five years Integrated M. Sc.(Chemistry)
M. Sc. II, Semester - III

	L	T	P	C
MG 201: COMMUNICATION SKILLS -1	**2**	**1**	**0**	**3**

Section – 1

- **SPEAKING AND LISTENING SKILLS** **(15 Hours)**

'TIGER'S EYE'

1. Welcome to India
2. Starting Work
3. The Missing Bass
4. Tiger's Eye
5. The Conference
6. Revision
7. The Inspector Calls
8. Strictly Confidential
9. The Box of Books
10. Bad News, Good News
11. A Surprise Present
12. Revision
13. A Case Full of Books
14. Deep Water
15. Tyger, Tyger

Section - 2

- **SPEAKING, LISTENING & WRITING SKILLS** **(15 Hours)**

1. EFFECTIVE PRESENTATION STRATEGIES

- Defining purpose
- Analyzing Audience & Locale
- Organizing Contents
- Preparing an outline
- Visual aids
- Understanding Nuances of Delivery
- Kinesics
- Proxemics
- Paralinguistics
- Chronemics

2. INTERVIEWS :

- Types of interviews
- Answering Strategies
- Job Interviews
- Preinterview preparation

3. GROUP COMMUNICATION

- Group Discussion Strategies
- Group Interaction Strategies
- Organizational Group Discussion
- Group Discussion as part of a selection process.

4. MEETING :

- Purpose
- Procedure
- Participation
- Physical Arrangement.

5. SEMINAR & CONFERENCES

- Types of Discussion Groups
- Regulating Speech
- Conducting Seminars
- Organizing Conferences
- Evaluating Oral Presentation

(Total Contact Time (Theory): 30 Hours)

BOOKS RECOMMENDED:

1. **Lesikar, Raymond V. and Flatley, Marie E,** *Basic Business Communication skills for Empowering the Internet generation*, Tata McGraw Hill publishing company limited. New Delhi 2005
2. **Riordan, Daniel G. and Pauley, Steven E.,** *Technical Report Writing Today*, Biz tantra. New Delhi. 2006.
3. **Rizvi, M. A.,** *Effective Technical Communication* ,The McGraw Hill New Delhi, 2005
4. **Raman, Meenakshi and Sharma, Sangeetha,** *Technical Communication Principles and Practices*, Oxford University Press, New Delhi, 2008.
5. **Sudan, Amrit Singh, Kumar N.,** *Business Communication*, Anmol Publications Pvt. Ltd. New Delhi, 2003.

Second year of Five Years integrated M.Sc. (Chemistry)

M.Sc.-II, Semester-III	**L**	**T**	**P**	**C**
MS 201: BASIC SCIENCE ELECTIVE (BSE) **FUNDAMENTALS OF CLASSICAL MECHANICS**	**3**	**0**	**0**	**3**

- **MECHANICS OF A PARTICLE AND SYSTEM OF PARTICLES** **(10 Hours)**
  Equation of motion, Different conservation laws, Constrained motion, Constraints, Degree of freedom, Generalized coordinates.
- **VARIATIONAL PRINCIPLE AND LAGRANGIAN FORMULATIONS** **(10 Hours)**
  Calculus of variations, Variational technique for many independent variables, Euler Lgrangian differential equation

- **HAMILTONIAN FORMULATION OF MECHANICS** **(10 Hours)**
  Phase space and motion of the system, Hamilton's canonical equation of motion, Physical significance of H, Advantage of Hamilton approach.

- **SPECIAL THEORY OF RELATIVITY** **(06 Hours)**
  Frames of Reference, Postulates, Time dilation, Length contraction, Mass-Energy Relation, Lorentz' transformation.

- **GENERAL THEORY OF RELATIVITY** (**08 Hours)**
  Space-time Fabric, Pinciple of equivalence, Euclidean and non−Euclidean Continuum

(Total Contact Hours (Theory) : 44 Hours)

BOOKS RECOMMENDED:

1. **Mathur D. S.,** *Mechanics*, S. Chand & Company, 2000.
2. **Takwale R. G. & Puranik P.S.** *Introduction to Classical Mechanics*, TMH., 1997.
3. **Feymann R. P., Lighton R. B. and Sands M.,** *The Feymann Lectures in Physics*, Vol. 1, Narosa Publishers, 2008.
4. **Verma H. C.,** *Concepts of Physics*, Vol. 1 & 2, Bharati Bhavan, 2007.
5. **Landau L. D. & Lifshitz E. M.,** *Course on Theoretical Physics*, Vol. 1: Mechanics, Addison-Wesley, 2002

Second year of Five Years integrated M.Sc. (Chemistry)

M.Sc.-II, Semester-III	**L**	**T**	**P**	**C**
MS 203: BASIC SCIENCE ELECTIVE (BSE) **MODERN PHYSICS**	**3**	**0**	**0**	**3**

- **LIMITATIONS OF CLASSICAL PHYSICS AND INTRODUCION TO QUANTUM PHYSICS** **(08 Hours)**

  Classical physics as an approximate of quantum physics, limitations of classical Physics at microscopic levels

- **BASICS OF QUANTUM PHYSICS AND QUANTUM MECHANICS** **(10 Hours)**
  Black body radiation, Wein's, Rayleigh-Jeans, and Planck's laws, Dual nature, Atomic models, Exclusion principle, and quantum numbers, The wave equation

- **PHOTOELECTRIC EFFECT AND COMPTON EFFECT** **(06 Hours)**
  Photoelectric effect and Einstein's explanation, Compton effect and equation of Wavelength

- **X – RAYS** **(08 Hours)**
  Production and characteristics of X-rays, X-ray diffraction and Bragg's law

- **LASERS ,FIBRE OPTICS & APPLICATIONS** **(12 Hours)**
  Laser fundamentals, types of lasers, Basics of Fibre optics, types of fibres, applications

(Total Contact Hours (Theory) : 44 Hours)

BOOKS RECOMMENDED:

1. Beiser A., *Concept of the Modern Physics*, TMH, 2008.
2. Ghatak A., *Optics*, Tata McGraw Hill, 2005.
3. Wehr M. R., Richards J. A. and Adair T. W., *Physics of the Atom*, Addison – Wesley, 1984.
4. Harris R., *Modern Physics*, Addison-Wesley/ Pearson,2/E ,2007
5. Born M. and Wolf E., *Principles of Optics*, Cambridge Uni. Press, 2000.

Second year of Five Years integrated M.Sc. (Chemistry)

M.Sc.-II, Semester-III	**L**	**T**	**P**	**C**
MS 205: BASIC SCIENCE ELECTIVE (BSE) **BASICS OF ASTRONOMY AND ASTROPHYSICS**	**3**	**0**	**0**	**3**

- **UNIVERSE AND CELESTIAL BODIES** **(18 Hours)**
  Matter vs Radiation Dominated universe, The early universe, structure formation Galaxies, Nebulae, Stars, Classification of celestial bodies, other celestial objects

- **SOLAR SYSTEM** **(10 Hours)**
  Birth, Life and death of a star, H-R diagram, Solar system & its members

- **EARTH AND ITS ATMOSPHERE** **(07 Hours)**
  Formation and structure of the Earth, different surface features of the earth, earth's Atmosphere and its different parts, radio window, ozone depletions

- **SPACE EXPLORATIONS** **(07Hours)**
  Radiation in the universe, its effect on human and other non living mechanisms, types Space vehicles, manned space explorarions

(Total Contact Hours (Theory) : 42 Hours)

BOOKS RECOMMENDED:

1. Degaonkar S. S., *Space Science*, Gujarat University Press, 1968
2. Patrick M., *Atlas of the Universe*, Cambridge University Press, 2000
3. Beiser A., *Concept of the Modern Physics*, TMH, 2008
4. Mukhanov, M., *Physical Foundations of Cosmology*, CUP, 2005.
5. Islam, J. N., *An Introduction to Mathematical Cosmology*, CUP, 2004.

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc. II, Semester - III	**L**	**T**	**P**	**C**
MS 213: BASIC SCIENCE ELECTIVE (BSE) **NUMERICAL ANALYSIS**	**3**	**0**	**0**	**3**

- **INTRODUCTION TO COMPUTING** **(08 Hours)**
  Errors & approximation, finite differences, difference operators & relations between them. Interpolation: Newton's forward & backward, Lagrange, divided differences.

- **NUMERICAL SOLUTIONS OF TRANSCENDENTAL EQUATIONS** **(08 Hours)**
  Bisection, Secant, Regular-Falsi, Newton-Raphson, Iteration method.

- **NUMERICAL DIFFERENTIATION & INTEGRATION** **(09 Hours)**
  Trapezoidal & Simpson's rule, Gauss Legendre quadrature, Newton Cote's formula.

- **NUMERICAL SOLUTION OF SYSTEM OF LINEAR EQUATIONS** **(09 Hours)**
  Direct (Gauss elimination, LU decomposition), Iterative (Jacobi & Gauss-Seidel).
  Eigen values problem: Jacobi's and power method.

- **NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION** **(08 Hours)**
  Taylor series method, Picard's method, Euler's method, Modified Euler's method, Runga-Kutta method.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Scarborough J. B**., *Numerical mathematical analysis*, Oxford & IBH Publishing Co. Pvt. Ltd., 1966.
2. **Atkinson K. E.,** *An introduction to Numerical Analysis*, Wiley, 1989.
3. **Jain M. K., S. Iyenger R. K. and Jain R. K.,** *Numerical Methods for Scientific and Engineering Computation*, New Age International Pvt. Ltd.,1996.
4. **Conte S. D. and de Boor C**., *Elementary Numerical Analysis-An Algorithmic Approach*, McGraw-Hill, 1981.
5. **Golub G. H. and Ortega J. M.,** *Scientific Computing and differential equations: An introduction to Numerical Methods*, Academic Press, 1992.

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc II, Semester – III	**L**	**T**	**P**	**C**
MS 215: BASIC SCIENCE ELECTIVE (BSE) **INTRODUCTION TO LINEAR ALGEBRA**	**3**	**0**	**0**	**3**

- **SYSTEM OF LINEAR EQUATIONS** **(08 Hours)**
  Matrices and elementary row operations, Gaussian elimination.

- **VECTOR SPACES** **(10 Hours)**
  Subspaces, Basis and dimension, co-ordinates.

- **LINEAR TRANSFORMATION** **(10 Hours)**
  Representation of linear transformation by Matrices, rank-nullity theorem, duality and transpose, Determinant.

- **EIGEN VALUES & EIGEN VECTORS** **(14 Hours)**
  Minimal & characteristic polynomials, diagonalisations, Cayley Hamilton theorem.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Lang, S.,** *Introduction to Linear Algebra (Undergraduate text in Mathematics),* Springer, 1986.
2. **Krishnamurthy, Mainra, V. V. P. and Arora, J. L**., A*n Introduction to Linear Algebra*, Afiliated East-West, 1976.
3**. Hoffman, K. and Kunze, R.,** *Linear Algebra* PHI, 1991.
4. **Strang, G.,** *Linear Algebra & Its Applications*, 4th edition, Thomson Brooks/Cole, 2006.
5. **Noble, B. And Daniel J.W**., *Applied Linear Algebra*, Prentice Hall, 1977.

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc. II, Semester - III	**L**	**T**	**P**	**C**
MS 217: BASIC SCIENCE ELECTIVE (BSE) **STATISTICS & PROBABILITY**	**3**	**0**	**0**	**3**

- **STATISTICS** **(08 Hours)**
  Correlation between two variable, types of correlation, coefficient of correlation, methods to evaluate Co-efficient of correlation & its application. Regression, equation of regression lines, multiple regression.

- **PROBABILITY DISTRIBUTION** **(10 Hours)**
  Binomial, Poisson's distribution and Normal distribution with derivation of its mean variance, different moments, β_1 & β_2, γ_1 &γ_2

- **TESTING OF HYPOTHESIS** **(12 Hours)**
  Test of significance, Chi-square (χ^2) test, student's t Test, F-distribution & its applications.

- **TIME SERIES ANALYSIS** **(12 Hours)**
  Trend, seasonal fluctuation, cyclic fluctuation, random fluctuation & its methods to evaluate.

(Total Contact Hours: 42 Hours)

BOOKS RECOMMENDED:

1. **Devore, Jay L,** *Probability & Statistics*, Thompson, Singapore, Ind. Ed. 2002
2. **Levien, Richard I. & Rubin, David S.,** *Statistics for Management*, Prentice Hall, 1997.
3. **Minh, D. L.,** *Applied Probability Models*, Thompson, Singapore, Ind. Ed. 2002
4. **O'Neil Peter.**, *Advanced Engineering Mathematics*, Thompson, Singapore, Ind. Ed. 2002.
5. **Ramana D. V.,** *Higher Engineering Mathematics*, The MacGraw-Hill Inc., New Delhi, 2007.

Second year of Five years Integrated M. Sc.(Chemistry)
M. Sc. II, Semester – IV

	L	T	P	C
MC 202: ORGANIC CHEMISTRY – I	**3**	**1**	**2**	**5**

- **CYCLOALKANES AND DIENES** **(04 Hours)**
  Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and it's limitations, theory of strainless ring. Dienes: Nomenclature, classification, methods of formation of butadiene, chemical reactions, 1,2 and 1,4 additions, Diel's – Alder reaction.

- **BENZENE AND ITS HOMOLOGUES** **(06 Hours)**
  Aromaticity, Mobius and Huckel polyenes, Huckel rule, annulene, mechanism of substitution reactions, directive effects of substituents, *o*, *p* and *m*-directing groups, effect of substituents on reactivity, theory of activity and deactivity effects. Fused ring compounds: Chemistry of naphthalene, anthracene and phenanthrene.

- **UNIT PROCESSES** **(06 Hours)**
  Sulphonation: Definition, methods, sulphonating agents, sulphonation of benzene with the help of SO_3 , H_2SO_4, oleum and $ClSO_3H$ Nitration: Definition, methods, nitrating agents, factors affecting nitration, nitration of benzene, naphthalene, importance of nitration in manufacture of artificial perfume.

- **HETROCYCLIC COMPOUNDS** **(07 Hours)**
  Nomenclature, aromaticity, synthesis, properties, uses and canonical structures of pyrrole, furan and thiophene.

- **CARBOHYDRATES** **(05 Hours)**
  Introduction to disaccharides, glycosidic bond, structure determination of sucrose, lactose, maltose and cellobiose.

