Kadi Sarva Vishwavidhyalaya

M.Sc. Chemistry

Syllabus

(Physical Chemistry)

Sem III and Sem IV

w.e.f. June 2018

KADI SARVA VISHWAVIDYALYA
M.Sc Physical Chemistry Syllabus

KADI SARVA VISHWAVIDYALAYA
M. Sc Physical Chemistry Semester – 3 & 4 Syllabus Structure
(W.E.F. June 2018)

	KADI SARVA VISHWAVIDYALYA					
	M.SC PHYSICAL CHEMISTRY SEMESTER-3 SCHEME					
Subject Code	**Course**	**Instruction Hrs / week**	**Examination**			**Credit**
			Internal	**University Exam**	**Total**	
CH-PC 301	Molecular Spectroscopy	4	30	70	100	4
CH-PC 302	Macromolecules	4	30	70	100	4
CH-PC 303	Electroanalytical Techniques	4	30	70	100	4
CH-PC 304	Chemical Kinetics and Thermodynamics	4	30	70	100	4
CC-301 A	Research Methodology I	2	15	35	50	2
CH-PC 305	Physical chemistry Practicals - I	16	0	200	200	8
	Total	**34**	**135**	**515**	**650**	**26**

	KADI SARVA VISHWAVIDYALYA					
	M.SC PHYSICAL CHEMISTRY SEMESTER - 4 SCHEME					
Subject Code	**Course**	**Instruction Hrs / week**	**Examination**			**Credit**
			Internal	**University Exam**	**Total**	
CH-PC 401	Electrochemistry	4	30	70	100	4
CH-PC 402	Nano materials and Instrumental analysis	4	30	70	100	4
CC-401 A	Research Methodology II	2	15	35	50	2
CH-PC 403	Physical Chemistry Practicals - II	8	0	100	100	4
CH-PC 404	Dissertation / Industrial Training	12	50	250	300	12
	Total	**30**	**125**	**525**	**650**	**26**

KADI SARVA VISHWAVIDYALYA
M.Sc Physical Chemistry Syllabus

M.Sc Physical Chemistry Semester-III

Paper: Molecular Spectroscopy (CH-PC 301) **Credit** 04

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-PC 301	Molecular Spectroscopy	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of molecular spectroscopy. To understand various molecular transitions and hence the spectra arising on the basis of transitions between different energy levels.

Learning Outcome:

- Students can understand different concepts of rotational and vibrational spectroscopy
- They can understand the fundamental principles of molecular transitions between various energy level arising due to incidence of different electromagnetic radiations.
- They can understand the principle and instrumentation of raman spectroscopy
- Students can gain knowledge of electronic spectroscopy and application of ESR spectroscopy.

Unit	Topics of Paper CH-PC 301	Marks	Teaching Hrs
	Section A		
1	**Microwave Spectroscopy (Rotational Spectroscopy)** Basics of spectroscopy. The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules. Applications of microwave spectroscopy.	15	15
2	**Infrared Spectroscopy (vibrational Spectroscopy)** The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P,Q,R branches, vibration of polyatomic molecules, normal mode of vibrations.	15	15
	Section B		

3	**Raman Spectroscopy** Classical and quantum theories, pure rotational Raman spectra of linear molecules and symmetric top molecules, vibrational Raman spectra, mutual exclusion principle, overtone and combination vibrations, polarization of the light and Raman effect, depolarization of Raman lines. instrumentation and applications of Raman spectroscopy.	15	15
4	**Electronic Spectroscopy** Electronic Spectra of Diatomic molecules, Frank-condon principle, Rotational fine structure of Electronic Vibrational Transition, Electronic Structure of diatomic molecules (Molecular orbital theory, Shapes of Molecular orbitals, electronic angular moment in diatomic molecules) **Electron Spin Resonance Spectroscopy** Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.	15	15
	Objective questions from all units	10	

Reference books:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.

