COURSE PROFILE M.Sc, Chemistry

SEMESTER – I

Title of the course: Major Elective 1- Nano Chemistry

Teaching hours: 15 ×5 = 75 **Credits: 4**

Course Code: 6P18/1E1/NAC **L T P 4 1 0**

	SEMESTER –I										
Course code	**Course title**	**L**	**T**	**P**	**Total Hours /week**	**TOTAL HOURS**	**Credit**	**Exam Hrs**	**MARKS**		
									CA	**SE**	**TOTAL**
6P18/1C/OC1	Core 1- Organic Chemistry – I	4	1	0	5	75	4	3	40	60	100
6P18/1C/IC1	Core 2 - Inorganic Chemistry – I	4	1	0	5	75	4	3	40	60	100
6P18/1C/PC1	Core 3 - Physical Chemistry – I	4	1	0	5	75	4	3	40	60	100
6P18/1E1/NAC	Major Elective 1- Nano Chemistry	4	1	0	5	75	4	3	40	60	100
	*Core Practical-1- Organic Chemistry	-	-	-	4	120	-		-	-	-
	*Core Practical -2- Inorganic Chemistry	-	-	-	4	120	-		-	-	-
PG18/1S/PEW	Soft skill 1 – Personality Enrichment for Women	2	0	0	2	30	2	2	-	50	50
	Total				**30**		**18**				

L = Lecture hours, T = Tutorial hours, P = Practical hours

CA = Continuous Assessment marks, SE = End semester Marks
*Practical Examinations are conducted once in a Academic year - at the end of II & IV Semester

Note: Students can take up NPTEL/ MOOC courses and earn extra credits

	SEMESTER – II										
Course code	**Course title**	**L**	**T**	**P**	**Total Hours /week**	**TOTAL HOURS**	**Credit**	**Exam Hrs**	**MARKS**		
									CA	**SE**	**TOTAL**
6P18/2C/OC2	Core 4 - Organic Chemistry – II	3	1	0	4	60	4	3	40	60	100
6P18/2C/IC2	Core 5 - Inorganic Chemistry – II	3	1	0	4	60	4	3	40	60	100
6P18/2C/PC2	Core 6 - Physical Chemistry – II	3	1	0	4	60	4	3	40	60	100
6P18/2E2/SPE	Major Elective 2 - Spectroscopy	3	1	0	4	60	3	3	40	60	100
6P18/2E/COS	Non Major Elective 1 - Cosmetology	3	1	0	4	60	3	3	40	60	100
6P18/2C/PR1	*Core 7 - Practical –1 Organic Chemistry	-	-	-	4	120	4	6	40	60	100
6P18/2C/PR2	*Core 8 - Practical -2 - Inorganic Chemistry	-	-	-	4	120	4	6	40	60	100
6P18/2C/INT	Internship	-	-	-	-	-	2	-	-	-	-
PG18/2S/LCE PG18/2S/FRE PG18/2S/GER	Soft skill- 2 Language and Communication in English/Soft Skill	2	0	0	2	30	2	2	-	50	50

	SEMESTER – III								
Course Code	**Name of the Course**	**L T P**	**Hours /Week**	**Credits**	**TOTAL HOURS**	**Exam Hours**	**Marks**		
							CA	**SE**	**Total**
6P18/3C/OC3	Core 9 - Organic Chemistry – III	3 1 0	4	4	60	3	40	60	100
6P18/3C/IC3	Core 10 - Inorganic Chemistry – III	3 1 0	4	4	60	3	40	60	100

	in French/Soft Skill in German										

6P18/3C/PC3	Core 11- Physical Chemistry – III	3 1 0	4	4	60	3	40	60	100
6P18/3E3/PHC	Major Elective 3- PhotoChemistry	3 1 0	4	3	60	3	40	60	100
6P18/3E/FDP	Non Major Elective -2 Fibre Fabrics , Dyeing and Printing of Textiles	3 1 0	4	3	60	3	40	60	100
6P18/4C/PR3	*Core Practical III – Physical Chemistry	-	4	-	120	-	40	60	100
	*Core - Project	-	4	-	-	-	40	60	100
6P18/3S/LSS	Soft Skill 3- Laboratory Safety Skills	2 0 0	2	2	30	2	-	50	50
Total			**30**	**20**					