- **PHOTOCHEMISTRY** **(06 Hours)**
  Laws of photochemistry, nature of electronically excited states, geometry, dipole moment, acid base properties, internal conversion, intersystem crossing, phosphorescence, fluorescence, quantum yield, examples of low and high quantum yield, actinometry, rate of photochemical reactions, photochemical reactions of >C=C<, >C=O, benzene ring, and nitrogen containing compounds, photooxygenations, photochemistry of air and air pollution, chemi- and bioluminescence.

- **COMPOUND CONTANING ACTIVE METHYLENE GROUP** **(02 Hours)**
  Malonic ester and acetoacetic ester: preparation and its synthetic applications.

- **PETROCHEMICALS** **(06 Hours)**
  Petrochemicals obtained from C_1 cut of petroleum, manufacture and applications of ammonia, formaldehyde, hexamethylene tetramine, chlorinated methane. Petrochemicals obtained from C_2 cut of petroleum, manufacture and applications of chemicals obtained from ethanol, acetaldehyde (Wacker Cheime Process), ethylene dioxide, ethylene glycol.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Morrison R. T. and Boyd R.N.,** '*Organic Chemistry'*, 6th Edn., Prentice Hall, 1992.
2. **Bahl A. and Bahl B. S.**, '*A Textbook of organic Chemistry'*, 2nd Edn., S. Chand, 2005.
3. **Kumar S**., '*Introduction to Petrochemicals'*. 6th Edn, Oxford & IBH, 2000.
4. **March J**., *'Inorganic Chemistry'*, 5th Edn., S. Chand, 2001.
5. **Finar I. L**., '*Organic Chemistry*' volume 1 &2 6th edition Longman, London 2006.

Second year of Five years Integrated M. Sc.(Chemistry)

M. Sc. II, Semester – IV	**L**	**T**	**P**	**C**
CH 206: INTRODUCTION TO CHEMICAL ENGINEERING – I	**3**	**1**	**2**	**5**

- **INTRODUCTION** **(03 Hours)**
  Dimension and Units, Fundamental and derived quantities, Mathematical techniques in chemical engineering.

- **BASIC CHEMICAL CALCULATIONS** **(04 Hours)**
  Gas laws and phase equilibria, Humidity, saturation and crystallization.

- **COMBUSTION** **(06 Hours)**
  Combustion and chemical processes.

- **MATERIAL BALANCE** **(06 Hours)**
  Material balances involving recycle, bypass and purge systems.

- **THERMOCHEMISTRY** **(06 Hours)**
  Heat capacity calculations. Enthalpy changes of reactions, dissolution and laws of thermochemistry. Effect of pressure and temperature on heat of reactions.

- **CHLOR-ALKALI INDUSTRY** **(01 Hour)**
  Manufacture of soda ash, Caustic Soda, Chlorine, Hydrogen and Hydrochloric acid.

- **PULP AND PAPER INDUSTRY** **(02 Hours)**
  Cellulose derivatives, pulp , paper and board.

- **SUGAR AND STARCH INDUSTRY** **(02 Hours)**
  Sugar, starches and related products

- **OIL, FATS, SOAPS AND DETERGENTS** **(02 Hours)**
  Vegetable Oils, animal fats, their nature, analysis and extraction methods, Hydrogenations oil,Fatty acids and alcohol, waxes, soap, synthetic detergent.

- **POLYMER INDUSTRY** **(02 Hours)**
  Manufacture of Phenol and Urea Formaldehyde resin, PVC, Polyethylene, Synthetic rubber etc.

- **MANUFACTURE OF FERTILIZERS** **(04 Hours)**
  Urea, $(NH_4)_2SO_4$, $(NH_4)_3PO_4$ etc.

- **PETROLEUM REFINING AND PETROCHEMICAL INDUSTRY** **(04 Hours)**
  Introduction to refining and petrochemicals from C_1 and C_2 cuts.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Bhatt B.I. & Vora S.M.,** '*Stoichiometry*', 4th Ed., Tata-McGraw-Hill, New Delhi, 2004.
2. **Austin G. T.,** '*Shreve's Chemical Process Industries*', 5th Ed. McGraw-Hill Pub., 1994.
3. **Hougen O.A., Watson K.M. & Ragatz R.A.,** '*Chemical Process Principals'* Part-I, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1995.
4. **Gopalarao M. & Sitting M**., '*Dryden's Outlines of Chemical Tech'*, 2nd Ed., East-West Pub., New Delhi,1997
5. **Himmelblau D.M**., '*Basics Principles and Calculations in Chemical Engineering*' 6th Ed., Prentice-Hall India,1996.

Second year of Five Years integrated M. Sc. (Chemistry)

M.Sc.-II, Semester-IV	**L**	**T**	**P**	**C**
MM 210: FUNDAMENTALS OF COMPUTER PROGRAMMING	**3**	**1**	**2**	**5**

- **COMPUTER FUNDAMENTALS** **(06 Hours)**
  Preliminary Concepts of Algorithms. Flow Charts and their execution traces. A simplified model of a Computer. Bit, byte, nibble, word, structure of computer (Von Neumann), I/O unit, ALU, CPU, CU, MU, different types of I/O devices.

- **DIGITAL TECHNIQUES** **(08 Hours)**
  Number system: Decimal, binary, octal, hexa decimal. Conversion. BCD, EBCD, ASCII code, Arithmetic operations on binary numbers: addition, subtraction using 1's and 2's complement, multiplication, division.

- **LOGIC GATES** **(06 Hours)**
  AND, OR, NOT, NAND, NOR, XOR gate, truth tables.

- **PROGRAMMING IN C** **(22 Hours)**
  BASICS

  VARIABLES – CONSTANTS – EXPRESSIONS - Operators and their precedence and associativity. Basic input and out put statements. Control structures. Simple programs in C using all the operators and control structures.

  FUNCTIONS

  Concepts of a function – Parameters and how they are passed – Auto Variables – Recursion – Scope and extent of variables. Writing programs using recursive and non-recursive functions.

  ARRAYS AND STRINGS

  Single and Multi dimensional arrays – Character array as a string. Functions on strings. Writing C Programs using arrays and for string manipulation.

  STRUCTURES

  Declaring and using structures. Operations on structures – Arrays of structures. User defined data types. Pointers to using Files.

  FILES

  Introduction- File Structure. File handling functions. File types. Error handling. C programming examples for using files.

(Total Contact Time (Theory) : 42 Hours)

PRACTICALS:

1. Write program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are on a straight line

2. Write a program which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the array. Write 3 versions of the program using different loop constructs e.g. for, while, do while

3. Write a set of string manipulation functions e.g. for getting a sub string from a given position. Copying one string to another, reversing a string, adding one to another

4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, long, float and double. What happens when you add 1 to the largest possible integer number that can be stored

5. Write a program which generates 100 random numbers in the range of 10.0 to 20.0 and sort them in descending order

6. Write a function for transposing a square matrix in place i.e. do not use full temporary matrix

7. First use an editor to create file with some integer numbers. Now write a program to read these numbers from the file to compute their mean and standard deviation

8. Given two points on the surface of a sphere, write a program to determine the smallest arc length between them

---

BOOKS RECOMMENDED:

1. **Rajaraman V.,** "*Programming in C*", PHI, 1994.
2. **Gottfried B. S.,** "*Theory and Problems of Programming with C*", Schaum Publishing Company, New York, 1995.
3. **K.R. Venugopal & Sudeep R Prasad, "**Programming with C**":** TMH, New Delhi, 2002.
4. **Mano M. Morris,** "*Computer Engineering: Hardware Design*", Prentice Hall, US edition, 1988.
5. Balagurusamy E., "*Programming in ANSI C"*, 3rd Ed., TMH, New Delhi, 2004.

Second year of Five years Integrated M. Sc.(Chemistry)

M.Sc. II, Semester - IV	**L**	**T**	**P**	**C**
MG 202: COMMUNICATION SKILLS – II	**2**	**1**	**0**	**3**

Section 1.

WRITING AND READING SKILLS **(15 Hours)**

- **TECHNICAL COMMUNICATION PRINCIPLES AND PRACTICES.**

1. Technical Proposal

- Definition & Purposes
- Key factors
- Types
- Elements & Structure
- Style & Layout
- Evaluation.

2. Note Making

- Mechanics of Note making
- Reading Strategy
- Note- Writing Techniques
- Topical sing
- Schematizing
- Reducing Devices
- Organization Techniques

3. **Research Papers / Articles / Dissertation / Thesis**

Research paper

- Characteristics components
- Articles
- Nature and Significance of Technical Articles
- Types of Technical Articles, Journal Articles & Conference papers
- Elements of Technical Articles
- Writing Strategies

Dissertation

- Essential feature,
- Action plan,
- Choosing the subject,
- Structure

Thesis

- Outline
- Organization
- Time Table
- Iteration
- Style
- Presentation
- Structure

Section 2.

DISCOURSE ANALYSIS: A LITERARY PIECE OF WORK (15 Hours)

TUGHLAQ by Girish Karnard

(Total Contact Time (Theory): 30 Hours)

BOOKS RECOMMENDED:

1. **Lesikar, Raymond V. and Flatley, Marie E,** *Basic Business Communication skills for Empowering the Internet generation*, Tata McGraw Hill publishing company limited. New Delhi 2005
2. **Riordan, Daniel G. and Pauley, Steven E.,** *Technical Report Writing Today*, Biz tantra. New Delhi. 2006.
3. **Rizvi, M. A.,** *Effective Technical Communication* ,The McGraw Hill New Delhi, 2005
4. **Raman, Meenakshi and Sharma, Sangeetha,** *Technical Communication Principles and Practices*, Oxford University Press, New Delhi, 2008.
5. **Karnard, Girish**, Tughlaq, Oxford University Press, New Delhi, 2007.

Second year of Five years Integrated M. Sc.(Chemistry)

M.Sc. II, Semester - IV	**L**	**T**	**P**	**C**
ES 202: (ENGG. SCIENCE ELECTIVES)	**3**	**0**	**0**	**3**

INDUSTRIAL ENGINEERING

- **INDUSTRIAL ENGINEERING (01 Hour)**
  Introduction, history, activities & techniques of Industrial Engineering, Organization of Industrial Engineering Department.

- **PRODUCTIVITY (03Hours)**
  Production & productivity, factors influencing productivity – technological advancement & human factors, measurement of productivity (Productivity Index), causes of low productivity and techniques of their elimination, improving productivity by reducing work content & ineffective time.

- **WORK STUDY (11Hours)**
  Work content, excess work content & ineffective time, Method study – objectives, steps, selection of job, process charts, micro-motion & memo-motion studies, principles of motion economy – Therbligs, Workplace layout, Work Measurement – objectives, steps, techniques, performance rating, allowances of standard time, techniques of work measurement, Work Sampling– confidence levels, methods of work sampling, Computation of machines utilization & standard time, Predetermined Motion Time Systems (PMTS), Work Factor System, Method Time measurement (MTM)- MTM basic motion elements, Production study, Physiological work measurement.

- **PRODUCT RESEARCH, DEVELOPMENT AND DESIGN (02Hours)**
  Product life cycle, selection of a profitable product, product design & development, process, product analysis Tools for product development viz. Standardization, Simplification, diversification, specialization etc. concurrent design, Design for Manufacturing & Assembly (DFMA), Reverse engineering, Manufacturability, Ergonomic considerations in Product design, Process design.

- **MATERIALS MANAGEMENT & INVENTORY CONTRO (06Hours)**
  Materials management, inventory, costs selective inventory control – ABC analysis, safety stock, inventory models such as basic EOQ model, inventory with planned shortages, inventory with quantity discount, inventory with finite replenishment, ideal & real inventory management systems, inventory control systems.

- **DEMAND (SALES) FORECASTING (06Hours)**
  Quantitative forecasting techniques such as time series analysis, method of least squares, simple moving & weighted moving average regression & correlation; exponential smoothing methods, economic indicators method, qualitative forecasting techniques such as collective opinion method, Delphi technique etc, measures of forecast accuracy, selecting a forecasting method, costs and accuracy of forecasts.

- **VALUE ENGINEERING (04Hours)**
  Value analysis & value engineering, reasons for unnecessary costs, Function Analysis System Technique (FAST), Techniques of value analysis & value engineering, value analysis procedure & questionnaire.

- **PRODUCT COST CONCEPTS & BREAK-EVEN ANYLSIS (02Hours)**
  Costs of production, classification of costs, analysis of production costs, Break-even analysis – graphical as well as mathematical analysis, costs – volume – Profit (CVP) analysis, managerial uses of Break even chart, Applications of Break-even analysis.

- **ERGONOMICS (Human Factor Engineering) (03Hours)**
  Objectives of human engineering, Ergonomics, productivity and working environment, man-machine systems, design of controls & information displays, working environment factors, Anthropometry, Human activities. Biomechanics, nature of movements, expenditure of energy for movements, Layout of working space , seating arrangements for providing maximum comfort.

- **ADVANCED INDUSTRIAL ENGINEERING TECHNIQUES (07 Hours)**
  Total Quality Management (TQM), Business Process Reengineering (BPR), Just-in-time (JIT) manufacturing, Lean management, Total Productive Maintenance (TPM), World Class manufacturing (WCM) etc.

(Total Contact Time (Theory): 45 Hours)

BOOKS RECOMMENDED:

1. **Telsang M.,** '*Industrial Engineering & Production Management*', S. Chand & Co. Ltd., New Delhi, 2005.
2. **Sharma S. K., Sharma Savita & Sharma Tushar**, '*Industrial Engineering & Operations Managemen'*, S.K. Kataria & Sons, New Delhi, 2004.
3. **International Labour Organization**, Geneva, *Introduction to work study, 2005*.
4. **Vohra N.D.,** '*Quantitative Techniques in Management*', Tata McGraw Hill Pub., New Delhi, 2005.
5. **Khanna R.B.,** '*Production & Operations Management*', PHI, New Delhi, 2007.