Paper: Macromolecules(CH-PC 302) **Credit** 04

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-PC 302	Macromolecules	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of polymers, its phase transitions, various degradation reactions of polymers, different polymerization techniques and properties of polymeric solutions

Learning Outcome:

- Students can understand different concepts of chemical structure of polymer and various phase transition in polymers.
- They can understand different types of polymer degradation reaction and functional group reaction of different polymers.
- They can understand rheological properties of macromolecules and some polymerization techniques.
- Students can gain knowledge of properties of polymeric solutions

Unit	Topics of Paper CH-PC 302	Marks	Teaching Hrs
	Section A		
1	**Chemical and geometrical structure of polymer molecule** Micro structures based on chemical structure, microstructures based on geometrical structures, stereo regular polymers **Phase transition in polymers** Glass transition temperature, glassy solid and glass transition, transition and associated properties, factors influencing glass transition temperature, glass transition temperature and molecular weight, glass transition temperature and plasticisers, glass transition temperature of copolymer, glass transition temperature and melting point, importance of glass transition temperature.	15	15
2	**Polymer Degradation** Types of degradation, Thermal degradation, mechanical degradation, degradation by ultrasonic waves, photodegradation, degradation by high energy radiation, oxidative degradation. **Polymer Reaction** Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reaction, cyclisation reaction, crosslink reactions, vulcanisation, cure reaction, reactions of various specific groups.	15	15

	Section B		
3	**Polymerisation Techniques** Bulk polymerisation, solution polymerisation, emulsion polymerisation, interfacial polymerization, solid and gas phase polymerization. **Polymer solutions** Polymer dissolution process, thermodynamics of polymer dissolution, deviations from Raoults law, flory-Huggins theory of entropy and enthalpy of mixing, nature of polymer molecules in solution.	15	15
4	**Rheology of polymeric materials** Hooke's equation, Newton's equation, Maxwell and voigt models for viscoelasticity, deformation behaviour of polymeric materials, relaxation and retardation. **Polymer Processing** Compounding, Casting, Moulding, Foaming, Reinforcing, Fibre spinning.	15	15
	Objective questions from all units	10	

Reference books:

1. Macromolecular Physical Chemistry by P. H. Parsania.
2. L.L. Polymer chemistry –Flory
3. Polymer science –Hiemenz
4. Polymer science- V.R. Gowariker, N.V. Viswanathan& J.Sreedhar, Wiley-Eastern
5. Text book of polymer science-F.W. Billmayer
6. Contemporary polymer chemistry- H.R.Alcock, F.W.Lambe, Prentice Hall
7. Introduction to polymer science and technology-An SPE text book, H.S.Kaufman, J.J.Faleetta, Wiley-Interscience publication 1977
8. Polymer chemistry-An introduction, M.P.Stevens-oxford univ. press, Indian ed.
9. Principles of polymer science, Bhahadur& N.V.Sastry-Narosa publication
10. Polymer processing D.H.Morton-Jones, champman and Hall Inc.
11. Principles of polymer system R.S.Schwartz, S.H.Gardman
12. Polymer chemistry- B.K.Sharma, Krishna prakashan, meeraut

Paper: Electroanalytical Techniques (CH-PC 303) **Credit** 04

Rationale of the Paper: To provide the basic knowledge of fundamental of electroanalytical measurement. To understand the principle and working of various electroanalytical techniques like coulometry, electrophoresis etc.