L = Lecture hours, T = Tutorial hours, P = Practical hours, CA = Continuous Assessment marks, SE = End semester Marks *Practical Examinations are conducted once in a Academic year ie at the end of II & IV Semester

	SEMESTER – IV								
Course Code	**Name of the Course**	**L T P**	**Hours /Week**	**Credits**	**TOTAL HOURS**	**Exam Hours**	**Marks**		
							CA	**SE**	**Total**
6P18/4C/OC4	Core 12 - Organic Chemistry – IV	4 1 0	5	4	75	3	40	60	100
6P18/4C/IC4	Core 13 - Inorganic Chemistry - IV	4 1 0	5	4	75	3	40	60	100
6P18/4E4/ECC	Major Elective 4 - Electrochemistry	4 1 0	5	4	75	3	40	60	100

	and Computational Chemistry								
6P18/4E5/POC	Major Elective 5 - Polymer Chemistry	3 1 0	4	3	60	3	40	60	100
6P18/4C/PR3	*Core 14 Practical III - Physical Chemistry	-	4	4	120	6	40	60	100
6P18/4C/PRO	*Core 15 - Project	-	5	4	-	-	40	60	100
6P18/4S/SRP	Soft Skill 4- Scientific Research and Presentation Skills	2 0 0	2	2	30	2	-	50	50
		Total	**30**	**25**					
		Total Credits		**93**					

L = Lecture hours, T = Tutorial hours, P = Practical hours
CA = Continuous Assessment marks, SE = End semester Marks
*Practical Examinations are conducted once in a Academic year ie at the end of II & IV Semester

Nano Chemistry

Credits: 3

Course Code: 6P18/1E1/NAC **L T P 3 1 0**

Objectives:

1. To introduce and give an insight into the fascinating area of nanoscience & its development.
2. To learn the experimental techniques of nonoscale synthesis.
3. To understand the tools of characterization of nano scale features.
4. To understand the variation of properties upon size
5. To study the applications of Nano materials

UNIT I: Background to nanoscience and nanotechnology: Scientific revolutions- nanosized effects- surface to volume ratio-atomic structure-molecules & phases- energy at

the nanoscale molecular and atomic size-quantum effects- types of nanotechnology and nano machines. Definition of nano system- -dimensionality and size dependent phenomena, Quantum dots, Nanowires and Nanotubes, 2D films; self assembly systems Nanotechnology- Nanomaterials-Fillers, fibres, Wires, Fluids, tubes-CNT, Graphene, Nanoclays-types.

15 hrs

UNIT II: Experimental Techniques and Separation: Mechanical methods: grinding- high energy ball milling-types of balls-WC and ZrO_2-material-ball ratio- medium for grinding. Physical methods: Vapour deposition and different types of epitaxial growth techniques-Pulsed laser deposition, magnetron sputtering-micro Lithography, photolithography, soft lithography, e-beam writing, -laser ablation-RF/DC magnetron sputtering-microwave plasma evaporation control of grain size-scale up process. Chemical methods: Sol-gel technique-Solvo thermal methods-control of grain size-Co-precipitation hydrolysis- Sonochemical method combustion technique- colloidal precipitation template process.
15 hrs

UNIT III: Characterization using Analytical tools: Applications of UV-Vis, NIR, FTIR, FT-Raman, Photoluminescence, NMR, ESR and Light scattering methods. X-ray techniques: X-ray power diffraction- Crystallite size determination- Sherrer equation, structure analysis, use of JCPDS, determination of crystal systems-accurate lattice parameters. Electron Spectroscopy: X-ray Photoelectron Spectroscopy, Auger electron spectroscopy, X-ray characterization of nanomaterials. SEM, TEM, AFM .
15hrs

UNIT IV: Properties at the Nano scale: Electrical properties- electrical conductivity, Optical properties absorption and luminescence, Magnetic Properties- Para, Dia, Ferro and Ferri magnetism, Super paramagnetism- SPIONS, Mechanical properties micro hardness fracture toughness, plastic nature of nanoceramics

15 hrs

UNIT V: Applications: Ceramics and Composites: membranes for purification of water, catalysis-tooth and bone substitute-hydroxyappetites-inductive bone- replacements of ceramic valves. Capping and caging system-dendrimers- functionalisation of CNT. Environmental applications-nanotoxicology- biomediation-removal of microbes, sensors for DNA, proteins, detection of malignancy and biological applications
15 hrs

RECOMMENDED TEXTBOOKS:

1. Nanoscale materials in Chemistry, Kenneth, J. Klabunde willey Interscience, 2001
2. Nano: The essentials, T. Pradeep Tata McGraw-Hill Publishing Company Limited, 2007.