Second year of Five years Integrated M. Sc.(Chemistry)
M.Sc. II, Semester-IV

	L	T	P	C
ES 208: (ENGG. SCIENCE ELECTIVE) APPLIED MECHANICS	**3**	**0**	**0**	**3**

- **RESULTANT OF COPLANAR FORCE SYSTEM (08 Hours)**
  Introduction to mechanics – Force – Types of forces – Newton's Law – System of units –Vector representation of a force – Parallelogram law – Resultant of concurrent forces Rectangular components of a force – Moment of a force Varignon's theorem – Couple – Equivalent Force – Couple system – resultant of Nonconcurrent coplanar forces**.**

- **EQUILIBRIUM OF COPLANAR FORCE SYSTEM (04 Hours)**
  Equation of equilibriums, The free- body diagram – Types of Supports Equilibrium of concurrent coplanar force systems – Equilibrium of nonconcurrent coplanar force systems.

- **SPATIAL FORCE SYSTEM (04 Hours)**
  Rectangular components of spatial force system – Resultant of a concurrent spatial force system – Equilibrium of concurrent spatial force system.

- **CENTROID AND MOMENT OF INERTIA (06 Hours)**
  Centroids of wires and plane areas – Centroids of composite wires and plane areas – Pappus Guldinus theorem – Moments of Inertia of plane areas – Parallel Axis theorem.

- **SIMPLE STRESS STRAINS (09 Hours)**
  Normal Stress & Strains – Mechanical Properties of materials – Constitutive relationship between stress and strain, Analysis of bars of varying sections uniformly tapering rods – Composite sections – Elastic constants – Thermal Stresses.

- **SHEAR AND MOMENTS IN BEAMS (03 Hours)**
  Types of beams – Loads and supports – Shear force and Bending moment Relationship between loads, shear force and bending moment – Shear force and Bending Moment diagrams.

- **STRESSES IN BEAMS (04 Hours)**
  Theory of simple bending – bending stresses – Moment of Resistance – Section Modulus – Flitch beams – Shear stresses in beams.

- **COLUMNS (04 Hours)**
  Euler formula for pin ended columns – Slenderness Ratio – Different end conditions – Limitation of Euler formula – Rankine's formula.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Desai, J. A. and Mistry, B.B.** "*Engineering Mechanics" Static and Dynamics*", 3rd Edition, Popular Prakashan, Surat, 2001
2. **Junnarkar, S.B. and Shah, H.J.** "*Applied Mechanics*", 16th Edition, Charotar Publication, Anand, 2001.
3. **Bear, F.P. and Johnston, E.R.** "*Vector Mechanics of Engineers: Statics and Dynamics"*, 8th edition, Tata McGraw Hill Publication, New Delhi, 2007.
4. **Bhavikatti, S.S.** "*Strength of Materials*", Vikas Publication House, New Delhi, 2007.
5. **Khurmi, R.S.** "*Strength of Materials*", S. Chand & Company Ltd., New Delhi, 2005.

Third year of Five Years integrated M. Sc.(Chemistry)

M. Sc. III, Semester - V	**L**	**T**	**P**	**C**
MC 301: PHYSICAL CHEMISTRY-II	**3**	**2**	**0**	**5**

- **SURFACE CHEMISTRY** **(09 Hours)**
  Different types of surfaces, Examination of surfaces using ESCA, Auger, SEM and STM, Properties of surface phase, Thermodynamics of surface, Surface tension of solutions, Surface Phenomena: Gibbs' adsorption equation and its verification, Solid- liquid interfaces, Contact angle and wetting, Solid-gas interface, Physisorption and chemisorptions, Langmuir, Surface films: Different types Surface pressure and surface potential and their measurements and interpretation, BET isotherms, Surface area determination.

- **ELECTRO CHEMISTRY** **(10 Hours)**
  Ions in solution. Deviation from ideal behaviour. Ionic activity. Ion-solvent interaction. Born equation. Ion ion interaction. Activity coefficient and its determination. Debye-Huckel limiting law. Equation for appreciable concentration. Osmotic coefficient. Acivities is concentrated solutions. Robinson-Stoke theory. Ion association. Strong electrolytes. Ion transport, Debye-Huckel treatment. Onsager equation. Limitation of the model. Conductance of high frequencies and high potentials.

- **COLLOIDAL CHEMISTRY** **(07 Hours)**
  Types of colloidal system, Classifications of colloids, Colloidal state, Multimolecular, macromolecular and associated colloids, Stability of colloids, Zeta potential. Kinetic, optical and electrical properties of colloids, Electrokinetic phenomena, Electrophoresis, Electroosmosis, Sedimentation potential and streaming potential.

- **NUCLEAR CHEMISTRY** **(08 Hours)**
  Natural Radioactivity & Laws of Radioactive Decay, Half life, Mean life, General characteristics of radioactive decay, Decay kinetics, Types of radioactive decay, Theory of α-,β-,γ-decay, Electron capture, Nuclear reactions, Bethe's notations, Types of nuclear reaction, Transmutations, Radioactive capture reactions, Photonuclear reactions, Thermonuclear reactions.

- **MATERIAL CHEMISTRY** **(08 Hours)**
  Smart Materials: Smart polymers, Application of smart polymers in biotechnology and biomedicine, Drug delivery using smart polymers.
  Types of ceramic materials: Glass, Cement and Refractory. Introduction, Classification, Basic chemistry

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Atkins P.W.**, '*Physical Chemistry*', ELBS and Oxford University Press, Oxford, 1994.
2. **MacInnes D. A.**, '*The Principles of Electrochemistry*', Dover Publishers, 1961.
3. **Arnikar H. J.**, *Essential of Nuclear Chemistry*, 4th Edn., 1995.
4. **Igor Galaev and Bo Mattiasson,** '*Smart Polymers-Applications in Biotechnology and Biomedicine*' Taylor & Francis, 2nd Edn., 2008.
5. **William D. C. Jr.**, *'Fundamentals of Materials Science and Engineering*' John Wiley & Sons, Inc., 5th Edn., 2001.

Third year of Five Years integrated M. Sc.(Chemistry)

M. Sc. III, Semester - V	**L**	**T**	**P**	**C**
MC 303: ORGANIC CHEMISTRY - II	**3**	**0**	**0**	**3**

- **REACTION MECHANISM** **(08 Hours)**
  SN_1, SN_2, SN_i Mechanism, Nucleophilic substitution of an allylic halides. The Neighbouring group Mechanism, neighbouring group Participation by π- and σ- bonds, -OH,-NH_2,-COO, -halogen, RS and aromatic ring.

- **REACTIVE INTERMEDIATES** **(06 Hours)**
  Study of reaction intermediates, generation, stability and rate of Carbocations, Non-classical Carbocations, Carbanions, Carbenes, Nitrenes & arynes, Free radicals

- **STEREOCHEMISTRY** **(06 Hours)**
  Chirality, CIP nomenclature of more than one chiral center, Prochirality,erythro and E_2 nomenclatures, Methods of resolution, Stereospecific and stereoselective synthesis, Asymmetric synthesis, Optical activity in absence of chiral carbon (biphenyl, Allenes and spiranes), Chirality due to helical shape.

- **SPECTROSCOPY** **(08 Hours)**
  Ultraviolet & visible: Various electronic transitions, Lambert-Beer law, effect of solvent on electronic transition, Ultraviolet bands for carbonyl compound, Unsaturated carbonyl compounds, Fieser-woodward rules for conjugated dienes and carbonyl compounds, UV spectra of aromatic and heterocyclic compounds steric effect in biphenyls.
  Infrared spectroscopy: Instrumentation & sample handling, Characteristic Vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, carbonyl compounds (ketones, aldehydes, esters, amides, anhydrides, lactones, lactams etc), Effect of solvent and hydrogen bonding on vibrational frequencies, Overtones, IR of gaseous, solids and polymeric materials.

- **PHOTOCHEMISTRY** **(08 Hours)**
  Photochemistry of carbonyl compounds: Representation of excited states of ketones, Reactivity of electrically excited ketones , Photo reduction, Norrish type I & II reactions, Reactions of cyclic ketones, oxetane formation (paterno-buchi reaction)
  Photochemistry of olefins: Cis-Trans isomerisation, Demerisation reactions, Di-π methane rearrangement, Photochemistry of aromatic compounds and its isomerisation.

- **AMINO ACIDS, PEPTIDES, PROTEINS AND NUCLEIC ACID** **(06 Hours)**
  Classification, acid-base behaviour, Isoelectric point and electrophoresis. Structure and nomenclature of peptides and proteins, Determination of structure of peptide and group analysis, Classical peptide synthesis solid phase peptide synthesis, Structure at peptide and proteins, Classification and function of proteins, Denaturation of proteins, Nucleic acids- Introduction, Constituents, Ribo-nucleosides and ribocleotides, Structure of DNA.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Jerry March**, '*Advanced Organic Chemistry: Reactions, Mechanisms and Structures*', John Wiley & Sons, 4th Edn., 1992.
2. **Peter Sykes**, '*A guide Book to Mechanism in Organic Chemistry*', Longman, 6th Edn., 1986.
3. **Eliel E. L.**, '*Stereochemistry of Carbon Compounds*', Tata – McGraw Hill, 1962.
4. **Kalsi P. S.**, '*Organic Reactions, Stereochemistry and Mechanism*', New age International (p) Ltd., 4th Edn., 2006.
5. **Silverstein R. M., Bassler G. C. and Morrill T. C.**, '*Spectrometric Identification of Organic Compounds*', John Wiley, 1991.

Third year of Five Years integrated M. Sc.(Chemistry)

M. Sc. III, Semester - V	**L**	**T**	**P**	**C**
MC 305: INORGANIC CHEMISTRY-II	**3**	**0**	**0**	**3**

- **METALLO ORGANIC CHEMISTRY** **(07 Hours)**
  Introduction, General methods of preparations and properties, Organo metallic compounds of alkali metals, Organo metallic compounds of beryllium, Magnesium, aluminum, Metal olefin complexes, Cyclopentadienyl complexes: Metallocenes, Some properties of ferrocene, Structure and bonding in ferrocene molecule, Ionic cyclopentadienyl compounds.

- **BIOINORGANIC CHEMISTRY** **(07 Hours)**
  Introduction, The role of model systems, Metalloproteins and enzymes-Role of metal ions in the active sites, structure and functions of metalloproteins and enzymes containing Zn, Mg, Fe, Ca and Cu.

- **INORGANIC PHOTOCHEMISTRY** **(10 Hours)**
  Introduction of inorganic photochemistry, Photochemically excited states and excited state process for transition metal complexes, Photochemical reactions of co-ordination compounds (Cr & Ru complexes), Types of photochemical reactions in transition metal complexes-Substitution, Decomposition, Fragmentation, Rearrangement and Redox reactions, Applications of photochemical inorganic reactions in synthesis, Catalysis, Biological processes and in laser.

- **METALLURGICAL CHEMISTRY** **(06 Hours)**
  Minerals and ores, General principles of metallurgy, Ore dressing or concentration of ore, Calcination and roasting, Extraction of free metal. Refining or purification of metals, Furnaces.
  Metallurgy of Ag and Pb
  Ag – occurrence, extraction, Cupellation process, Carbon reduction process, Purification.
  Pb: Occurrence, Extraction, Properties, Uses, Alloys and compounds of lead.

- **LANTHANIDES** **(06 Hours)**
  Lanthanides: Characteristic properties. Electronic configurations and term symbols. Occurrence and extraction.
  .

- **ACTINIDES** **(06 Hours)**
  Actinides: Occurrence and general properties. Electronic configuration and term symbol. Oxidation state.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Cotton S. A.**, "*Lanthanides and Actinides*", Macmillan, 1991.
2. **Albert C., Geoffery W. and Paul L. G.**, '*Basic Inorganic Chemistry*', 3rd Edn., Wiley, New York, 1976.
3. **Wahid U. M., Tuli G. D. and Madan R. D.**, '*Selected Topics in Inorganic Chemistry*', 7th Edn., S. Chand & Company Publishers Ltd., 2001.
4. **Geoffrey G. L. and Wrighton M. S.**, '*Organometallic Photochemistry*' Acadamic Press, 1979.
5. **Lippard S. J. and Berg J. M.**, '*Principles of Bioinorganic Chemistry*' 1994.

Third year of Five Years integrated M. Sc.(Chemistry)

M. Sc. III, Semester-V	**L**	**T**	**P**	**C**
MC 307: COMPUTERS IN CHEMISTRY	**3**	**1**	**2**	**5**

- **INTRODUCTION TO COMPUTATIONAL SCIENCE** **(07 Hours)**
  Computational chemistry, Why computational chemistry, Advantages and disadvantages.

- **COMPUTERS IN CHEMISTRY** **(10 Hours)**
  Development of small computer codes involving simple formulae in chemistry, such as Vander Waals equation, P^H titration, Kinetics, Radioactive decay, Evaluation of Lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equations with the Huckel theory.

- **SYSTEM DYNAMICS IN CHEMISTRY** **(08 Hours)**
  QSAR (Quantitative structure activity relationship) and QSPR (Quantitative structure property relationship)

- **APPLICATIONS OF COMPUTATIONALCHEMISTRY** **(17 Hours)**
  Biochemical Applications of computers in Chemistry, Application of Computer graphics for simulation,Singles point energies, Electron densities, Electrostatic potentials, Modelling in solutions, Transition states, Choice of theoretical methods.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Raman K. V.**, '*Computer in chemistry'*, Tata McGraw Hill, 1987.
2. **David Y.**, '*Computational Chemistry-A Practical Guide for Applying Techniques to Real World Problems*', Wiley-Interscience, 2001.
3. **Frank J.**, '*An Introduction to Computational Chemistry*', John Wiley & Son Ltd., 1998.
4. **Andrew R. L.**, '*Molecular Modelling-Principles and Applications*', Prentice Hall, 2001. Alan Hincliffe, 'Modeling Molecular Structures', 2nd Edn., John Wiley & Sons, 2000.
5. **Hehre W. J., Shusterman A. J. and Huang W. W.**, '*A Laboratory Book of Computational Organic Chemistry'*, 1996.

Third year of Five Years integrated M.Sc (Chemistry)
M.Sc. - III, Semester –V

	L	T	P	C
MC 309 : CHEMISTRY LAB-I	**0**	**0**	**10**	**5**

This course comprises of few laboratory experiments related to the theory courses.