Learning Outcome:

- Student can understand the basics of electroanalytical measurement
- They can understand working and applications of various electrochemical and bio-sensors
- Students can gain knowledge of different electroanalytical techniques like coulometry, electrophoresis and electrogravimetry

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Paper: Electroanalytical Techniques (CH-PC 303) **Credit 04**

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-PC-303	Electroanalytical Techniques	4	4	……	70	30	100

Unit	Topics of Paper CH-PC-303	Marks	Teaching Hrs
	Section A		
1	**Electroanalytical Measurements** Introduction to physico chemical devices and their mechanism of Working, Voltage, Impedance, The electric double layer, Electrocapillarity.Current, Diffusion transport.	15	15
2	**Electrochemical and Bio-sensors** Potentiometric sensors. Potentiometric biosensors. Amperometric sensors. Conductometric sensors. Applications of Field-Effect Transistors sensors.	15	15
	Section B		
3	**Electrodeposition and Coulometry** Electrolysis. Current-Voltage relation. Electrogravimetric analysis at constant current, constant potential and at controlled potential. Coulometric analysis	15	15
4	**Electrophoresis** Principles of electrophoresis, theory and applications of Poly acrylamide gel electrophoresis, capillary zone electrophoresis, micelles electrokinetic electrophoresis, Iso-electric focusing. Efficiency and resolution. Applications	15	15
	Objectives from all units	10	

References:

1. Peter T. Kissinger, William R. Heineman, "Laboratory Techniques in Electroanalytical Chemistry",Marcel Dekker Inc., New York.

2. Basil H. Vassos, Galen W. Ewing, "Electroanalytical Chemistry",John Wiley & Sons, New York.
3. Allen J. Bard, Larry R. Faulkner, "Electrochemical Methods – Fundamentals and Applications", John Wiley & Sons, New York.
4. Daniel C. Harris, "Quantitative Chemical Analysis",W.H. Freeman and Company, New York.
5. I. M. Kolthoff, and P.J. Elving, "Treatise on Analytical Chemistry",WileyInterscience, New York.
6. Brian R. Eggins, "Chemical Sensors and Biosensors",John Wiley & Sons, NewYork
7. Skoog, D.A.; Holler, F.J.; Crouch, S.R "Principles of Instrumental Analysis" 6th ed. Thomson Brooks/Cole Publishing: Belmont, CA **2007**.
8. Skoog, D.A.; Holler, F.J.; Nieman, T.A. "Principles of Instrumental Analysis, 5th ed." Saunders college publishing: Philadelphia, **1998**.

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Paper: Chemical Kinetics and Thermodynamics (CH-PC 304) **Credit** 04

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-PC 304	Chemical Kinetics and Thermodynamics	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of different theories of reaction rates, kinetics of fast and slow reactions. To understand the basics of non-equilibrium thermodynamics.

Learning Outcome:

- Students can understand various advanced theories of reaction rates.
- They can understand various methods of determination of the kinetics of fast and slow reaction
- They can understand theory and kinetics of homogenous and heterogenous catalysis
- Students can gain basic knowledge of non equilibrium thermodynamics

Unit	Topics of Paper CH-PC 304	Marks	Teaching Hrs
	Section A		
1	**Theory of reaction rates** Collision theory of reaction rate, hinshelwoods theory, Kassel, Rice and Ramsperger theory, The RRKM theory, kinetics of opposing or reversible reaction, kinetics of consecutive reaction, kinetics of chain reaction, kinetics of branched chain reaction, diffusion-controlled reaction in solution.	15	15
2	**Kinetics of Fast and Slow reactions** Kinetics of fast reactions, NMR, Gas Liquid Chromatography, Mass spectrometry, EPR method, Flow method, Flash Photolysis, pulse radiolysis, small perturbation method. Kinetics of slow reactions, physical methods, pressure, partial pressure and density of gaseous system, density method or dilatometer method, colorimetry, electrical conductivity, GLC, Mass spectrometry, absorption spectroscopy, conventional kinetic systems.	15	15
	Section B		

