SARDAR PATEL UNIVERSITY
Programme: MSC
(Under the Choice based Credit scheme)
SEMESTER-IV
STRUCTURE with effect from: November 2018

ANALYTICAL CHEMISTRY

Course Type	Course Code	Name of Course	T /P	Credit	Exam Duration in hrs	Component of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PS04CANC21	Spectroscopy - II	T	4	3	30/10	70/28	100/40
	PS04CANC22	Electro-Analytical Methods	T	4	3	30/10	70/28	100/40
	PS04CANC23	Analysis of Industrial Products	T	4	3	30/10	70/28	100/40
Core Course (Any one)	PS04CANC24	Practicals **OR**	P	4	3	30/10	70/28	100/40
	PS04CANC25	Project Work	P	4	3	30/10	70/28	100/40
Core Course (Any one)	PS04CANC26	Practicals **OR**	P	4	3	30/10	70/28	100/40
	PS04CANC27	Project Work	P	4	3	30/10	70/28	100/40
Core Course	PS04CANC28	Comprehensive Viva	-	1			50/20	50/20
Elective Course (Any one)	PS04EANC21	Envirnomental Chemistry and Analysis	T	4	3	30/10	70/28	100/40
	PS04EANC22	Analysis of Pharmaceutical drugs	T	4	3	30/10	70/28	100/40
				25				650

*** Project work** (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2018-19
M.Sc. CHEMISTRY
SEMESTER-IV
ORGANIC CHEMISTRY

(Total 650 marks)

Paper Code: PS04CANC21	**Total Credit: 4**
Title of Paper: Spectroscopy-II	

Unit	Description in detail	Weightage (%)
I	**Infrared Spectroscopy:** Theory and principles, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in hydrocarbons, aromatic compounds, alcohol and phenols, ethers, carbonyl compounds, amines, nitriles, nitro compounds, carboxylic acids and halide. **UV Spectroscopy:** Theory and principles of electronic transition and UV absorption, chromophores and auxochromes, Woodward-Fieser rules for dienes and enones, characteristic absorptions in alkenes and alkynes, alcohols, ethers, amines, carbonyl compounds. Effects of conjugation. Characteristic absorptions in aromatic compounds.	**25**

II	**PMR Spectroscopy:** Proton resonance condition, aspects of PMR spectra – number of signals, chemical shifts, shielding and deshielding, diamagnetic anisotropy, factors affecting chemical shifts, peak area and integration, splitting of the signals – spin-spin coupling, coupling constants – vicinal, geminal, long range and virtual couplings, Pople notation and spin assignments, chemical shift equivalence and magnetic equivalence, first order and second order spectra, complex PMR spectra, simplification of the PMR spectra – high resolution spectra, use of shift reagents, spin-spin decoupling-double resonance, proton exchange, deuterium exchange, Nuclear Overhauser Effect (NOE). Use of PMR spectra in differentiation of compounds/stereoisomers.	**25**
III	**^{13}C-NMR Spectroscopy:** Difficulties and solution for recording ^{13}C-NMR spectra, recording of ^{13}C-NMR spectra – scale, solvents, solvent signals and their positions, multiplicity, ^{13}C-^{1}H coupling constant – proton coupled and decoupled ^{13}C spectra, broad band decoupling, off resonance technique. Chemical shifts in ^{13}C spectra – chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds. Use of ^{13}C spectra in differentiating stereoisomers, Nuclear Overhauser Effect. ^{13}C - DEPT spectra – differentiation in primary, secondary and tertiary carbons by DEPT – 45, DEPT – 90, DEPT – 135 spectra. **2D NMR Spectroscopy:** Theory and principles of 2D NMR spectroscopy (COSY), Interpretation of ^{1}H-^{1}H COSY, ^{1}H-^{13}C HETCOR, HMQC, HMBC, INADEQUATE spectra.	**25**
IV	**Mass Spectroscopy:** Theory and principles of mass spectroscopy, Instrumentation, low and high resolution mass spectra, Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Ion Bombardment (FAB), Electronspray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI). Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak. Fragmentations – rules governing the fragmentations, McLafferty rearrangement. Interpretation of mass spectra of different class of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens. To identify structure from mass spectral data.	**25**

Reference books:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons).
2. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole).

3. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, 4th edition (Mcgraw – Hill Book Company).
4. Organic Spectroscopy, William Kemp, 3rd edition (Palgrave).
5. Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House).
6. Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers).
7. Principles of Instrumental Analysis, by Skoog, Holler and Neiman, Sunders College Publishers (USA).
8. Instrumental Methods of Chemical Analysis, 24th Edition 2005, by B. K. Sarma, Goel Publishing House, Meerut.
9. Elementary Organic Spectroscopy: Principles and Chemical applications (Revised Edition), by Y. R. Sharma (S. Chand Publishing).
10. Instrumental methods of analysis by B. Sivasanker, Oxford University Press, 2012.

Paper Code: PS04CANC22	Total Credit: 4
Title of Paper: Electro-Analytical Methods	

Unit	Description in detail	Weightage (%)
I	**pH and Ion-Selective electrodes:** Introduction, Construction and working of electrodes, Ion selective electrodes-Glass-membrane electrodes, Solid-state sensors, Liquid-membrane electrodes, Gas-sensing and Enzyme electrodes Interferences, Application of pH measurements, Ion-activity Evaluation Methods, Electrometric Measurement of pH and pI.	25
II	**Potentiometry:** Introduction, types of electrodes and its classification, Location of the Equivalence point, EMF and thermodynamic of the cell reactions, Determination of activity co-efficient from EMF measurements, Potentiometric titrations Methods and Its applications. **Coulometry & Electrogravimetry:** Introduction, Faradays laws of electrolysis, Methods of Coulometry, Instrumentations-Constant current and constant voltage instruments, Potentiostatic coulometry-Instrumentation and applications, Applications of Coulometry, Coulometric titrations, Advantages and limitations of Coulometric titrations, EG, applications, problems.	25
III	**Conductometry:** Introduction, Principle, Basic terms and their inter relationships, Measurement of conductance, factors affecting conductance, type & cell, Conductometric titrations, Applications such as Determination of degree of dissociation & dissociation constant of acids-bases, Determination of ionic product of water, Determination of Basicity of Organic compounds, Determination of solubility and solubility product of sparingly soluble salts, Determination of degree of hydrolysis and hydrolysis constant, advantages. **High Frequency Conductance Measurements:** Introduction, Types of Cells used, Instrumentation, Applications	25
IV	**Polarography & Voltametric Methods:** Introduction, Principle, Apparatus and electrode systems, Polarogram and Polarographic currents,	25

	Component of limiting current, Polarographic maxima, Half-wave potential, Derivation of a relation between half-wave potential & diffusion co-efficient, The ILKOVIC equation, Factors governing diffusion current, Evaluation Methods, Applications of polarography; Modified voltametric techniques such as A. C. Polarography, Rapid Scan Polarography, Pulse polarography, Cyclic Voltametry, Hydrodynamic Voltametry etc… **Ampereometric titrations :** Principle, Apparatus, Amperometric titrations. Biampereometric titrations - Titration with the Rotating platinum microelectrode, advantages and disadvantages, applications.	

Reference books:

1. Principles of Instrumental Analysis, 6th Edition 2006, by Douglas A. Skoog, F. James Holer, Timothy A. Nieman. Sunders College Publishers (USA).
2. Instrumental Methods of Chemical Analysis, 24th Edition 2005, by B. K. Sarma, Goel Publishing House, Meerut.
3. Instrumental methods of analysis by B. Sivasanker, Oxford University Press, 2012.
4. Principples of Instrumental Analysis, Instrumental Methods of Analysis, 6th Edition, by Willard, Merritt, Dean, Settle, CBS Publishers and Distributors.
5. Contemporary Chemical Analysis, by J. F. Rubinson and K. A. Rubinson, Princtice-Hall International Inc. 1998.
6. Analytical Chemistry, 6th Edition 2004, by Gary D. Christian, John Wiley & Sons Inc.
7. Introduction to Instrumental Analysis, by Robert D. Braun, McGraw-Hill Book company, New Delhi.
8. The Principles of Electrochemistry, by Duncan A. Maclnnes, Dover Publications Inc., N.Y.

Paper Code: PS04CANC23	Total Credit: 4
Title of Paper: Analysis of Industrial Products	