Third year of Five Years integrated M. Sc.(Chemistry)
M. Sc. III, Semester - VI **L T P C**

MC 302: PHYSICAL CHEMISTRY - III **3 0 0 3**

- **SURFACE CHEMISTRY** **(08 Hours)**
  Adsorption from solutions on solids. Langumuir and classical isotherms. Chemisorption-differences with physical adsorption. Adsorpiton isotherms. Adsorption with dissociation. Adsorption with interaction between adsorbate molecules. Measurement of surface area of solids: Harkins-Jura absolute method, entropy method, and the point B method. Use of Langmuir, BET and Harkins-Jura isotherms for surface area determination.

- **ELECTRO CHEMISTRY** **(10 Hours)**
  Different types of elctrodes. Electrochemical cells. Concentration cell and activity coefficient determination. Origin of electrode potential. Liquid junction potential. Evaluation of thermodynamic proeprties. The electrode double layer: Electrode-electrolyte interface. Theory of multiple layer capacity. Electrocapillary. Lippmann potential. Membrane potential. Elecrokinetic phenomena. Mechanism of charge transfer at electrode-electrolyte interface. Electrolysis. Current-potential curves. Dissolution, deposition and decomposition potentials. Energy barriers at metal-electrolyte interface. Different types of over potentials. Butter-Volmer equation. Tafel and Nernst equation. Rate determining step in electrode kinetics. The hydrogen over voltage. The oxygen over voltage. Theories of over voltage.

- **COLLOIDAL CHEMISTRY** **(08 Hours)**
  Donnan membrane equilibrium, Lyophobic and lyophilic sol, Size range, preparation and properties of colloidal solution, Dialysis, electrodialysis, Ultrafiltration, Ultramicroscope, Charge on colloidal particles, Coagulation of colloidal solution, Flocullation values, Determination of size and colloidal particles, Importance and applications of colloids.

- **NUCLEAR CHEMISTRY** **(08 Hours)**
  Nuclear structure, mass and charge. Nuclear moments. Binding energy. Semiemperical mass equation. Stability rules. Magic numbers. Nuclear models: Shell, Liquid drop, Fermi gas, Collective and Optical models. Equation of radioactive decay and growth.
  Nuclear reactions: Energetic of nuclear reactions. Types of nuclear reactions. Spontaneous and reduced fission. Neutrons capture cross section and critical size. Principles of working of the reactors of nuclear power plants. Applications of radioactivity.

- **MATERIAL CHEMISTRY (NANOCHEMISTRY)** **(08 Hours)**
  Introduction-Definition of nanoscale materials, Different types , Different physical and chemical synthetic routes, characterization of nanoscale materials by modern instrumental techniques, ***Physical and chemical properties of nanoscale materials-***Electrical properties, Magnetic properties, optical extinction properties, unique optical signatures of various nanostructures, fluorescence chemical reactivity, self assembly of various nanostructures and its importance, ***Nanoscale materials in emerging technology-***Useful properties that can be exploited for applications, Applications in the areas such as adsorption, drug delivery, environmental remediation.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Klabunde K. J.**, '*Nanoscale Materials in Chemistry*', Wiley-Interscience, 2001.
2. **Atkins P.W.**, '*Physical Chemistry*', ELBS and Oxford University Press, Oxford, 1994.
3. **Glasstone S.**, '*Introduction to Electrochemistry*', Affiliated East-West Press, 1968.
4. **MacInnes D. A.**, '*The Principles of Electrochemistry*', Dover Publishers, 1961.
5. **Arnikar H. J.**, *Essential of Nuclear Chemistry*, 4th Edn., 1995.

Third year of Five Years integrated M. Sc.(Chemistry)

M.Sc. III, Semester VI	**L**	**T**	**P**	**C**
MC 304: ORGANIC CHEMISTRY-III	**3**	**1**	**0**	**4**

- **ELIMINATION REACTIONS** **(08 Hours)**
  (a). The E_1, E_2 and E_1CB mechanism and their spectrum orientation of the double bond, Reactivity effects of substrate structures, Attacking base, Leaving groups & the medium, Mechanism and orientation in pyrolytic elimination.
  (b). Aromatic nucleophilic substitution, Addition elimination type reaction, reactions of diazonium compounds, the Von-Richter and Sommlet-Houser rearrangement.

- **PERICYCLIC REACTIONS** **(10 Hours)**
  Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1,3,5-hexatriene. Classification of pericyclic reactions, Woodward Hoffman correlation diagrams, FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, 4n and 4n+2 systems, Cycloadditions-antrafacial & suprafacial additions in 4n & 4n+2 systems. Sigmatropic rearrangements-suprafacial and antrafacial shifts of H.

- **AROMATIC ELECTROPHILIC SUBSTITUTION** **(06 Hours)**
  The arenium ion mechanism, Orientation and reactivity, Energy profile diagrams, Ortho and para ratio, Ipso effect, Orientation in other ring systems, Quantitative treatment of reactivity in substrates & electrophiles, General solvent effect, Introduction of azide, phosphorus & sulphur nucleophiles.

- **NATURE OF BONDING IN ORGANIC MOLECULES & AROMATICITY** **(06 Hours)**
  Delocalised chemical bonding-conjugation, Cross conjugation, Resonance and hyper conjugation. Aromaticity and aromatic character, Huckel's rule, Frost circle diagram for cyclobutadiene & benzene, Aromatic character based on NMR, Energy level of л molecular orbitals, Huckels molecular orbital method, Annulenes, Anti aromaticity and Homoaromaticity.

- **MASS SPECTROSCOPY** **(06 Hours)**
  Introduction, Ion production- EI , CL, FD and FAB, Factors affecting fragmentation of organic compounds , Mass spectral fragmentation of organic compounds, Common functional groups, Molecular ion peak, Meta stable peak, Mclafferty rearrangement, Nitrogen rule, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

- **REAGENTS IN SYNTHESIS** **(06 Hours)**
  Mechanism of action, selectivity and utility of following reagents
  Selenium dioxide, Aluminium isopropoxide, Diazomethane, Lead tetra acetate, Sodamide, N-Bromo-succinimide, Lithium aluminium hydride, Osmium tetraoxide, Raney nickel, Sodium borohydride, , Manganese dioxide, Lithium diisopropylamide (LDA), DCC, ,DDQ, HIO_4.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Mukherji S. M. and Singh S. P.**, '*Reaction mechanism in Organic Chemistry*', Mc.Millan India Ltd., 3rd Edn., 1984.
2. **Carey F. A. and Sandberg R. J.**, '*Advanced Organic Chemistry*', Springer, 5th Edn., 2007.
3. **Hoffman R. V.**, '*Organic Chemistry*' Oxford University Press, 1997.
4. **Norman R. C. and Coxon J. M.**, '*Principles of Organic Synthesis*', Chapman and Hill, 3rd Edn., 1993.
5. **Carey F. A.**, '*Organic Chemistry*', Mc-Graw Hill, 2006.

Third year of Five Years integrated M. Sc.(Chemistry)

M.Sc. III, Semester-VI	**L**	**T**	**P**	**C**
MC 306: INORGANIC CHEMISTRY-III	**3**	**1**	**0**	**4**

- **METALLO ORGANIC CHEMISTRY** **(08 Hours)**
  Organometallic compounds-Metal alkyls, Metal aryls, Electron deficient organometallic compounds, electron rich organometallics, Metal hydrogen and metal halogen exchange reactions, Transmetallation reactions, Important reactions of Grignard reagent.

- **BIOINORGANIC CHEMISTRY** **(07 Hours)**
  Bioinorganic chemistry of Zn-Catalytic and structural zinc sites in proteins, Carbonic anhydrase, Carboxypeptidase, Zinc finger proteins.
  Bioinorganic chemistry of copper-Electron transfer proteins, Dioxygen transport and metabolism, Plastocyanin, haemocyanin, Ascorbate oxidase.
  Bioinorganic chemistry of other metals- Mg, Fe and Ca.

- **INORGANIC PHOTOCHEMISTRY**. **(08 Hours)**
  Electronic transitions in Metal complexes, Metal-centered and charge-transfer transitions –Various photophysical and photochemical processes of coordination compounds–Unimolecular charge-transfer photochemistry of Cobalt(III) complexes.
  Mechanism of CTTM photoreduction. Ligand-field photochemistry of chromium(III) complexes, Adamson's rules, Photoactive excited states, V-C model – photophysics and photochemistry of Ruthenium-polypyridine complexes, Emission and redox properties –photochemistry of organometallic compounds, Metal carbonyl compounds, Compounds with metal-metal bonding. Reinecke's salt chemical actinometer.

- **METALLURGICAL CHEMISTRY** **(07 Hours)**
  Metallurgy of Fe, Ni, Cu, Ag, Pb and U
  Ni – Ores, extraction, Crushing and concentration of the ore, Production of Ni by Orford's process and Mond's process.
  Cu – Ores, Extraction, dressing of the ore. Roasting, treatment of matte for copper by Bessemerisation, Refining or purification by electrolytic refining.
  Fe – Occurrence, cast iron, wrought iron, steel – Bessemer process and open-hearth process.
  U – Occurrence, extraction: Cupellation process, Amalgamation process, alkali digestion process. From carnotite ore, Properties, Compounds of uranium–uranium hexafluoride – UF6.

- **LANTHANIDES** **(06 Hours)**
  Separation techniques, Oxidation states, Spectral and magnetic properties, Shapes of f - orbitals and their splitting in cubic ligand field, Applications of lanthanide compounds.

- **ACTINIDES** **(06 Hours)**
  Separation techniques, Spectral and magnetic properties, Trans-uranium elements and their stabilities, Applications of actinide compounds.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Bochmann M.**, '*Oxford Premier Series, on Organometallics*' Vol.1 & 2, Oxford Press, 2002.
2. **Ferraudi G. J**., "*Elements of Inorganic Photochemistry*", Wiley, New York, 1988.
3. **Simon Cotton**, "*Lanthanides and Actinides Chemistry"*, John Wiley & sons, 2006.
4. **Lippard S. J. and Berg J. M.**, '*Principles of Bioinorganic Chemistry*' 1994.
5. **Wahid U. M., Tuli G. D. and Madan R. D.**, '*Selected Topics in Inorganic Chemistry*', 7th Edn., S. Chand & Company Publishers Ltd., 2001.

Third year of Five Years integrated M. Sc.(Chemistry)

M.Sc. III Semester-VI	**L**	**T**	**P**	**C**
MH 352: ECONOMICS & BUSINESS MANAGEMENT	**3**	**1**	**0**	**4**

- **ECONOMICS** **(12 Hours)**
  Introduction To Economics, Micro & Macro Economics, Applications & Scopes of Economics, Demand Analysis, Demand Forecasting, Factors of Production, Types of Cost, Market Structures, Break Even Analysis, Concept of Supply, National Income

- **MANAGEMENT** **(16 Hours)**
  Introduction To Management, Features Of Management, Nature of Management, Development Of Management Thoughts – Scientific Management By Taylor & Contribution of Henry Fayol, Coordination & Functions of Management, Centralization & Decentralization, Decision Making
  Fundamentals of Planning
  Objectives & MBO
  Types of Business Organizations: Private Sector, Public Sector & Joint Sector
  Organizational Behavior: Theories of Motivation, Individual & Group Behavior, Perception, Value, Attitude, Leadership

- **FUNCTIONAL MANAGEMENT** **(12 Hours)**
  Marketing Management: Core Concepts of Marketing, Marketing Mix (4p), Segmentation – Targeting – Positioning, Marketing Research, Marketing Information System, Concept Of International Marketing, Difference Between Domestic Marketing & International Marketing
  Personnel Management: Roles & Functions of Personnel Manager, Recruitment, Selection, Training
  Financial Management: Goal of Financial Management, Key Activities In Financial Management, Organization of Financial Management, Financial Institutions, Financial Instruments, Sources Of Finance
  Operations Management: Introduction to Operations Management, Types of Operation Systems, Types of Layouts, Material Handling, Purchasing & Store System, Inventory Management

- **MODERN MANAGEMENT ASPECTS** **(05 Hours)**
  Introduction To ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc.

(Total Contact Time (Theory): 45 Hours)

BOOKS RECOMMENDED:

1. **Prasad L.M.,** '*Principles & Practice Of Management'*, Sultan Chand & Sons, 1994
2. **Banga T. R. & Shrama S.C**., '*Industrial Organisation & Engineering Economics'*, Khanna Publishers, 1995
3. **Robbins S***., 'Organizational Behavior'* , Phi (Pearson), 1998
4. **Kotler P., Keller, Koshi & Jha,** '*Marketing Management'* – A South Asian Perspective, Pearson, 2007
5. **Aswathapa K., ''***Human Resource and Personnel Management'*, Tata McGraw Hill, 2001

Third year of Five Years integrated M.Sc (Chemistry)

M.Sc. - III, Semester –VI	**L**	**T**	**P**	**C**
MC 308 : CHEMISTRY LAB-II	**0**	**0**	**12**	**6**

This course comprises of few laboratory experiments related to the theory courses.

Fourth Year of Five Years integrated M. Sc.(Chemistry)
M. Sc.-IV, Semester-VII

Sr. No.	Course	Code	Teaching Scheme Hours per Week			Credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW /Viva Pract	
1	Advanced Physical Chemistry-I	MC 401	3	1	4	6	100	25	50	175
2	Advanced Organic Chemistry –I	MC 403	3	0	4	5	100	--	50	150
3	Advanced Inorganic Chemistry-I	MC 405	3	0	4	5	100	--	50	150
4	**# Elective-I***	***MC 4XX**	3	0	6	6	100	--	50	150
			12	1	18		400	25	200	625
Total Contact hrs per week =31				**Total Credit = 22**						**Total Marks=625**

‘Elective-I (MC4XX): MC 407, MC 409, MC 411

S. No.	Code	Course
1	MC 407	Basic separation methods and chromatography
2	MC 409	Corrosion Science and Technology
3	MC 411	Chemical Process Industries

♯ The student who opt for any one elective paper has to opt in future from the relevant special papers in Electives -II, -III & -IV.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester VII	**L**	**T**	**P**	**C**
MC 401 : Advanced Physical Chemistry-I	**3**	**1**	**4**	**6**

- **KINETIC MOLECULAR THEORY OF GASES** **(08 Hours)**

  Kinetic molecular gas model, pressure of gas, molecular velocities, kinetic energy and temperature, limitations of kinetic theory, Molecular energies and molecular speed, degree of freedom, Distribution of molecular velocities, Mean free path, Collision diameter and collision number, Kinetic theory of gas viscosity, Theory of non-ideal behaviour, van der Waals equation of state, Condensation of gases and critical points, Law of corresponding states, van der waals equation and critical points, van der Waals equation- law of corresponding states.