3	**Catalysis** Types of catalysis, theory of homogenous catalysis, theory of heterogenous catalysis, kinetics of heterogenous catalysis, Kinetics of Surface reactions, Unimolecular Surface reactions, Bimolecular Surface reactions, effect of temperature on heterogeneous reactions, classification of catalysis, acid base catalysis, pH dependence of rate constant of catalysed reactions, Autocatalysis and Oscillatory reactions.	15	15
4	**Non-equilibrium Thermodynamics** Meaning and scope of irreversible thermodynamics. Phenomenological laws-linear laws, Gibb's equation, Onsager's reciprocal relation, Principle of microscopic reversibility and the onsagar reciprocal relations, Entropy production, specific examples of entropy production and entropy flow in open system, Non-equilibrium stationary states, Prigogine's principle of entropy production, Entropy production in coupled reactions. Some important applications.	15	15
	Objective questions from all units	10	

Reference books:

1. Physical chemistry- Atkins
2. Advanced physical chemistry- Gurdeep Raj
3. Physical chemistry- N.B.Singh, Shiva Saran Das, A.K.Singh (newage international publication),2009
4. Advanced physical chemistry –J.N.Gurtu and A. Gurtu, pragatiprakashan, 2008
5. Physical methods of chemistry –R.S. Drago
6. Introduction to the principles of heterogeneous catalysis. J.M.Thomas and W.J.Thomas, Acad.press, London, 1967
7. Chemical kinetics and catalysis G.M.Panchenkov and V.P.Lebedev., Mir publication, 1976
8. Fine chemicals through heterogeneous catalysis. Ed.by. R.A.Sheldon, H.Van Bekkem, 2001, Wiley-VCH.
9. Theory of adsorption and catalysis-A.Clark
10. Homogeneous catalysis-mechanisms and industrial applications-S.Bhaduri,D.Mukesh, 2000
11. Introduction to physical chemistry-S. Glasstone

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M.Sc Physical Chemistry Syllabus

Paper:Research Methodology-I(CC-301A) Credit 02

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CC-301A	Research Methodology-I	2	2	……..	50	------	50

Rationale of the Paper: To provide the basic knowledge of Research & Methodology

Learning Outcome:

- Students can learn the basic Introduction of Objective of research.
- Student will learn to define a research problem.

Unit	Topics of Paper CC-301A	Marks	Teaching Hrs
1	Research Methodology: An Introduction Meaning of research, Objectives of research, motivation in research, Types of research, Research Approaches, significance of research, research method vs methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research, problems encounter by researchers in India.	25	15
2	Defining Research Problem: what is research problem? selecting the problem, necessity of defining the problem, Technique involved in defining a problem, an illustration, conclusion Research Design: Meaning of research design, need for research design, features of good design, important concepts relating to research design, different research designs, basic principles of experimental design	25	15

Reference Books:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
4. Writing Your Thesis by Paul Oliver, VistaarPublication, New Delhi, 2006
5. The Research Student's Guide to Success by Pat Cryer, Viva Books Pvt Ltd., New Delhi

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Laboratory Course Sem-III Physical Chemistry

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total
CH-PC 305	Physical chemistry Practical- I	8	--	16	200	-----	200

Laboratory Course (MINIMUM 15)

1. Physico-chemical exercises
   Viscosity, thermodynamic excess properties, solubility, phase rule, kinetics.
2. Instrumental analysis: pHmetry, potentiometry, conductometry, spectrophotometry, refractive index, polarimetry, polarography and amperometry.
3. Chromatography: Paper, TLC and Column chromatography.
4. Polymer Synthesis
   Addition and condensation polymers: PS, PMA, PMMA, PAN, PVAc,UPE, Epoxy, PF, UF and MF resins.
5. Characterization of Polymers: Viscosity, molecular weight determination, epoxy equivalent, acid value, hydroxyl value, density, IR.

Reference books:

1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
2. Experimental Physical Chemistry, R.C. Das and B. Behera,McGraw Hill.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
5. Experiments in physical chemistry, P.H. Parsania, F. karia

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M.Sc. Physical Chemistry Semester IV

Paper:Electrochemistry (CH-PC 401) **Credit 04**

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total
CH – PC 401	Electrochemistry	4	4	-----	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of electrochemistry, migration of ions, polarization, overpotential and corrosion.