REFERENCE BOOKS:

1. Nano and Microelectromechanical Systems: Fundamentals of Nano and microengineering, Sergy Lyshevski, Vallabh publications 2/e 2005.
2. Nanotechnology Environmental application and Solutions, Lious Theodore, Robert g.Kunz palgrave macmillan 2005.
3. Nanostructure& Nanomaterials: Synthesis, Properties & Applications, G. Cao, Imperial College Press, 2004.
4. Nanomaterials, Nanotechnologoes and Design: An introduction for Engineers and Architects, Micheal F. Ashby. P.J. Ferria. D.L. Schodekpalgrave macmillan 2005.

PERIODICALS:

1. Current Science
2. Journal of nanotechnology
3. Journal of nanomaterials

WEBSITES & e-LEARNING SOURCES:

1. http://search.ebscohost.com
2. http://nisenet.org/
3. http://www.nanoparticles.org/nano%20links/
4. http://www.nsti.org/
5. http://nanozone.org/
6. http://www.understandingnano.com/
7. http://www.nanoparticles.org/nano%20links/
8. http://www.nanotechweb.org/

http://www.pjonline.com/pdf/forum/pj_20060318_apsgb.pdf

SEMESTER-II

Title of the course: Major Elective 2 Spectroscopy

Teaching hours: 15 x 4 =60 **Credits: 3**

Course Code: 6P18/2E2/SPE **L T P 3 1 0**

Objectives:

1. To understand the concepts of IR, UV, Raman, Mass, PES, NMR, EPR, Mossbauer spectroscopy.
2. To learn the principles of the techniques.
3. To apply the fundamentals to various systems .
4. To study the applications of the tools .
5. To determine the structure of organic and inorganic compounds.

UNIT I : **Infrared Spectroscopy:** Introduction-Origin- Fundamental modes, overtones combination and difference bands Fermi resonance. Selection rule-anharmonicity of vibrations-Normal coordinate analysis (brief outline)- choice of solvents-Base line correction-standard for calibration of the instrument –Application of IR to complexes of metals with isocyanides, carbonyls and nitrosyls. Different modes of binding of acetate, thioacetate and DMSO. Urea (amides) and amino acids, DMG as a ligand. Ethylene and acetylene complexes, Evidence for extensive pi bonding in these complexes. Isotopic labeling D^2 ,N^{15} and C^{13} and applications.

12hrs

UNIT II **UV absorption Spectroscopy**: Electronic spectra of diatomic and polyatomic molecules – Franck – Codon principle – determination of dissociation energy – predissociation spectra – selection rules- types of electronic transitions – effect of conjugation and solvent – chromophores. Auxochromes, Bathochromic and Hypsochromic Shifts. Applications in organic structure determination – Woodward – Feiser rules for conjugate systems and unsaturated ketones. **Raman Spectroscopy:** Stokes- Antistokes lines classical theory- selection rule, polarisibility ellipsoids-quantum theory-polarization of scattered radiation-depolarization ratio-Assignment of bands-Laser Raman-Ruby Laser- Instrumentation –Resonance Raman effect-Application- Study of solution equilibria-Detection of dimeric species like Hg_2^{2+}, N_2O_2 .

12 hrs

UNIT III: **Mass Spectroscopy:** Basic principles.Theory- Instrumentation -ion production. Electron Impact technique- CI Mass spectrometry-Field desorption-FAB and SIMS-Mass analyzer,-Mass spectrometers Molecular ion,Fragment ions,Meta stable peaks-McLafferty rearrangement-Fragmentation pattern in alkanes,alkenes,alkynes,alcohols & aromatic alcohols, phenols, Toluene, aldehydes and ketones. **Photo electron spectroscopy:** Introduction-UV/XPES Instrumentation. Ionization from bonding, antibonding and non bonding MO-UVPES data/spectrum of H_2 N_2 and O_2-XPES data/spectrum of O_2, N_2 and application of Koopman's theorem Spin Orbit coupling-photo electron spectrum of Xe, Kr, Ar etc and UV PES of HCl, HBr and HI. Spin spin coupling O_2, NO molecules- Jahn Teller & Renner Teller distortions- NH_3, CH_4, UVPES data, Satellite signals- Auger lines- Binding energy- Oxidation state correlation-Errors in binding energy , data correction .
12 hrs