- **THERMODYNAMICS** **(09 Hours)**

  Brief concept of laws of thermodynamics, entropy, variables of system, Third law of thermodynamics, Evaluation of absolute entropy, free energy and equilibrium, Fugacity and activity concept, standard state of gas, solid and liquid, Standard free energy of formation, Criteria for equilibrium, Relation between free energy and equilibrium constant, Vapour pressure of liquids and its variation with temperature.

- **STATISTICALTHERMODYNAMICS** **(08 Hours)**

  Limitations of classical thermodynamics, Distribution laws, Boltzmann distribution law, Bose-Einstein distribution law and Fermi-Dirac distribution law, limitation of applicability of various distribution laws, Partition function and its significance, Translational, rotational, vibrational, and electronic partition functions and their evaluation, Relation between partition and their thermodynamic function, average internal energy, heat capacity, Helmholtz free energy and entropy of mono and diatomic molecules, Sekur-Tetrode equation. Numerical problems

- **SOLUTION: THERMODYNAMIC TREATMENT** **(08 Hours)**

  Types of solutions, Ideal and non ideal solutions, The thermodynamic properties of ideal solutions, Molecular interpretation of the entropy of mixing, Vapour pressure and thermodynamics of non-ideal systems, general considerations (mixing and excess functions), Solvents of non-ideal solutions, the activity and activity coefficients, solutes of non-ideal solutions, The Gibbs-Duhem equation and determination of solute activity, Partial molal quantities, Partial and apparent molar properties (chemical potential, enthalpy and volume), Methods for their determinations.

- **THEORIES OF REACTION RATES** **(09 Hours)**

  Temperature dependence and the Arrhenius theory of reaction rates, Collision theory of bi-molecular gaseous reaction, collision and the steric effects, limitations, The transition-state theory, statistical mechanical approach to the transition state theory, derivation of rate equation, Thermodynamic formulation of transition state theory, Unimolecular gas reactions: Lindeman-Christiansen hypothesis, the Hinshelwood's theory, Rice-Ramsperger-Kassel theory.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

6. **Atkins P. and Paula J.** *'Physical Chemistry'* oxford, students edition 2006.
7. **Barrow G.M.**, *'Physical Chemistry'*, Tata Mc Graw Hill Elsevier, 2004.
8. **Glasstone S.**, '*Thermodynamics for Chemists* ', Narhari Press, 2007.
9. **Gupta M. C.**, '*Statastical Thermodynamics'* New Age International (p) Limited, 2008.
10. **Laidler K.J. '***Chemical kinetics',* Dorling Kindersley (india) Pvt Ltd, 2008.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester VII	**L**	**T**	**P**	**C**
MC 403: Advanced Organic Chemistry-I	**3**	**0**	**4**	**5**

- **ASYMMETRIC SYNTHESIS** **(12 Hours)**
  Stereochemistry of larger rings ,fused and bridged rings, Synthesis of Taxol, asymmetric epoxidation ,dihydroxylations and other reactions, metathesis reactions .

- **ADDITION TO CARBON-CARBON MUTIPLE BONDS** **(12 Hours)**
  Mechanistic and stereochemical aspects of additon reactions involving electrophiles, nuclophiles and free radicals, regio- and chemoselectivity, orientation and reactivity, addtion to cyclopropane ring, hydrogenation of double and triple bonds, hyrogenation of aromatic rings, hydroboration, Michael reaction, sharpless asymmetric epoxidation, ene reaction.
  ADDITION TO CARBON- HETERO MULTIPLE BONDS
  Addition of organozinc and organolithiumreagents to carbonyl and unsaturated carbonyl compounds. Mechanism of considensation reactions involving enolates- Knoevenagel, Mannich and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

- **FREE RADICAL REACTIONS** **(07 Hours)**
  Generation of free radicals - thermolysis, photolysis, redox methods, abstraction, addition and fragmentation; Detection of radicals- ESR, CIDNP, Chemical methods; Types of free radical reactions- Radical coupling, Displacement (abstraction, transfer) reactions, Addition to ð-systems, Fragmentation of radicals, Radical rearrangements, Electron transfer catalysis; Factors influencing radical reactivities- Radical stability, Polar influences, Solvent and Steric effects on radical reactions."

- **REMODELLING OF A CARBON SKELETON** **(08 Hours)**
  Cleavage of C-C Bonds. Decarboxylation, Baeyer-Villiger Oxidation, and 1,2-Diol Cleavage in a Total Synthesis, Synthetic Utilization of the Double Bond Cleavage Reactions, Rearrangements of the Carbon Skeleton. Specific Features and Synthetic Benefits, Claisen-Johnson-Ireland and Oxy-Cope Rearrangements, Transformations of Small Ring Fragments and their Role in a Total Synthesis. Wagner-Meerwein Rearrangement, Fragmentation, Favorskii Rearrangement.

- **PROTECTING GROUPS** **(03 Hours)**
  Protection and deprotection methodology for alcohol, amine, carbonyl and carboxyl groups. Few synthetic applications in peptide synthesis, biology and medicines.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Carey F.**, '*Organic Chemistry*', Tata McGraw Hill, 2007.
2. **Isaacs. S. N.**, *'Physical Organic Chemistry',* ELBS, 1990.
3. **Jerry March**, '*Advanced Organic Chemistry: Reactions, Mechanisms and Structures*', John Wiley & Sons, 4th Edn., 1992.
4. **Reinhard B.**, '*Advance Organic Chemistry: Reaction Mechanisms*', Elsevier, 2002.
5. **Eliel E. L.**, '*Stereochemistry of Organic Compounds*', Mc Graw Hill, 1962.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M. Sc IV, Semester – VII	**L**	**T**	**P**	**C**
MC 405: Advanced Inorganic Chemistry – I	**3**	**0**	**4**	**5**

- **SYMMETRY AND GROUP THEORY** **(09 Hours)**

  Symmetry elements, symmetry operations and point group of molecules. Representation of symmetry operations as matrices, definition of groups, sets of symmetry operations of molecules satisfying the conditions of a group, generators. Classes of operations, reducible and irreducible representations, derivation of character table – C_{2v} point group. applications of group theory to atomic orbitals and spectroscopy.

- **ORGANO METALLIC COMPOUNDS** **(05 Hours)**

  Classification based on the nature of metal carbon bond, including л – metal complexes; Bonding in ferrocene, Reactions of ferrocene.

- **METAL CLUSTERS** **(06 Hours)**

  Metal clusters, carbonyl clusters, low nuclearity carbonyl clusters, high nuclearity carbonyl clusters, electron counting scheme for HNCCS, Wade's rules, halide type clusters, chevrel phases, Zintlions (naked clusters)

- **SPECTRA OF TRANSITION METAL COMPLEXES** **(12 Hours)**

  The energy terms, coupling schemes, spin-spin coupling, orbital coupling, spin orbital coupling, Russel Saunders coupling scheme, J-J coupling scheme, Effect of V_{oct} and V_{tet} on terms, Basic concepts of electron absorption spectroscopy, selection rules, relaxation of selection rules, Orgel diagrams, Application of Orgel diagrams to electronic spectra of transition metal complexes, Charge transfer spectra, electronic absorption spectra of spin paired complexes, Jahn Tellar effect and electronic spectra of complexes.

- **REACTION MECHANISM IN COMPLEXES** **(10 Hours)**

  Substitution reactions in octahedral and square planar complexes, Reaction mechanism of ligand substitution reactions in octahedral complexes: SN_1 (D-process), SN_2 (A-process), lability and inertness of octahedral complexes, solvent intervention, ion pair formation, conjugate base formation SN_1CB. Solvolysis reactions: acid and base hydrolysis, Redox (single electrode transfer) reactions. Trans effect, theories of Trans effect;
  Factors affecting structure of complexes, Chelates and macrocyclic effects, determination of stability constant by various methods.

Total contact Time:

(42Hours)

BOOKS RECOMMENDED:

1. **Banwell C. N., McCash C M,** *Fundamentals of molecular spectroscopy,* 4th edn, TMH, 2008.Group theory and its chemical applications, 2003.
2. **Bhattacharya P. K.,** *'Group Theory and its Chemicals Applications',* 6th Edn., Himalaya Pubs., 2007.
3. **Cotton F. A., Wilkinson G., Murlio C. A., Bochmann M.**, '*Advanced Inorganic Chemistry'* John Wiley & Sons (ASIA) PTE Ltd., 6th Edn, 2003.
4. **Lippard S. J., Berg J. M.**, *'Principles of Bio Inorganic Chemistry*', University Science Books, 1994.
5. **Puri B. R., Sharma L.R., and Kalia K. C.**, *'Principles of Inorganic Chemistry'*, 30th Edn., Milestones, 2008.

M. Sc. IV Semester - VII	L	T	P	C
MC 407: BASIC SEPARATION METHODS AND CHROMATOGRAPHY	**3**	**0**	**6**	**6**

- **BASIC TOOLS OF ANALYTICAL CHEMISTRY** **(6 Hours)**
  Fundamental units of measure - significant figures units for expressing concentration(molarity and formality, normality, molality, weight, volume, and weight-to-volume ratios - converting between concentration units - p-functions - stoichiometric calculations (conservation of mass, conservation of charge, conservation of protons, conservation of electron pairs - conservation of electrons - using conservation principles in stoichiometry) - basic equipment and instrumentation (instrumentation for measuring mass - equipment for measuring volume - equipment for drying samples) preparing solutions (preparing stock solutions, preparing solutions by dilution) accuracy – precision – sensitivity – selectivity - sobustness and ruggedness - scale of operation
- **STATISTICS IN CHEMICAL ANALYSIS** **(4 Hours)**
  Methods of sampling and associated errors, classification of errors, propagation of errors, treatment of errors, normal distribution, test of significance and confidence limits – F-test and T-test.
- **SEPARATION TECHNIQUES** **(4 Hours)**
  Solvent extraction techniques – conventional, liquid membranes – bulk, supported and emulsified, solid phase extraction (SPE) - Ion-exchange – conventional membranes
- **CHROMATOGRAPHY** **(6 Hours)**
  General description of chromatography – migration rates of solutes – zone broadening and column efficiency – optimization of column performance – Covat retention index – plate theory – rate theory – Van-Demter equation – resolution, Chromatographic Resolution, Capacity Factor, Column Selectivity, Column Efficiency, Peak Capacity, Nonideal Behavior Optimizing Chromatographic Separations (Using the Capacity Factor to Optimize Resolution, Using Column Selectivity to Optimize Resolution, Using Column Efficiency to Optimize Resolution)
- **GAS CHROMATOGRAPHY** **(4 Hours)**
  Gas chromatography – principle of gas chromatography – different types of gas chromatography – mobile phase – stationary phase – sample introduction system – columns – difference between GSC and GLC – criteria in selecting liquid stationary phase – capillary columns – applications and limitations of gas chromatography.
- **LIQUID CHROMATOGRAPHY** **(4 Hours)**
  Principle of liquid chromatography – different types of liquid chromatography. Instrumentation (HPLC Columns, Stationary Phases, Mobile Phases, HPLC Pumps, Sample Introduction System ,Detectors for HPLC), Quantitative Applications, Representative Method.

- **ION-EXCHANGE CHROMATOGRAPHY** **(8 Hours)**
  Introduction – principle – resins - swelling of resins - capacity of resin - effect of different parameters on exchange behaviour - techniques of IEC - suppressor column
  Size-exclusion chromatography theory and applications - supercritical fluid chromatography theory and applications
  ELECTROPHORESIS
  Introduction – migration rates and plate hights in CE – electroosmotic flow - various types of electrophoresis - instrumentation – detectors – microchip electrophoresis – CE-MS - applications.
- **GC-MS and LC-MS** **(6 Hours)**
  GC-MS: Introduction - Waston-Biemann separator, Ryhage Separator, Llewellyn Separator, Instrumentation, Applications
  LC-MS: LC/MS interfaces solvent removal and ionization - atmospheric-pressure interfaces - electrospray Interface - ion spray interface - secondary detectors. LC/MS Overview HPLC and the ionization source - vacuum pumps - analyzer and ion detector designs - data and control systems - peak detection, ID, and quantification.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **David Harvey, '***Modern Analytical Chemistry'***,** McGraw Hill Publication, 2000.
2. **J. M. Miller**, '*Chromatography Concepts and Contrasts*', Wiley-Interscience, 2001.
3. **D. A. Skoog, F. J. Holler, T. A. Nieman, '***Principles of Instrumental Analysi's', 5th Edn.,* Brooks, 2006.
4. **R. L. Grobe, '***Modern Practice of Gas Chromatography*', 4th Edd., *John Wiley Intersceince*, 2004.
5. **M.C.Mcmaster, '***GC/MS: A Practical User's Guide', John Wiley and Sons Inc*., 2008.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV, Semester -VII	**L**	**T**	**P**	**C**
MC 409: CORROSION SCIENCE AND TECHNOLOGY	**3**	**0**	**6**	**6**

- **CORROSION SCIENCE AND TECHNOLOGY** **(04 Hours)**
  Corrosion science, cost of corrosion, corrosion engineering, environments, corrosion damage, classification of corrosion, future outlook.

- **MIXED POTENTIAL THEORY OF CORROSION AND ITS APPLICATIONS** **(10 Hours)**
  Free energy, cell potentials, EMF and galvanic series, exchange current density, activation, concentration and combined polarizations, mixed potential theory, mixed electrodes, passivity, mechanism of the growth and break-down of passive film, predicting corrosion behavior, effect of oxidizers and velocity, galvanic coupling, alloy evaluation, corrosion prevention by anodic protection, noble metal alloying, corrosion rate measurements by Tafel extrapolation and linear polarization methods.

- **CORROSION PRINCIPLES** **(09 Hours)**
  Corrosion rate expressions, electrochemical aspects-electrochemical reactions, polarization, passivity, environmental effects- effect of oxygen and oxidizers, effects of velocity, effect of temperature, effects of corrosive concentration, effect of galvanic coupling, metallurgical and other aspects- metallic properties, economic considerations, importance of inspection, new instrumentation.