Learning Outcome:

- Students can understand the theories of ionization, dilution lawsand applications of electrochemistry.
- They can know the concept ofmigration of ions and transport number of ions
- They can understand the fundamentals of polarization and over potential
- Students can gain knowledge of corrosion, various factors influencing corrosion and prevention of corrosion.

Unit	Topics of Paper CH –PC 401	Marks	Teaching Hrs
	Section A		
1	**Theoretical and Application Aspects** Introduction, Arrhenius theory of ionization, Ostwald's dilution law, Application of electrolysis, Debye HuckelOnsagager equation and its validity and limitation Wein effect, Debye Falkenhagen effect, Industrial applications of Electrochemistry Migration of ions, transport number, determination of transport numbers hittorfs method, moving boundry method, EMF method, from ionic mobility,	15	15
2	**Oxidation Reduction systems** Types of reversible oxidation-reduction systems, determination of oxidation reduction potentials, variation of oxidation reduction potentials, oxidation reduction equilibrium **Amphoteric Electrolytes** Dipolar ions and evidences for their existence. Dissociation of amino acids, isoelectric points and neutralization curves of ampholytes.	15	15
	Section B		

3	**Polarization and Overpotential** Electrolytic polarization and concentration polarization. Decomposition voltages or decomposition potential. Measurement of decomposition potential, deposition potential, Overvoltage, Hydrogen over voltage, Oxygen over voltage, Factors Affecting over voltage, theories of over voltage, Importance of over voltage	15	15
4	**Corrosion**: Introduction to corrosion, causes of corrosion, Theories of corrosion, Factors influencing corrosion, corrosion inhibitors, Passivity, Types of corrosion, corrosion prevention techniques	15	15
	Objective questions from all units	10	

Reference books:

1. Electrochemical Methods: Fundamentals and Applications, 2nd Ed., A. J. Bard and L. R. Faulkner John Wiley & Sons: New York, 2002.
2. Modern Electrochemistry 1: Ionics 2nd Ed., Springer (1998), J. O' M. Bockris& A. K. N. Reddy.
3. Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science 2nd Ed., Springer (2001), J. O' M. Bockris& A. K. N. Reddy.
4. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O' M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.
5. An Introduction of Electrochemistry by S. Glasstone. Affiliated East West Press, New Delhi.
6. Electrochemistry by ShipraBaluja and FalguniKaria.
7. Electrochemistry by B. K. Sharma. Krishna Prakashan,Meerut
8. Physical chemistry- Atkins
9. Advanced physical chemistry- Gurdeep Raj
10. Physical chemistry- N.B.Singh, Shiva Saran Das, A.K.Singh (newage international publication),2009
11. Advanced physical chemistry –J.N.Gurtu and A. Gurtu, pragatiprakashan, 2008
12. Physical methods of chemistry –R.S. Drago

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Paper: Nano materials and Instrumental analysis (CH-PC-402) **Credit 04**

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-PC 402	Nano materials and Instrumental analysis	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of Nanomaterials and Instrumental analysis. To understand various surface activity and thermal stability of nanomaterials the SEM, TEM and thermal instrumentation will help them.

Learning Outcome:

- Students can understand different Physical and Chemical methods of the synthesis of nanomaterials.
- They can understand the fundamental of surface activity of these materials with the concepts of SEM, TEM and XRD.
- They can understand the importance of thermal stability of these materials.