Unit	Description in detail	Weightage (%)
1	**Polymer analysis:** Introduction of polymer analysis, Theory of polymer analysis, Properties ofpolymer, Polymer analysis by various Instrumental such as GPC, VPO, electrophoresis, thermal methods (TGA, DTA, DSC) etc. and classical methods end group analysis, spot test etc. **Forensic Analytical Analysis:** Introduction and Importance of forensic Analytical analysis, DrugIdentification: overview, drug classes, spot tests, Toxicology: ethanol, breathtesting, headspace GC, Trace analysis: microscopy-hair, fiber, glass analysisAA and AE spectroscopy, IC, SEM, forensic pathologist, DNA analysis.	25
2	**Analysis of Agro-chemicals:** Introduction of pesticides and fertilizers, compositional and residual analysis,Classical and instrumental method of insecticides, pesticides and agrochemicals analysis, ISIspecification and analysis of BHC, Malanion, DDT, P and S containing pesticides etc.	25
3	**Pharmaceutical and Clinical analysis:** Introduction and overview of pharmaceutical analysis, Sulfa drugs,Antipyratic and Analgesics, and antibiotics, Instrumental and classical techniques use in pharmaceutical analysis; Hyphenated techniques use for pharmaceutical analysis. Clinical analysis: Introduction andoverview of clinical analysis, Composition of blood, collection andpreservation of samples and its analysis, Hyphenated techniques use in clinical analysis,Pharmacogentic testing.	25
4	**Oil and Fat analysis:** Introduction of oil and fat analysis, Chemical composition of oil and fat and itsimportance, Significance and analytical importance of Acid value, R. M. Value, P.V. Value, Saponification value, Iodinevalue, Ester value, Acetyl value, Peroxide value, thiocynogen number, Ratioof saturated and unsaturated fatty acids, Detection of adulterants in various oil and fat.	25

Reference Books:

1. Standard Methods of Chemical analysis Vol. I & II wil W. Scott D. Van Nostrand Co. Inc. Rinceton New Jersey, Toronto, N.Y.
2. Commercial method of analysis By Foster Dec Snell, Frank M. Biffeu Taraporwak and sons.
3. Encyclopaedia of Industrial chemical analysis Vol. I & II, W. Scott, D. Van Nostrand Co. Inc. Princeton New Jersey, Toronto, N.Y.
4. Spectroscopy of Polymer IInd Edition By Jack L. Koenig , Elsevier Science Inc. 655 Avenue of Americas, New York USA.
5. Polymer science and technology By Joel R. Fried, Prentice – Hall of India private limited, New Delhi.
6. Food composition and analysis By Howard Triebold, Leonard W. Auranel D Van Nostrand Company, Inc. Prienceton, New Jersey, Toronto.
7. Metallurgical analysis By B. C. Agrawal & S. P. Jain Khanna Publisher.
8. Applied Complexometry By Rudolf Pribrill and R. A. Chalmess Oxford N. Y.
9. W.G. Eckert, Introduction to Forensic Sciences, Second Edition, Elsevier, New York, 1992.
10. B.A. J. Fisher, Techniques of Crime Scene Investigation, Seventh Edition, CRC Press, Boca Raton, 2004.
11. Analytical Chemistry by Gary D Christian, 6th Edition, Wiley India

Paper Code: PS04CANC24	Total Credit: 4
Title of Paper: Practical	

Practicals Based On:	Classical Methods of Analysis.	
1.	To determine the neutralization capacity of given antacid.	(S)
2.	To determine free fatty acid in crude and refined edible oils.	(S)

Unit	Description in detail	Weightage (%): 100%
3.	To determine the free phenol in phenol formaldehyde resin by Koppeschaar's method.	(L)
4.	To determine the % of free formaldehyde in a given phenolic resin (Novolak or Resol).	(S)

Practicals Based On:	Analysis of Industrial Products.	
1.	Determination of Saponification value of an oil.	(S)
2.	Determination of Iodine value of an oil by Wij's method.	(S)
3.	Determine the Reichert-Missal value (R.M value) and P.V value of given sample.	(S)
4.	To determine the total phosphorous as P_2O_5 in detergent.	(L)

Practicals Based On:	Instrumental Methods of Analysis.	
1.	To determine Na , K , Ca in given sample by flame photometry.	(S)
2.	To determine the amount of paracetamol in given pharmaceutical sample.	(S)
3.	Fluorimetric determination of Riboflavin (Vitamin B2)	(S)
4.	Determination of glucose by Potentiometric method.	(L)
5.	To determine the amount of aspirin in a given tablet by Conductometrically.	(S)

(S) = Short exercise ; (L) = Long Exercise

References:

1. Food composition and analysis by howard & leonard D. Van Nostinol Comp. Inc. p.165.
2. Chemical Analysis of Plastic, A. Krause and A. Lange, London Illiffe Book Ltd., p. 65.
3. Official Methods of Analysis of the Association of official Analytical Chemists. 28, 029, p. 490, 12th Ed. 1975.
4. Encyclopedia of Industrial methods of analysis, Vol. 14 & 19.
5. Text book of Quantitative Chemical Analysis by A. I . Vogel.
6. A Textbook on Experiments Calculation in Chemical Engineering By S. S. Dara, S. Chand & Company Ltd., New Delhi, 1997.
7. Vogel's "Textbook of Quantitative chemical analysis" by G. H. Jeffery, J. Basserr Edition. 1989.
8. Analytical Chemistry by G. D. Christian , 3rd Edition.