- **FORMS OF CORROSION** **(20 Hours)**
  Uniform and localized attacks, galvanic cell and galvanic (two-metal) corrosion- environmental effects, distance effect, area effect, prevention and beneficial applications. concentration cell and crevice corrosion-environmental factors, mechanism, combating crevice corrosion, filiform corrosion. pitting corrosion- pit shape and growth, autocatalytic nature of pitting, solution composition, velocity, metallurgical variables, evaluation of pitting damage, prevention. intergranular corrosion- in austenitic stainless steels, weld decay, control of corrosion in austenitic stainless steels, knife-line attack, intergranular corrosion of other alloys, Selective leaching, dezincification: characteristics, mechanism, prevention, graphitization, other alloy systems, high temperatures, erosion corrosion-surface films, velocity, turbulence, impingement, galvanic effect, nature of metal or alloy, prevention, cavitation damage, fretting corrosion, stress corrosion-crack morphology, stress effects, time to cracking, environmental and metallurgical factors, mechanism, multienvironment charts, prevention, corrosion fatigue, hydrogen damage- characteristics, environmental factors, hydrogen blistering, hydrogen embrittlement, prevention.

(Total contact Time: 43 Hours)

BOOKS RECOMMENDED:

1. **Atkinson J T N and Van Droffelaar H.**, '*Corrosion and its Control: An Introduction to the Subject'* NACE, Houston, TX. 1982.
2. **Fontana Mars G.,** *'Corrosion Engineering'*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
3. **Scully J C.**, *'The Fundamentals of Corrosion',* 3rd ed, Pergamon Press, Oxford, UK,1990.
4. **Trethewey K R and Chamberlain J.**, '*Corrosion for students of science and engineering',* Longman Scientific and Technical, Harlow, UK, 1988.
5. **Uhlig H H and Revie R W,** *'Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering',* 3rd ed., John Wiley, New York,1985.

Fourth year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester-VII	**L**	**T**	**P**	**C**
MC 411: CHEMICAL PROCESS INDUSTRIES	**3**	**0**	**6**	**6**

- **NITROGEN INDUSTRY** **(07 Hours)**
  Manufacture of synthetic nitrogen products and miscellaneous chemicals such as ammonia, hydro amine, iodine, fluorine, fluorocarbon and various types of nitrogenous fertilizers such as urea, ammonium sulphate, ammonium nitrate, calcium ammonium nitrate.
- **CHLOR-ALKALI INDUSTRY & INDUSTRIAL GASES** **(07 Hours)**
  Manufacture of Chlor-alkali chemicals, caustic soda by membrane cell method and by lime soda process, soda ash, sodium hypochlorite and chlorine.
  Industrial Gases – Hydrogen, Oxygen, Nitrogen, Carbon dioxide, Sulphur dioxide.
- **ELECTROCHEMICAL-THERMAL INDUSTRY** **(07 Hours)**
  Manufacturing of silicon carbide, calcium carbide, boron carbide, boron nitride, synthetic graphite, carbon electrode, magnesium anhydrous, $MgCl_2$, MgO, hydrogen peroxide, potassium permanganate, hydroxyl amine.
- **FERMENTATION INDUSTRY** **(07 Hours)**
  Fermentation-culture development, inoculums preparation, nutrients for micro organism, toxic effects on culture, manufacture of industrial alcohol, absolute alcohol, vinegar, downstream processing.
- **AGROCHEMICAL & PESTICIDES** **(07 Hours)**
  Manufacture of phosphorus, phosphoric acid, ammonium phosphate, super phosphate. Introduction to Agrochemical and pesticides.
- **QUALITY CONTROL & SAFETY HAZARDOUS** **(07 Hours)**
  Quality control of products, concept of quality, important of quality, quality decision, quality management, quality cost, quality assurance, reliability, economics of manufacturing, costing, social and human values, ISO 9001: 2000.
  Industrial hazards and safety considerations in chemical industries, mechanical, electrical and chemical hazards, fire and explosion hazards, health hazards, laboratory safety, control of plant hazards, safety practice.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Chunawalla S. A. and Dr. Patel,** *"Products of Operation management"* Himalaya Publishing House.
2. **George T. A.,** *"Shreve's Chemical Process Industries"* McGraw- Hill international editions, 5th Ed, 1985.
3. **James A. Kent**, "*Riegel's Hand Book of Industrial Chemistry"* CBS Publishers & Distributors – New Delhi, 6th Ed., 1986.
4. **Sharma B. K.,** *"Industrial Chemistry"* Krishna Prakashan Media (P) Ltd., Meerut, 2001.
5. **Srivastava M. L.,** *"Fermentation Technology",* Narosa Publisher.

Fourth Year of Five Years integrated M. Sc.(Chemistry)
M. Sc.-IV, Semester-VIII

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW /Viva Pract	
1	Advanced Physical Chemistry–II	MC 402	3	1	4	6	100	25	50	175
2	Advanced Organic Chemistry –II	MC 404	3	0	4	5	100	--	50	150
3	Advanced Inorganic Chemistry–II	MC 406	3	1	4	6	100	25	50	175
4	***Elective –II**	***MC 4YY**	3	0	6	6	100	--	50	150
			12	2	18		400	50	200	650
Total Contact hrs per week =32			**Total Credit = 23**							**Total Marks=650**

***Elective-II (MC4YY): MC 408, MC 412, MC 414**

Sr.	Code	Course
1	MC 408	Spectroscopic Methods-I
2	MC 412	Corrosion of Materials and Corrosion Testing
3	MC 414	Unit Processes

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester VIII	**L**	**T**	**P**	**C**
MC 402 : Advanced Physical Chemistry-II	**3**	**1**	**4**	**6**

- **POLYMER SOLUTION I** **(08 Hours)**
  Specific properties of true solution, Dissolution and swelling of polymer, degree and kinetics of swelling, Polyelectrolyte solution, factors affecting dissolution and swelling, Application of phase rule to polymer solution, UCST, LCST, Fractionation of polymers, Interaction in polymer solution, Association and structure formation, Resistance of polymeric material to solvent.

- **POLYMER SOLUTION II** **(07 Hours)**
  Thermodynamics of polymer solutions, Thermodynamic criteria of polymer solubility, Integral heat of solution and dilution, Entropy of mixing, Thermodynamics of solution and polymer structure, Estimation of chain flexibility, packing density, Regular solution, Flory-Huggins theory, Theory of dilute polymer solution.

- **FAST REACTIONS** **(07 Hours)**
  Experimental techniques for fast reactions: Flow methods, Relaxation methods, Pulse methods, Flash photolysis, Pulse radiolysis, Intermittant photolysis, Pulsed laser, Shock tube method, Fast flow dishcharge tube mehod, Molecular beam methods, Life-time methods

- **MOLECULAR INTERACTIONS** **(06 Hours)**

  Electric dipole moments, polarizability, relative permittivity, Interactions between dipoles, Repulsive and total interactions, Impact on medicine: molecular reorganization and drug design, Molecular interactions in gases, The liquid-vapor interface

- **INVESTIGATION OF MOLECULAR SRUCTURE** **(07 Hours)**
  Molar refraction, polarizability, dipole moment, molecular structure and dipole moment, Molecular spectra, rotational spectra, micro wave spectra, vibrational-rotational spectra, electronic spectra, Raman spectra, Magnetic properties of substance, diamagnetic, paramagnetic, paramagnetisum and unpaired electron, ortho and para state of molecule.

- **BIOPHYSICAL CHEMISTRY** **(07 Hours)**
  Configuration and conformation of biomolecules(Protein, Haemoglobin, Enzymes, DNA, Chromomycin), Acid base properties of amino acids and peptides, Molecular interaction between and within the biomolecules, mechanism and interactions, mechanism of enzyme catalysed reactions .

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Atkins P. and Paula J.** *'Physical Chemistry'* Oxford, students edition 2006.
2. **Barrow G.M. .**, 'Physical *Chemistry*', Tata Mc Graw Hill Elsevier, 2004.
3. **Donald Voet, Judith Voet** *'Bio chemistry* '**.**Wiley&Sons, 3rd ed**.** 2004.
4. **Laidler K.J. '***Chemical kinetics',* Dorling Kindersley (india) Pvt Ltd, 2008.
5. **Tager A. '***Physical chemistry of polymers'*, MIr Publishing House, Moscow, 1972.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester VIII	**L**	**T**	**P**	**C**
MC 404: Advanced Organic Chemistry-II	**3**	**0**	**4**	**5**

- **NATURAL PRODUCT CHEMISTRY** **(10 Hours)**
  Primary and Secondary metabolites, General methods of isolation of natural products, Structure elucidation of Natural Products. Biogenesis and biosynthesis of natural products.

- **TERPENOIDS** **(8 hours)**
  Classification, occurrence, isoprene rule, structure, stereochemistry, biosynthesis and synthesis of representative molecules: Citral, Geraniol, α-Terpeneol, Menthol, Vitamin A, D and E.

- **ALKALOIDS** **(8 hours)**
  Structure, stereochemistry, biosynthesis and synthesis of representative molecules: Nicotine, Quinine and Morphine.

- **DRUGS** **(10 Hours)**
  Drug discovery and drug diversity, Classification of drugs, Chemistry of Sulfa drugs, Antipyretics and analgesics, Antibiotics, Antituberculor, Antifungal and Antiinflammatory drugs.

- **NATURAL PIGMENTS** **(06 Hours)**
  General Structure features, origin of color and applications, Classification of natural pigments, plastids and saps, Structure determination of Porphine, Porphyrin,Hb, Chl, Flavones, and Flavonoids.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Agarwal O.P.** '*Organic Chemistry Natural Products,Vol-II*,Goel Publishing, 2008.
2. **Burger A.** *'Medicinal Chemistry'*, Wiley Interscience, 1981.
3. **Finar I. L.**, *'Organic Chemistry: stereochemistry and the Chemistry of Natural Products'Vol. I & II,* Dorling Kindersley (india) Pvt Ltd, 2008.
4. **Lednicer D. and Mitscher L. A.,** *'The Organic Chemistry of Drug Synthesis'*, Wiley Interscience, 1994.
5. **Salerini O.L.**, *'Natural and Synthetic Organic Medicinal Compounds'*, C. V. Mosby Co., 1976.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M. Sc IV, Semester – VIII	**L**	**T**	**P**	**C**
MC 406: Advanced Inorganic Chemistry – II	**3**	**0**	**4**	**5**

- **METALS IN MEDICINES** **(08 Hours)**
  Fe, Al, Cu, Cd related diseases, disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic; chelation therapy; metals used for diagnosis and chemotherapy, platinum complexes as anticancer drugs, Pt-DNA binding, complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.

- **INORGANIC POLYMERS** **(06 Hours)**
  Synthesis, structure, properties and application of PN and SN based polymers.

- **MANUFACTURING OF VARIOUS CARBON MODIFICATIONS** **(07 Hours)**
  Lamp black, Carbon black, Acetylene black, Activated carbon. Oil furnace process, manufacturing of graphite, amorphous carbon electrodes, carbon fibers in the preparation of composites. carbon nanotubes and fullerenes.

- **NEW ROUTES TO SYNTHESIS OF INORGANIC MATERIALS** **(07 Hours)**
  Sol-gel method of synthesis, template reaction, preparation of thin films, CVD technique, Epitaxial methods, high purity crystal growth (bridgement techniques), microwave assisted synthesis, sonochemical method of synthesis, Host-guest reactions, intercalation reactions, and its applications, routes to synthesis of nanomaterials.

- **INORGANIC CATALYTIC MATERIALS** **(07 Hours)**
  Catalyst concepts, Classification and types of catalysts, forms of catalysts, metals as catalysts, metal supported catalysts, solid acid catalysts; Homogeneous catalysis, heterogeneous catalysis, phase transfer catalysis, heterogenised homogeneous catalysis, industrial catalysis. Practicing in green chemistry through catalysis.

- **ORGANOMETALLIC COMPOUNDS IN HOMOGENEOUS CATALYTIC REACTIONS** **(07 Hours)**
  Homogeneous catalysis reactions – Mechanism of addition, elimination, oxidation, reductions, migration reactions, water gas shift reactions, alkene insertions, hydro formylation.

Total contact Time: (42Hours)

BOOKS RECOMMENDED:

1. **Burton J. J., Garten R. L**, *'Advanced Materials in Catalysis – Material Science Series*', Academic Press, London Wiley, 1982.
2. **Cotton F. A., Wilkinson G., Murlio C. A., Bochmann M.**, '*Advanced Inorganic Chemistry'* John Wiley & Sons (ASIA) PTE Ltd., 6th Edn, 2003.
3. **Lippard S. J., Berg J. M.**, *'Principles of Bio Inorganic Chemistry*', University Science Books, 1994.
4. **Puri B. R., Sharma L.R., and Kalia K. C.**, *'Principles of Inorganic Chemistry'*, 30th Edn., Milestones, 2008.
5. **Vishwanathan B., Sivasanker S., Ramaswamy A. V.**, Catalysis – Principles and applications, Narosa Publishing House Pvt. Ltd, 3rd Edn., 2009.