Unit	Topics of Paper CH-PC 402	Marks	Teaching Hrs
	Section A		
1	**General introduction & synthesis of nanomaterials by physical methods** Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition withconsolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter deposition, electric arc deposition, Chemical Vapour Deposition (CVD).	15	15
2	**Synthesis of Nanomaterials by Chemical Methods** Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.	15	15
	Section B		

3	**Surface Morphology** **XRD:** Symmetry elements in crystals, miller indices for planes and directions, criteria for determining unit cell of lattice, space lattices. Introduction, origin of X-rays, monochromatization and diffraction methods. Crystal structure elucidation limited to cubic system. Characteristic difference between X-ray, electron and neutron diffraction techniques Applications of XRD. **SEM and TEM:** Introduction, principle, theory, instrumentation and applications	15	15
4	**Thermal Analysis** **TGA:** Introduction to thermal analysis, TG and DTG, static, Instrumentation, thermogram, factors affecting thermograms, application of thermogravimetry. Reaction Kinetics–kinetics by single and multiple heating rates. Differential thermal analysis, DTA theories, DTA curves, factors affecting DTA curves, Instrumentation, applications of DTA, simultaneous determination in thermal analysis. **DSC:** Introduction, Instrumentation, Power compensated DSC, Heat Flux DSC, DSC-curves, factors affecting DSC curves, applications	15	15
	Objective questions from all units	10	

Reference books:

1. Solid State Chemistry and applications- A.R. West (John Wiley and Sons)
2. Principles of the Solid State- H.V. Keer (Wiley Eastern Limited) 39
3. Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
4. NANO- The next revolution –Mohan SurendraRajan(National book Trust, India)
5. The British Glass Website- Types of Glass://www.britiglass.org.uk.
6. Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F.Tibbals, JoydeepDutta.
7. Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. L. Cushing, V. L. Kolesmichenko&C.J.O".Connor Chemical Review 104, 3893-3946.(2004).

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Paper: Research Methodology-II(CC-401A) Credit 02

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CC-401A	Research Methodology-II	2	2	……..	50	------	50

Rationale of the Paper: To provide the basic knowledge of Research & Methodology

Learning Outcome:

- Students can learn the methods to collect research data through different methods. Also understand role of computer in research
- Student will gain the knowledge of processing data and understand the guidelines of thesis writing.

Unit	Topics of Paper CC-401A	Marks	Teaching Hrs
1	**Methods of Data Collection:** collection of primary data, observation method, Interview method, collection of data through questionnaires, collection of data through schedules, difference between questionnaires and schedules, some other method of data collection, collection of secondary data, selection of appropriate method for data collection, role of computer in research.	25	15
2	**Processing And analysing data:** Processing operations, solving problems in processing, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationship, simple regression analysis, multiple correlation and regression, partial correlation, association in case of attributes, significance of writing thesis, different types of research writing, guidelines of writing good thesis.	25	15

Reference Books:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
4. Writing Your Thesis by Paul Oliver, VistaarPublication, New Delhi, 2006
5. The Research Student's Guide to Success by Pat Cryer, Viva Books Pvt Ltd., New Delhi

Physical chemistry Practical's (CH-OC 403) Credit: 04

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CH-PC 403	Physical ChemistryPracticals II	04	-----	08	100	-----	100

Laboratory Course (minimum 6)

1. Physico-chemical exercises
   Viscosity, thermodynamic excess properties, solubility, phase rule, kinetics.
2. Instrumental analysis: pH metry, potentiometry, conductometry, spectrophotometry, refractive index, polarimetry, polarography and amperometry.
3. Chromatography: Paper, TLC and Column chromatography.
4. Polymer Synthesis
   Addition and condensation polymers: PS, PMA, PMMA, PAN, PVAc, UPE, Epoxy,PF, UF and MF resins.
5. Characterization of Polymers: Viscosity, molecular weight determination, epoxy equivalent, acid value, hydroxyl value, density, IR.

Reference books:

1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
2. Experimental Physical Chemistry, R.C. Das and B. Behera,McGraw Hill.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard,Longman.
4. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
5. Experiments in physical chemistry, P.H. Parsania, F. karia

Physical Chemistry- Dissertation /industrial training (CH-PC 404) Credit 12

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CH-PC 404	**Dissertation /industrial training**	12	-------	12	250	50	300