Paper Code: PS04CANC26	Total Credit: 4
Title of Paper: Practical	

Practicals Based On:	Classical Methods of Analysis.	
1.	To determine the % of Alluminium in a given alloy.	(L)

Unit	Description in detail	Weightage (%): 100%
2.	Determination of % of amino group of given amine.	(S)
3.	To determine % purity of given alcohol sample by iodometric titration.	(S)
4.	To determine the % of nitrogen in a given sample of an organic compound by Kjeldalh's method.	(S)

Practicals Based On:	Analysis of Industrial Products.	
1.	Determination of the dissolved oxygen present in a water sample.	(S)
2.	Estimation of Penicillin content of given pharmaceutical.	(S)
3.	To determine the percentage of calcium carbonate in a given toothpaste sample.	(S)
4.	Preparation of column chromatography (by Dry/Wet methods) and separation/estimation of organic compounds by column chromatography.	(S)
5.	To determination of Ca in Ginger smple.	(S)

Practicals Based On:	Instrumental Methods of Analysis.	
1.	To determine the amount of aspirin in a given tablet by UV Spectrophotometry (calibration curve method).	(S)
2.	To determine the amount of aspirin in a given tablet by UV	(S)

	Spectroscopy (standard addition technique).	
3.	To determine % Fe in iron tablet by colourimetry. Fe (III)	(S)
4.	Assay of iron in pharmaceutical preparation using potassium thiocyanate by colorimetry. Fe(II)	(S)
5.	To determine NO_3^- nitrogen in water.	(L)

(S) = Short exercise ; (L) = Long Exercise

References:

1. A Textbook on Experiments Calculation in Chemical Engineering By S. S. Dara, S. Chand & Company Ltd., New Delhi, 1997,
2. J. G. Dick, Analytical Chemistry, p.640, International student Edn., Mc Grow Hill, Kogaksusha Ltd., 1973.
3. Analytical chemistry by S. Shapiro Ya., Gurvich Eng. Transition, Mir Publisher, Moscow 1975.
4. Quantitative Analytical Chemistry, P. 596, 15 Edition by James S. Fritz, George II. Schenk.
5. Experimental Physical Chemistry by R. C. Das and B. Behera. P. 27.
6. Quantitative Organic Analysis, Part-3 First Edition By A. I . Vogel (1958).
7. Encyclopedia of Industrial methods of analysis, Vol. 8, p. 166.
8. Analytical Chemistry by G. D. Christian , 3rd Edition, p. 278, p. 411.

OR

PS04CANC25 and PS04CANC27 : Project Work*

Project work (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

PS04CPHC28 : Comprehensive VIVA

Paper Code: PS04 EANC21	Total Credit: 4
Title of Paper: Environmental Chemistry and Analysis	

Unit	Description in detail	Weightage (%)
1	**Environmental segments**	
	Introduction to scope of study and useful terms, **Earth's atmosphere:** Composition and structure, stratospheric chemistry-Ozone, tropospheric chemistry- fog, precipitation, particles, ions, radicals, aerosols **Hydrosphere:** water resources, properties of water, distribution of species in aquatic systems, sea water model, microbiological processes, gases in water etc. **Terrestrial environment:** Concentric layers of earth, formation and composition of soil, soil properties and textures, nitrogen cycle and NPK in soil **Biosphere:** ecosystem and natural cycles	**25**
2	**Environmental pollution**	
	Pollutants & their classification, environmental indicators, **Air pollution**: sources and impact of air pollutants, pollution by CFCs, SMOK, FOG, SMOG, PAN, PAH, green house effect, acid rain, ozone depletion, EL Nino event, **Water pollution:** toxic elements and pesticides in water, their impact on enzymatic and biochemical processes, **Soil pollution:** wastes and pollutants in soil and their classification, Pollution-fertilizers, pesticides, plastics and metals	**25**
3	**Environmental chemical analysis methods**	