Fourth Year of Five Years integrated M. Sc.(Chemistry)

M. Sc. IV Semester - VIII	**L**	**T**	**P**	**C**
MC 408: SPECTROSCOPIC METHODS-I	**3**	**0**	**6**	**6**

- **ULTRA-VIOLET SPECTROSCOPY** **(4 Hours)**
  Types of transitions of inorganic and organic molecules **-** shape of UV-absorption curve – transition probability – chromophore – changes in position and intensity of absorption - solvent effect - choice of solvent - instrumentation **-** single beam and double beam spectrometry - application of UV spectrometry.
- **IR SPECTROSCOPY** **(4 Hours)**
  Instrumentation - Infrared sources and transducers, Infrared instruments, Typical applications of infrared spectroscopy (qualitative and quantitative).
- **NMR SPECTROSCOPY** **(10 Hours)**
  Introduction to ^{1}H NMR – quantum description of NMR – chemical shift – measurement of chemical shift – factors influencing chemical shift – splinting of signals – coupling constant – instrumentation – solvents in NMR – interpretation of NMR - chemical shifts and coupling behavior of alkanes, alkenes, aromatic compounds, alkynes, alkyl halides, alcohols, ethers, amines, nitriles, aldehyes, ketones, esters, carboxylic acids and amides. 13 C spectroscopy , 2D NMR methods such as COSEY,NOSY etc.
- **MASS SPECTROMETRY** **(4 Hours)**
  Introduction – ion sources (EI source, CI source, FI source, desorption source, FAB and MALDI) - detectors – time of flight – ion trap analyzer – instrumentation - double focusing mass analyzer – application
- **ATOMIC SPECTROSCOPY** **(4 Hours)**
  Atomic absorption spectroscopy (AAS) - introduction – principle – detection non-metals – single and double beam AAS – instrumentation – detection limit and sensitivity – advantages and disadvantages - difference between AAS and flame emission spectroscopy – advantages of AAS over FES.
  Atomic fluorescence spectroscopy – introduction – principle – mathematical relationship – instrumentation – advantages of AFS – limitations of AFS – AFS as analytical tool.
- **STRUCTURE DETERMINATION OF ORGANIC COMPOUNDS** **(16 Hours)**
  Structure determination of organic molecules using UV, IR, Mass and NMR Spectroscopy.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **G. R. Chatwal and S. K. Anand, '***Spectroscopy*', Himalaya Publishing House, 2001.
2. **D. L. Pavia, G. M. Lampman, G. S. Kriz,** '*Introduction to Spectroscopy'*, 3rd Edition, Thomson Learning Inc., 2001.
3. **R. M. Silverstein and F. X. Webster, '***Spectrometric Identification of Organic Compounds'***,** Academic Press,7th Edition, 2008
4. **J.M. Hollas,** '*Modern Spectroscopy*', 3rd Edition (1996), John Wiley, New York.
5. **P.S.Kalsi, '***Spectroscopy Of Organic Compounds',* New Age International (p) Limited, 6th Edition, 2004.

Fourth Year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV, Semester -VIII	**L**	**T**	**P**	**C**
MC 412: CORROSION OF MATERIALS AND CORROSION TESTING	**3**	**0**	**6**	**6**

- **FERROUS MATERIALS** **(06 Hours)**
  Mechanical, corrosion resistance and other properties of metals and alloys like cast irons, high-silicon cast irons, carbon steels and irons, low-alloy steels, stainless steels.

- **NON-FERROUS MATERIALS** **(07 Hours)**
  Corrosion resistance, mechanical and other properties of aluminum, magnesium, lead, copper, nickel, zinc and their alloys. .

- **MATERIALS** **(04 Hours)**
  Corrosion resistance, mechanical and other properties of tin and tin plate, cadmium, titanium and its alloys, refractory and noble metals, metallic glasses and composites.

- **NONMETALLIC MATERIALS** **(10 Hours)**
  Corrosion resistance and other properties of nonmetallics- natural and synthetic rubbers, other elastomers, plastics, thermoplastics- fluorocarbons, acrylics, nylon, polyethylenes, polypropylene, rigid polyvinyl chloride, thermo setters-epoxies, phenolics, polyesters, silicones, ureas, laminates and reinforced plastics, ceramics, carbon and graphite.

- **CORROSION TESTING** **(15 Hours)**
  Gravimetric method- materials and specimens, surface preparation, measuring and weighing, exposure techniques, duration, planned-interval tests, aeration, cleaning specimens after exposure, temperature, standard expressions for corrosion rate.
  Methods of testing galvanic corrosion, crevice corrosion, pitting corrosion and intergranular corrosion, Testing at high temperatures and pressures, Huey and Streicher tests for stainless steels, Warren test, stress corrosion- NACE test methods, slow-strain-rate tests.
  Testing by electrochemical methods- Tafel equation and Tafel extrapolation method, its advantage, limitations, Stern - Geary equation, Linear polarization method, advantages and limitations. Experimental details-various electrodes, test cell and instrumentation,
  AC Impedance spectroscopy-Equations, parallel circuits, real and imaginary impedances, Nyquist and bode plots, charge transfer resistance, solution resistance, phase shift, double layer capacitance, electrodes, instruments and soft wares, Small amplitude cyclic voltammetry, paint tests, sea water tests, miscellaneous tests of metals, plastics and elastomers, presenting and summarizing data, nomograph for corrosion rates.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Fontana Mars G.,** *'Corrosion Engineering'*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. **Mansfeld F and Bertocci U**, eds., '*Electrochemical Corrosion Testing',* ASTM, Philadelphia Pa., 1979.
3. **Stephen D., Cramer and Bernard S., Covino Jr.** '*Corrosion' Metals Handbook*, Vol.13B., 9th ed., American Society for Metals, Materials Park, OH, USA, 2005.
4. **Uhlig H H and Revie R W,** *'Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering',* 3rd ed., John Wiley, New York,1985.
5. **Sedricks A .J**, '*Corrosion of Stainless Steels',* Wiley, London, 1979.

.

Fourth year of Five Years integrated M. Sc. (Chemistry)

M.Sc. IV Semester-VIII	**L**	**T**	**P**	**C**
MC 414: UNIT PROCESSES	**3**	**0**	**6**	**6**

- **NITRATION, REDUCTION &HALOGENATION** **(07 Hours)**
  Nitration: nitrating agents, mechanism, batch v/s continuous nitration process and manufacturing of Nitrobenzene (batch and continuous), mdinitrobenzene and p-nitro acetanilide.
  Reduction: amination by reduction and by ammonolysis. Different types of reduction reactions and manufacturing of Aniline by Bechamp reduction, m-nitro aniline and Aniline by ammonolysis.
  Halogenations: mechanism and manufacturing of BHC and Chlorobenzene.
- **SULFONATION, OXIDATION, HYDROLYSIS & ESTERIFICATION** **(07 Hours)**
  Sulfonation: sulfonating agents, mechanism and commercial manufacturing of benzene sulfonic acid (Barbet process) and Naphthalene sulfonic acid.
  Oxidation: types of oxidation reaction, oxidizing reagents and commercial manufacturing of Benzoic acid, Phthalic anhydride and Acetic acid.
  Esterification: mechanism and commercial manufacturing of Ethyl acetate and Vinyl acetate.
  Hydrolysis: hydrolyzing agents and different mechanism of Hydrolysis.
- **SYNTHETIC DYES-I** **(08 Hours)**
  Dye, classification of dyes on the basis of structure and methods of application (two examples in each class). Chemistry of Azo, Anthraquinone, reactive and disperse dyes. Synthesis of Direct Black EW, Eriochrome black T, Tartrazine, Congo Red, Naphthol Blue Black-6B, Metanil Yellow, Indanthrene Yellow-4GK, Procion Brillant 4A, Reactive Yellow3, Methyl Orange, Eriochrome Red-B dyes.
- **SYNTHETIC DYES-II** **(07 Hours)**
  Application of synthetic dyes on various fabrics, fastness test and fastness properties. Analysis of dyes and dye intermediates: nitrite value, coupling value, titanous chloride reduction, Halogen content determination and estimation of Cu, Ni and Cr.
- **SYNTHETIC DRUGS** **(07 Hours)**
  Drugs, pro-drugs, biotransformation of drugs, routes of drugs administration and dosage forms, drug binding, drug toxicity, drug addiction, some important terms used in chemistry of drugs, biological and medical terms used in the study of drugs, distinctive definition. Classification of drugs, relation of chemical structure and chemical activity. Steroids and Hormones.
- **APPLICATION OF UNIT PROCESSES** **(06 Hours)**
  Application of various unit processes in the manufacturing of dyes and drugs, Nitration, Reduction, halogenations, Sulfonation, Oxidation.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Groggins P. H.,** *"Unit Processes in Organic Synthesis"* McGraw-Hill, New York, 1958.
2. **Klaus Hunger,** "Industrial Dyes: Chemistry, Properties, Applications", Wiley-VCH, 2003.
3. **Donald J. A.,** "Burger's Medicinal Chemistry and Drug Discovery, Vol.-1, Wiley-Interscience, 6th Ed.
4. **Shah K. M.,** "*Handbook of Synthetic Dyes & Pigments*" Multi-tech Publishing Co., Vol.-I, 2 Ed.
5. **H. E. Fierz David and L. Blangey, "**Fundamental Processes of Dye Chemistry", Interscience Publishers Inc., New York, 1949.

Fifth Year of Five Years integrated M. Sc.(Chemistry)
M. Sc.-V, Semester-IX

Sr. No.	Course	Code	Teaching Scheme Hours per Week			Credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tu	TW /Viva Pract	
1	***Elective-III**	***MC 5XX**	3	0	6	6	100	--	100	200
2	**#Elective-IV**	**#MC 5YY**	3	0	8	7	100	--	100	200
3	Research Project-I	MC 505	0	0	12	6	--	--	200	200
4	Industrial Visits/ Training-I*	MC 507	0	0	0	1	--	--	50	50
			6	0	26		200	--	450	650
Total Contact hrs per week =32					**Total Credit = 20**				**Total Marks=650**	

***Elective-III (MC5XX): MC 501, MC 509, MC 513**

S.No.	Code	Course
1	MC 501	Spectroscopic Methods-II
2	MC 509	Corrosion of Materials by Environments
3	MC 513	Technology of Petroleum Products and Polymers

#Elective-IV (MC5YY): MC 503, MC 511, MC 515

S.No.	Code	Course
1	MC 503	Thermal Radio and electrochemical Techniques
2	MC 511	High Temperature Corrosion and Corrosion Control
3	MC 515	Unit operations and Process Control

MC 505: Research Project-I Short Term project in Chemistry and allied subjects/ Corrosion /Electrochemistry etc.

Fifth Year of Five Years integrated M. Sc.(Chemistry)

M. Sc. V Semester - IX	**L**	**T**	**P**	**C**
MC 501: SPECTROSCOPIC METHODS - II	**3**	**0**	**6**	**6**

- **ELECTRON SPIN RESONANCE SPECTROSCOPY** **(10 Hours)**
  Theory, Instrumentation and Important analytical applications.
  ELECTRON SPECTROSCOPY
  Theory, Instrumentation and applications of Electron spectroscopy (ESCA and Auger), Scanning electron microscopy (SEM), Scanning tunnelling microscopy (STM) and Atomic force microscopy (AFM).
  PLASMA EMISSION SPECTROSCOPY
  Theory, Instrumentation and Analytical applications of Inductively coupled plasma emission spectroscopy (ICPE).
- **SURFACE ANALYSIS** **(8 Hours)**
  Auger electron spectroscopy - introduction – Auger process – secondary electron energy distribution – instrumentation – data interpretation and surface analysis – Auger yield – calculation of surface composition – sensitivity limit – trace analysis.
- **FLUORESCENCE SPECTROMETRY** **(8 Hours)**
  Introduction – comparison of absorption and fluorescence methods - theory - singlet and triplet state – excited State – factors affecting fluorescence – relation between fluorescence intensity and concentration – Instrumentation – double beam fluorescence spectrophotometer – total luminesccence spectrometry – application of fluorescence spectrometry.
- **RAMAN SPECTROSCOPY** **(4 Hours)**
  Introduction – principle – characteristic properties of Raman lines – difference between Raman spectra and Infra red spectra – mechanism of Raman effect – instrumentation – intensity of Raman peaks – application.
- **SINGLE CRYSTAL** **(4 Hours)**
  Method of preparation of single crystal - instrumentations for characterization and application.
- **CYROPTICAL METHODS (ORD AND CD)** **(4 Hours)**
  Instrumentations for characterization and application.
- **MICROANALYTICAL TECHNIQUES**: **(4 Hours)**
  Scope and objectives of microanalytical technique, Difference between micro and trace analysis, Microanalytical technique based on size and amount of the sample. X ray techniques

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **F. Gerson, W. Huber, '**Electron Spin Resonance Spectroscopy of Organic Radicals**',** John Wiley & Sons, New York. 2003.
2. **J. R. Lakowicz, '***Principles of Fluorescence Spectroscopy*', Springer 4th Edition.2006.
3. **B. Raj,** '*Advances in Material Characterization', Universities Press*, 2007.
4. **P. F. Kane, G. B. Larrabee, '***Characterization of Solid Surfaces', Plenum Press*, 1978.
5. **S.M. Khopkar,** '*Analytical Chemistry of Macrocyclic and Supramolecular Compounds*', Narosa Publishing House, New Delhi, 2002.

Fifth Year of Five Years integrated M. Sc.(Chemistry)

M. Sc.V, Semester - IX	**L**	**T**	**P**	**C**
MC 509: CORROSION OF MATERIALS BY ENVIRONMENTS	**3**	**0**	**6**	**6**

- **CORROSION OF METALS AND ALLOYS IN HYDROFLUORICACID (04 Hours)**
  Corrosion resistant metals and alloys for aqueous and anhydrous hydrofluoric acids and for fluorine gas service.

- **CORROSION OF METALS AND ALLOYS IN HYDROCHORIC ACID (08 Hours)**
  Class-1 Metals and Alloys, Class-2 Metals and Alloys, Class-3 Metals and alloys, Aeration and oxidizing agents, nonmetallic materials, hydrogen chloride and chlorine.

- **CORROSION OF METALS AND ALLOYS IN PHOSPHORIC ACID (06 Hours)**
  Materials of construction for handling pure and impure phosphoric acids at higher concentrations and temperatures. Concentration and temperature limits in phosphoric acid of some nonmetallics.

- **CORROSION OF METALS AND ALLOYS IN SULPHURIC ACID (11 Hours)**
  Corrosion of steel, cast iron, chemical lead, high-silicon cast iron, Durimet 20, Nickel-molybdenum and Nickel-molybdenum-chromium alloys, combined isocorrosion chart, conventional stainless steels, Monel, Nickel, Inconel and Ni-resist alloys, Copper and other metals and their alloys, Nonmetallics, Summary charts, H_2SO_4 Plant equipment.

- **CORROSION OF METALS AND ALLOYS IN NITRIC ACID (07 Hours)**
  Stainless Steels, Class-1 Materials, Class-2 Materials, Class-3 Materials, Mixed acids.

- **CORROSION IN OTHER ENVIRONMENTS (07 Hours)**
  Metallic corrosion in organic acids and in petroleum industry, atmospheric and biological corrosion, corrosion in petroleum, paper and pulp industries, rebar and dew point corrosion, corrosion under insulation, electronic equipment, liquid metal embrittlement or cracking, hydrogen peroxide, bolting.