UNIT IV: **Nuclear Magnetic Resonance** : Origin chemical shift- dependence on filed- spin spin coupling. One bond, two bond, three bond and higher order coupling constants. Sample data from ^{31}p-^{31}p, ^{13}C- ^{1}H, ^{31}p-^{19}F coupling. Dependence of coupling constant on 's' electron density. Decoupling and off Resonance- NOE effect-factors contributing to it. Systems like $PF_3(CH_3)_2$, $PF_3(CF_3)_2$ NMR temperature variation-time scale- Relaxation, effect of Quadrupolar nuclei Fluxional behaviour as applied to allyl, cyclopentadienyl systems-Inter and Intra molecular exchange.
12 hrs

UNIT V: **Electron spin resonance**: Introduction-Electron Zeeman effect, Hyperfine interaction, structural information, EPR of Benzylanion, pyrazylanion, BH_3,

Nephalauxetic effect-Data on simple complexes. Factors affecting EPR spectrum – Low symmetry fileds- Anisotropic 'g' and hyperfine constants. Zerofield splitting. **Mossbauer Spectroscopy** Origin-Isomer shift–correlation with S electron density, Quadrupolar splitting- ^{57}Fe and ^{119}Sn data. Time scale- Line width- Instrumentation-iron complexes, Low & high spin-iron carbonyls-prussiates- Turnbull's blue-structure –MB data correlation

12hrs

RECOMMENDED TEXT BOOKS:

1. Structural Methods in Inorganic Chemistry- EAV Ebsworth, D.Will Rankin, S.Cradock, Blackwell scientific publ(1987)
2. Physical methods in Inorganic Chemistry- Drago R.S.-Reinhold –1965
3. Infrared spectra of Inorganic and coordination compounds – Nakamoto k 2nd edn Wiley 1970
4. Basic principles of spectroscopy R.Chang, McGraw Hill, New york (1971)
5. Complexes of I row transition elements D.Nicholas
6. Introduction to Ligand field B.N.Figgis, John Wiley (Newyork) 1966
7. Fundamental of molecular spectroscopy, C.N.Banwell McGraw Hill Newyork 1966 Organic spectroscopy by William Kemp 3rd edn W.H.Freeman & Co, 1991 Spectroscopic methods in organic Chemistry by Silverstein Bassler
8. Instrumental method of analysis by H.Willard, W.Merrit, J Dean. 6th edn Van Nostrand 1981

REFERENCE BOOKS:

1. Inorganic Electronic spectroscopy-A.B.P.Lever-Elsevier, Amsterdam (1984)
2. Physical methods in advanced inorganic Chemistry, H.A.O Hill and P.Day, John Wiley (1968)
3. Coordination Chemistry Experimental methods, J.K.Burger butterworths (1973)

PERIODICALS:

1. Resonance- Journal of science education
2. Applied Spectroscopy
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society

7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. *http://nptel.ac.in*
3. *MATLAB*
4. *mooc.org*
5. *http:/swayam.gov.in*
6. http://search.ebscohost.com
7. **www.spectro.com**

SEMESTER - IV

Title of the course: Major Elective 4 - Electrochemistry and Computational Chemistry

Teaching hours: 15 x 5 = 75 **Credits: 4**
Course Code: 6P18/4E4/ECC

L T P 4 1 0

Objectives:

1. To understand the concepts, principles and theories of ionic and electronic interactions in solutions
2. To explore thermodynamic models of electrode-electrolyte interface
3. To study the working and applications of electro chemical systems – Cells and Batteries
4. To derive the kinetics and the parameters affecting them
5. To understand first principles atomic structure using computational methods.