	Monitoring techniques in water and gas analysis**:** sampling, total solids, alkalinity and acidity, chlorides and sulfate, hardness, D.O., BOD, COD, nitrate and nitrite, analysis of pollutants in water, analysis of fuel gas, analysis of gaseous pollutants in air, Karl-Fisher reagent and its use, **Instrumental techniques:** atomic absorption spectrometry, X-ray fluorescence, gas-chromatography etc.	**25**
4	**Waste management and green chemistry**	
	Waste management: classification of wastes, overview of waste management programme, methodologies and techniques available and new approaches, **Green chemistry:** basic Principle and its need, tools for green synthesis, twelve principles of green chemistry, and elementary ideas about green process, green reagent, solvent, catalyst, atom economy	**25**

Reference Books:

1. *Environmental Chemistry* by J.W.Moore & E.A.Moore, Academic Press.Inc.New York,1976
2. *Environmental Chemistry* by A.K.De,4th edition, New Age International Publishers
3. *Principles of Environmental Science : Inquiry and Applications* by William P.Cunningham & Mary A.Cunningham,1st edition,2002,Tata McGraw Hill Publishing Company Ltd.,New Delhi
4. *Environmental Chemistry* by S.K. Banerji, 2nd Edition, 1999, Prantice Hall of India Pvt. Ltd., New Delhi.

1. Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH
2. Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley
5. *A text book on Experiments and Calculations-Engineering Chemistry*, 1st Edition, 1984, S.Chand &Co. Ltd., New Delhi.

Paper Code: PS04CANC22	Total Credit: 4
Title of Paper: Analysis of Pharmaceuticals	

Unit	Description in detail	Weightage (%)
I	**Role of FDA in Pharmaceutical Industries**: Definitions of Drug & Cosmetics, Substandard Drugs, Role of FDA, Introduction to New Drug, Development of New Drugs- Selection of Area,, Phase I, Phase II, Phase III Application to FDA for formulation and marketing for new drug. Stability studies and Self life fixation. **Biological Tests & Assay :** Introduction to biological assay, Biological assay of Heparin sodium, Determination of Amylase activity, Determination of Photolytic Activity, Test for Insulin in solution, Biological Assay of Tetanus Antitoxin, Test for Undue Toxicity.	25
II	**Microbiological Tests and Assays :** Microbiological test for antibiotics Standard preparation and units of activity, Test organisms and Inoculums, Cylinder-plate assay receptacles, Turbidimetric assay receptacles, Assay Designs, Cylinder plate or Cup-plate method, Two level fractional assay, Test for Sterility. **Physical Test, Determinations, Limit tests and Sterilization :** Disintegration Test for Tablets and Capsules, Dissolution Test for Tablets and Capsules, moisture / water content by Karl-Fischer titration, limit tests for arsenic, heavy metals, iron, lead, sulphate, chloride, Ash, sulphated ash, Methods for Sterilization Steam Sterilization, Dry heat sterilization, Sterilization by Filtration, Gas Sterilization, Sterilization by Ionizing radiation, Sterilization by heating with Bactericides, Water for Pharmaceutical use.	25
III	**Analysis of vegetable Drugs :** **Vegetable drugs**: Sampling, foreign organic matter, ash value, acid soluble ash, acid insoluble ash, sulphated ash, Extraction of alkaloids. **Sources of Impurities in Pharmaceutical raw materials & finished products, Shelf life of pharmaceutical product:**	25

	Raw materials, Method of manufacture, Atmospheric contaminations, Cross Contamination, Microbial contamination, Container contamination, Packaging errors, Chemical instability, Temperature effect and Physical changes, shelf life of pharmaceutical product and determination of shelf life.	
IV	**Standardization and quality control of different raw materials and dosage form:** Analysis of raw materials with respect to identification, other or related substances, loss on drying, and Assay as per IP, i) adrenaline ii) Cephalexin, iii) isoniazid and iv) paracetamol. Problems based on assay of these materials. Brief introduction to different dosage forms with the IP requirements Analytical methods for the following- Tablets, different types of tablets, uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, (Rifampicin) Powders (Sodium benzoate), Solutions (saline NaCl) Suspensions (barium sulphate –limit test for impurity) Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), ophthalmic preparations (sulphacteamine), Aerosols (salbutamol)	**25**

Reference books:

1. Practical biochemistry, Principles and Techniques, 5th Edition, by Keith Wilson and John Walker, Cambridge University Press.
2. Quantitative Analysis of Drugs in Pharmaceutical formulations, 3rd Edition, by P. D. Sethi, C.B.S. Publishers & Distributors, New Delhi.
3. Indian Pharmacopeia Volume I and II.
4. Practical Pharmaceutical chemistry, 3rd Edition, volume 1, By A.H.Beckett and J. B. Stenlake.
5. Remington's Pharmaceutical sciences.
6. Ansel's Pharmaceutical Analysis