(Total Contact Time: 43 Hours)

BOOKS RECOMMENDED

1. **Sedricks A .J**, '*Corrosion of Stainless Steels',* Wiley, London, 1979.
2. **Fontana Mars G.** *'Corrosion Engineering',* Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
3. **Shreir L L, Jarman R A and Burstein G T,** eds., Vol.I*, 'Corrosion. Metal/Environment Reactions and Alloys', and Vol. II, 'Corrosion Control',* Butterworth-Heinemann, 3rd ed, Oxford, UK, 1994.
4 **De Renzo D J and Mellan I***, 'Corrosion Resistant Materials'- Handbook***,** Noyes Data Corp, New Jersey, USA, 1985..
5. **Stephen D., Cramer and Bernard S., Covino Jr.** '*Corrosion' Metals Handbook*, Vol.13B., 9th ed., American Society for Metals, Materials Park, OH, USA, 2005.

Fifth year of Five Years integrated M. Sc. (Chemistry)

M.Sc. V Semester-IX	**L**	**T**	**P**	**C**
MC 513: TECHNOLOGY OF PETROLEUM PRODUCTS AND POLYMERS	**3**	**0**	**6**	**6**

- **THEORIES OF PETROLEUM PRODUCTS** **(07 Hours)**
  Theories of petroleum formation, composition of petroleum, refining and rectification process of petroleum, light petroleum products, their specifications and test methods, cracking and reforming process, reaction taking place in cracking, cracking catalyst, cracking plants.
- **FRACTIONATION OF PETROLEUM** **(07 Hours)**
  Chemicals derived from C_1, C_2, C_3 and C_4 fractions, separation of components of petroleum by using techniques like- compression, absorption, adsorption, low temperature distillation, special and combined techniques. Manufacture of HCN, CS_2, Maleic anhydride, Caprolactum and Phthalic anhydride.
- **MANUFACTURE OF PETROCHEMICALS BY FOLLOWING UNIT PROCESS** **(08 Hours)**
  Alkylation: ethyl benzene and isopropyl benzene from benzene
  Dehydrogenation: butadiene from butane/butane
  Esterification: vinyl acetate
  Hydration: acetaldehyde from acetylene
  Hydrolysis: ethanol from ethylene
  Oxidation: ethylene oxide from ethylene and phenol from cumene
  Hydroformylation : propionaldehyde from ethylene and synthesis gas
  Sulphonation : benzene sulfonic acid from benzene
- **INDUSTRIAL PRODUCTION OF POLYMER** **(14 Hours)**
  Production of LDPE by conventional and slurry process, HDPE by Ziegler, Indiana and Phillips process, Polypropylene (PP) by UNIPOL, Spheripol and commercial process, PVC by suspension and emulsion process, Polystyrene (PS) by mass, solution suspension and emulsion polymerization, Teflon, PMMA, PET, nylon 6,6 , rayon, CMC.
- **INDUSTRIALAPPLICATIONS OF POLYMER** **(06 Hours)**
  Industrial applications of conventional, smart, functional and high performance polymer like LDPE, HDPE, PVC, PP, PS, Teflon, PMMA, PET, nylon 6,6, rayon, CMC.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Premamoy Ghosh,** *"Polymer Science and Technology of Plastics and Rubbers",* Tata McGraw-Hill Publishing Co. Ltd., New Delhi 1990.
2. **Gowariker V. H., Viswanathan N. V. and Jayadev Sreedhar**, *"Polymer Science"* Wiley Eastern. (New Age International (P) Ltd., New Delhi, 2005.
3. **Bhaskar Rao**,"*Modern Petroleum Refining Process"* Oxford & IBH Publishing Co. Pvt. Ltd. – New Delhi, 2nd ed. 1990.
4. **Waddam A. L.,** *"Chemicals from Petroleum"* ELBS edition, London, 2001.
5. **George T. A.,** *"Shreve's Chemical Process Industries"* McGraw- Hill international editions, 5th Ed, 1985.

Fifth Year of Five Years integrated M. Sc.(Chemistry)

M. Sc. V Semester - IX	**L**	**T**	**P**	**C**
MC 503: THERMAL RADIO AND ELECTROCHEMCIAL TECHNIQUES	**3**	**0**	**8**	**7**

- **THERMAL METHODS** **(8 Hours)**

  Theory, methodology and applications of thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC). Principles, techniques and applications of thermometric titration methods. Derivative thermal gravimetry – introduction and instrumentation – thermometric titration – titration of mixture of Ca^{2+} and Mg^{2+} with EDTA – titration of sodium melanate with $HClO_4$ – direct injection enthalpy.

- **ELECTROCHEMICAL METHODS** **(8 Hours)**

  Introduction – Classification of Electrochemical Methods (Interfacial Electrochemical Methods, Controlling and Measuring Current and Potential) potentiometry - ion selective electrodes (ISE) - voltammetry – polarography – cylclic, pulse and stripping voltammetry, coulometry and amperometry, AC electrochemical techniques.

  Potentiometric methods of analysis (potentiometric measurements - reference electrodes - metallic indicator electrodes - membrane electrodes - quantitative applications) - coulometric methods of analysis (controlled-potential coulometry - controlled-current coulometry - quantitative applications - voltammetric methods of analysis (voltammetric measurements, - current in voltammetry - shape of voltammograms - quantitative and qualitative aspects of voltammetry - voltammetric techniques - quantitative applications)

- **KINETIC METHODS OF ANALYSIS** **(8 Hours)**

  Methods based on chemical kinetics - radiochemical methods of analysis - flow injection analysis :theory and practice - instrumentation - quantitative applications - characterization applications - evaluation of chemical kinetic methods

  MICROANALYSIS BY KINETIC METHODS: Theoretical basis, Kinetic parameters, Kinetic methods of microanalysis: Tangent, fixed time and addition method.

- **RADIOISOTOPE TECHNIQUES** **(5 Hours)**

  Introduction – types of radioactive decay – types of detectors – data acquisition – radiotracer technique principle and applications – activation analysis principle – techniques – application – autoradiography principle – techniques – applications.

- **SURFACE ANALYSIS (APPLICATIONS)** **(5 Hours)**

  X-Ray as a source - X-Ray tube - continuous and discontinuous spectra - absorption of X-Rays - sources of X-rays – filters - crystals as monochromators - quantitative method of X-ray absorption

  X-RAY FLUORESCENE SPECTROSCOPY

  Principle – theory – quantitative method of X-ray fluorescene – instrumentation - energy dispersive and wavelength dispersive device - application of X-ray fluorescene.

- **X-RAY DIFRACTION ANALYSIS** **(4 Hours)**

  Diffraction of X-rays by crystals: The Laue equations and Bragg's law. Definitions related to crystal structure. X-ray diffraction experiments: the powder method and the single crystal method. Reciprocal lattice. Structure factor. Structure factor and intensity. Electron density maps.

- **POLAROGRAPHY** **(4 Hours)**

  Origin of polargraphy, Current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovič equation, Qualitative and quantitative applications.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Arnikar H. J.**, '*Essential of Nuclear Chemistry*', 4th Edn., 1995.
2. **G. Svehla,** '*Thermal Methods In Analytical Chemistry, Substoichiometric Analytical Methods',* Elsevier, 1976.
3. **P.L. Kirk,** '*Quantitative Ultramicroanalysis*', John Wiley & Sons, New York, 2002.
4. **E. M. McCash**, '*Surface Chemistry',* Oxford University Press, 2nd 2002.
5. **Glasstone S.**, '*Introduction to Electrochemistry*', Affiliated East-West Press, 1968.

Fifth Year of Five Years integrated M. Sc. (Chemistry)

M. Sc. V, Semester-IX	**L**	**T**	**P**	**C**
MC 511: HIGH TEMPERATURE CORROSION AND CORROSION CONTROL	**3**	**0**	**8**	**7**

- **HIGH TEMPERATURE CORROSION** **(12 Hours)**

  Mechanism and kinetics- Pilling-Bedworth Ratio, electrochemical and morphological aspects of oxidation, oxide defect structure, oxidation kinetics- empirical linear law, parabolic oxidation rate law, empirical logarithmic reaction rate law, inverse logarithmic oxidation reaction rate law, cubic law, effect of alloying, catastrophic oxidation, internal oxidation, high-temperature materials- mechanical properties, oxidation resistance, other metal-gas reactions- decarburization and hydrogen attack, effect of hydrogen and hydrocarbon gases, hydrogen and water vapor, carbon monoxide- carbon dioxide mixtures, corrosion by sulphur compounds, hot corrosion of alloys.

- **CORROSION CONTROL** **(30 Hours)**

  Material selection- Selection of proper corrosion resistant metals and alloys for specific environment, metal purification, nonmetallics, Alteration of environment- Changing medium, temperature, velocity, by removing oxygen or oxidizers, dissolved gases, suspended particles, dissolved solids, redox couples, use of inhibitors- adsorption type inhibitors, hydrogen evolution poisons, scavengers, oxidizers, vapor-phase inhibitors, Proper design- wall thickness, design rules, Cathodic protection- primary protection, secondary protection by impressed current and sacrificial anode methods, selection of anodes, backfills, protective currents, stray current effects and applications, anodic protection- active- passive behavior of materials and structures, potentiostat, electrodes, environments and their comparison, Coatings- metallic and other inorganic coatings- surface preparation- degreasing, descaling, etc., heat treatments- annealing, hardening, carburizing, nitriding, etc., coating methods like flame spraying, cladding, hot dipping, vapor deposition, diffusion, chemical conversion, electroplating and electro less nickel plating, surface modification- ion implantation, organic coatings- surface preparation, selection of primers, coatings and top coat, corrosion control NACE Standards, failure analysis.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED

1. **Kofstad P. '***High Temperature Corrosion'.* Elsevier Applied Science, London, 1988.
2. **Strafford K N, Datta P K and Googan C G,** eds., '*Coatings and Surface Treatment for Corrosion and Wear Resistance'*, Ellis Horwood, Chichester, UK, 1984.
3. **Fontana Mars G.,** *'Corrosion Engineering',* Tata McGraw-Hill Publishing Company Limited, New Delhi,2005.
4. **Riggs O L and Locke C E.,** *'Anodic Protection',* Plenum Press, New York, 1981.
5. **Morgan J H.,** '*Cathodic Protection'*, Leonard Hill London, 1987.

Fifth year of Five Years integrated M. Sc. (Chemistry)

M.Sc. V Semester-IX	**L**	**T**	**P**	**C**
MC 515: UNIT OPERATIONS & PROCESS CONTROL	**3**	**0**	**8**	**7**

- **MIXING AND FILTRATION** **(07 Hours)**
  Mixing, types of mixing problems, mixing liquids with liquids, mixing liquids with solids, mixing solids with solids, mixing viscous masses. Filtration, filter media and fiber aid, filters- sand filters, plate & frame filters, leaf filters, rotary filter, centrifuges.
- **DISTILLATION** **(07 Hours)**
  Distillation- volatility and relative volatility, boiling point diagram and equilibrium diagram, types of distillation, mass and enthalpy balance calculation, calculation of number of theoretical plates, numerical and graphical method, importance of reflux ratio, steam distillation, equipments for gas-liquid contact operation, types of columns, tower packing, solvent for absorption.
- **CRYSTALLIZATION AND DRYING** **(07 Hours)**
  Crystallization- approaches for crystallization, batch and continuous crystallization, theory of crystallization. Drying- classification of dryers, compartment dryer, tunnel dryer, rotary dryer, drum dryer, spray dryer etc., types of moisture, mechanism of drying.
- **EXTRACTION, SIZE REDUCTON AND SEPRATION** **(07 Hours)**
  Leaching and liquid extraction, factors affecting leaching, industrial extractors, leaching of cellulose material and fine solids, mechanical agitators. Size reduction and size separation, primary and secondary crushers, fine grinders, methods of operating crusher, size separation of solids, industrial screens, air separation method, size separation by laws of setting.
- **FLOW, TEMPERATURE, PRESSURE, LEVEL AND GRAVITY MEASUREMENT** **(07 Hours)**
  Instrumentation: Terminology, elements of an instrument, classification of instruments, Flow measurement, Temperature measurement, measurement of pressure, level sp. gravity and viscosity.
- **CONTROL SYSTEM** **(07 Hours)**
  Indicating, recording, signalling and digital instruments, recording means and types of recorders, operating mechanism of recording devices, control panels, graphic instrumentation. Pneumatic and electrical transmission system. Control system, terminology, manual and automatic control, open and closed loop control, process time lags, control action and modes of control actions, ON-OFF and proportional control, integral and derivative control, PI, PD & PID control, control valves.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Walter L. B. and Juline T. B.,** *"Introduction to Chemical Engineering"* Tata McGraw-Hill, 2002.
2. **Warreh L Mc Cabe & Jullian C Smith**, *"Unit Operation of Chemical Engineering*" Tata McGraw-Hill, 6th Ed., 2001.
3. **Coulson J. M. & Richardson K. F.,** "*Chemical Engineering"* Volume I & II, Asian Books Pvt. Ltd., New Delhi
4. **Donald P Eckman**, *"Industrial Instrumentation*" Wiley Estern Ltd., 1950.
5. **Douglas M Considine,** "*Process Instrumentation & Control Handbook*", McGraw-Hill, Inc., New Delhi, 5th Ed.

Fifth Year of Five Years integrated M. Sc. (Chemistry)
M. Sc.-V, Semester-X

Sr. No.	Course	Code	Teaching Scheme Hours per Week			Credit	Examination Scheme				Total Marks
							Theory	Tu	TW /Viva Pract/		
			L	Tu.	Pr.				Int.	Ext.	
1	Seminar	MC 502	0	0	4	2	--	-	40	60	100
2	Industrial Visits/ Training-II*	MC 504	0	0	0	2	--	--	100	-	100
3	Research Project-II	MC 506	0	0	30	15	--	--	120	180	300
			0	0	34		--	--	260	240	500
Total Contact hrs per week =34				**Total Credit = 19**						**Total Marks=500**	

ıdustrial visit/training-I and II are intended to bring flexibility by giving to student experiences, exposure and training of their choice in Chemistry and allied subjects such as Pharma, polymer, dyes, etc.

ИC 506: Research Project-II: Analytical Chemistry/Polymers./Corrosion/ Environmental Science & Engg./ Solution chemistry, etc.

Ɔn Successful Completion of the course, the candidate will be awarded 5-years integrated M.Sc. Degree in Chemistry.
Ґotal contact Hrs for 5-years integrated M.Sc. = 277 Total credits for 5-years integrated M.Sc. = 210