COURSE OUTLINE

UNIT I: **Electrochemistry I:** Ionics: Ions in solutions, true and potential electrolytes, ion – solvent , ion –ion interactions ,ionic strength- concept and calculations, Debye Huckel theory of strong electrolytes , Poisson equation, Poisson- Boltzman equation, activity co-efficient and mean ionic activity efficient of electrolytes, Debye Huckel limiting law - Derivation verification and its extensions, Debye Huckel Onsager equation- derivation and verification. 15 Hrs

UNIT II: **Electrochemistry II:** Electrodics: Electode-electrolyte interface, adsorption at electrified interface-electrical double layer, Structure of double layer- Helmholtz-Perrin, Guoy Chapmann and Stern models of electrical double layers. Thermodynamic derivation of electrified interfaces- Lippmann capillary equation- electro capillary phenomenon, Polarizable and Non Polarizable electrodes. Electrokinetic phenomenon- explanation of these phenomenon with the concept of forces and flux-Onsager reciprocity. **15 hrs**

UNIT III: Electrochemistry III: Electrodics- Butler Volmer equation for one step and multi step electron transfer reactions. Limiting cases- Tafel and Nernst equation. Significance of equilibrium exchange current density and symmetry factor, transfer co-efficient. Electrochemical (inorganic and organic) reactions of technological interest (one example each). **15 hrs**

UNIT IV: Electrochemistry IV: Mechanism of electrode reactions-polarizations and over potential –Corrosion and passivation of metals- Pourbaix (Iron and Lead systems only) and Evans diagrams, Theories of corrosion. Prevention from corrosion–anodic and cathodic protection, corrosion inhibitors. Electrochemical energy systems - primary and secondary batteries- dry cells, lead acid storage batteries, silver zinc cell, nickel cadmium battery, mercury cell, fuel cells. Electrodeposition - principles and applications. **15 hrs**

UNIT V: **Computational Chemistry**:A brief outline of molecular mechanics, semi-empirical approximations, *ab initio* methods, basis sets and Z-matrix; Gaussian, Slater type. Density Function Theory- overview- Kohn Hohenberg and Kohn Sham equation (no derivation) Hartree -Fock calculations for determining electronic energies. Basic concepts of molecular dynamics and simulations. **15 hrs**

RECOMMENDED TEXT BOOKS:

1. S. Glasstone- Introduction to Electrochemistry, Affiliated East West press, New Delhi
2. D. R.Crow-Principles and Applications of Electrochemistry, Chapman and Hall.
3. Frank Jensen, Introduction to computational chemistry, 2nd edition, John Wiley & Sons Ltd. (2007)

4. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, John Wiley & Sons, 2002.
5. D. Young, Computational Chemistry: A practical Guide for applying Techniques to Real World Problems, Wiley Interscience, 2001.
6. A.R.Leach, Molecular Modelling: Principles and Applications, Pearson Education, 2001.
7. J. B. Foresman, A. Frisch, Exploring Chemistry with Electronic Structure Methods. Gaussian Inc., 1996.
8. M. P. Allen and D. J. Tildesley, Computer Simulations of Liquids, Oxford, 1987

REFERENCE BOOKS:

1. J.O.M.Bockris and A.K.N.Reddy-Electrochemistry-Vol I & II, Plenum, Newyork 1977
2. P.Delhay – Electrode Kinetics and structure of double layer interscience, New york, 1965
3. J.Robbins-Ion in solution-an introduction to electro chemistry, Clarendon press, Oxford (1972)
4. C.M.A.Brett and A.M.O.Brett –Electrochemistry principles, methods and applications, OUP,Oxford, 1993.
5. P.H.Rieger-Electrochemistry,Chapman and Hall, Newyork (1994)
6. R.L.De Koch and H.B.Gray – Chemical structures and Bonding, Benjamin/Cummings, Menlo Park, California.

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. *http://nptel.ac.in*
3. *MATLAB*
4. *Mooc.org*
5. *http:/swayam.gov.in*
6. http://search.ebscohost.com
7. http://ccl.osc,edu/ccl.cca.html
8. http://www.chem.swin.esu.au/chem_ref.html

9. http://www.colby.edu/chemistry/PChem/Lecture1.html
10. http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/electrode.html#c3

Computational chemistry software

11. SPARTAN
12. http:/www.wavefun.com
13. GAUSSIAN
14. www.gaussian.com
15. MOLPRO
16. www.tc.bham.ac.uk/morpro

SEMESTER- IV

Title of the course: Major Elective-5 Polymer Chemistry

Teaching hours: 15 x 4=60 **Credits: 3**

Course Code: 6P18/4E5/POC **L T P 3 1 0**

Objectives:

1. To learn the theoretical concepts in polymer chemistry
2. To appreciate their significance and applications of polymers
3. To motivate the students to pursue research in polymer chemistry
4. To study the techniques for characterization of polymers
5. To study the mechanism of polymerisation

COURSE OUTLINE

UNIT I: **Introductory Survey:** Concept of Polymers, common terms used in Polymers-Classification of Polymers-natural and synthetic Polymers-condensation polymers, addition polymers, co-polymerization, polymerization of cyclic compounds-

Inorganic Polymers-Techniques of polymerization- bulk polymerization-solution polymerization, suspension polymeriztion, emulsion polymerization, melt poly condensation-interfacial condensation-solid and gas phase polymerization and plasma polymerization. Polymer Structure- Co-polymers, Tacticity, Geometrical isomerism. **12hrs**

UNIT II: Mechanism and Kinetics of Polymerisation: Step Growth Polymerisation or Polycondensation Chain Polymerisation- Radical polymerization Anionic polymerization, Cationic polymerization, coordination polymerization,with respect to Ziegler Natta catalyst, co-polymerization, composition of co-polymers-block and graft co-polymers,-ring opening-polymerisation. **12hrs**

UNIT III: **Structure and Properties:** Primary and secondary bond forces in Polymers. Coherence energy-structure property relationship. Mechanical properties-Tensile strength, Compressive, Flexural strength, fatigue resistance and impact resistance Relationship between molecular weight and mechanical properties. Glass Transition Temperature Degradability-Degradation by a. Oxidative degradation b. Mechanical, c. Ultrasonic wave. d. Photo degradation bio degradation Chain flexiblity. Electrical Conductivity. Flow properties of polymer melts and solutions.

12hrs

UNIT IV: **Polymer Analysis and Characterisation**: Identification-Physical testing, IR, NMR, (spectral methods) Identification of typical plastic materials eg. ABS, Acrylics, polyfluorocarbons pvc,. Other examples polystyrene, poly vinyl acetate, polyvinyl alcohol. Testing Thermal, electrical and chemical. Characterization - Molecular weight distribution in polymers. Determination of molecular weight, fractionation-gel permiation chromatography, number average molecular weight-osmometry. Weight average molecular weight light scatterinng measurements, ultracentrifugation, viscosity and DLS method.

12hrs

UNIT V: Polymer Processing and Applications: Plastics-thermosetting and thermoplastics, Rubber-the composition of rubber latex- the processing of rubber Natural and Synthetic fibres criteria for fibre formation. Basic Processing Operations-Extrusion, Moulding, Calendering, Coating Membrane Application for Polymeric Materials. Biomedical Applications-Artificial Organs, Controlled Drug Delivery, Homodialysis and Hemofiltration. Application in Electronics-Electrically conductive polymers, electronic shielding, encapsulation. Polymers in Photonics applications, Drag Reduction and Dentrimers.

12hrs

RECOMMENDED TEXT BOOKS:

1. F.W.Billmeyer- Textbook of Polymer science, Wiley intersicence
2. A.Rudin- The elements of Polymer Science and Engineering- An introductory text for engineers and chemists, Academic Press, Newyork
3. Polymer Science- V.R.Gowarikar, N.V.Viswanathan & Jayadev Sreedar

4. Principles of Polymer Science- P.Bhadur, N.V.Sastry, Warosa Publishing House
5. Introductory Polymer Chemistry-G.S.Mishra

REFERENCE BOOKS:

1. C.E.H.Bawn- The chemistry of high polymers, Butterworth and Co., London
2. E.A.Collins, J.Bares and E.W.Billmeyer- Experiments in Polymer Science, Wiley Inter Science, New york
3. G.S.Krishenbaum-Polymer Science study guide, Gordon Breach Science Publishing, New york
4. G.Odien – Principles of Polymerisation, Mc Graw Hill book co, Newyork
5. P.H.Flory- Principles of Polymer Chemistry, Cornell Press, Ithaca
6. Polymer Science and Technology- Joel and Fried
7. Polymer Chemistry- An introduction, Malcolm P.Stevens.

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. *http://nptel.ac.in*
3. *MATLAB*
4. *mooc.org*
5. *http:/swayam.gov.in*
6. http://search.ebscohost.com