Resolution Number: AC/II (20-21).2.RPS5

S.P. Mandali

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for Semester III and IV

Program: M.Sc. (Analytical Chemistry)

Program Code: (RPSCHEA)

(Credit Based Semester and Grading System with effect from the academic year 2020–2021)

SEMESTER-III			
Course Code	**Unit**	**Course Title / Unit Title**	**Credits**
RPSCHEA301	**Quality in Analytical Chemistry**		**4**
	I	Quality in Analytical Chemistry – I	
	II	Quality in Analytical Chemistry – II	
	III	Chromatographic Techniques -I	
	IV	Chromatographic Techniques -II	
RPSCHEA302	**Advanced Instrumental Techniques**		**4**
	I	Spectral Methods I	
	II	Hyphenated Techniques	
	III	Radiochemical & Thermal methods	
	IV	Electroanalytical Methods	
RPSCHEA303	**Bioanalytical Chemistry & Food Analysis**		**4**
	I	Bioanalytical chemistry	
	II	Immunological Methods	
	III	Food Analysis – I	
	IV	Food Analysis – II	
RPSCHEAEC-I 304	**Environmental & Certain Industrially Important Materials**		**4**
	I	Air Pollution	
	II	Water Quality Standards	
	III	Other Types Of Pollution	
	IV	Green Chemistry	
RPSCHEAEC-II 304	**Pharmaceutical & Organic Analysis**		**4**
	I	Pharmaceutical Analysis	
	II	Drugs	
	III	Forensic Science	
	IV	Cosmetic Analysis	
RPSCHEA3P1	**Practical**		**8**
RPSCHEA3P2			
RPSCHEA3P3			
RPSCHEA3P4			

SEMESTER-IV			
Course Code	**Unit**	**Course Title/Unit Title**	**Credits**
RPSCHEA401	**Separation Techniques & Industrial Materials**		**4**
	I	Separation Science	
	II	Electrophoresis	
	III	Separation, Analysis and Standardization of Herbal based products.	
	IV	Industrial Materials	
RPSCHEA402	**Advanced Instrumental Techniques**		**4**
	I	Spectral Methods II	
	II	Spectral Methods III	
	III	Spectral Methods IV	
	IV	Micellaneous Techniques	
RPSCHEA403	**Environmental & Certain Industrially Important Materials**		**4**
	I	Effluent Treatment	
	II	Solid Waste Management	
	III	Plastics and Polymers	
	IV	Metallurgy	
RPSCHEAOC-I 404	**Intellectual Property Rights & Cheminformatics**		**4**
	I	Introduction to Intellectual Property – I	
	II	Introduction to Intellectual Property - II	
	III	Cheminformatics-I	
	IV	Cheminformatics-II	
RPSCHEAOC-II 404	**Research Methodology**		**4**
	I	Review of Literature	
	II	Data Analysis	
	III	Methods of Scientific Research and Writing Scientific Papers	
	IV	Chemical Safety & Ethical Handling of Chemicals	
RPSCHEA4P1	**Practical**		**8**
RPSCHEA4P2			
RPSCHEA4P3			
RPSCHEA4P4	**Project Evaluation**		

SEMESTER-III

Course Code : RPSCHEA301

Course Title : QUALITY IN ANALYTICAL CHEMISTRY

Academic year 2021-22.

Course Outcomes:

After completion of this course, the learner will be able to,	
CO 1	Elaborate on the concept of Sampling and various methods involved in sample preparation and storage.
CO 2	Select the best method out of all the methods available for the analysis of samples.
CO 3	Calculate the uncertainty involved in a measurement.
CO 4	Describe the sources & different methods used for the enhancement of signal to noise ratio.
CO 5	Apply the parameters involved in method validation for developing a new method for the analysis of a sample.
CO 6	Make use of the principles involved in various chromatographic techniques such as Ionexchange, Size exclusion, SCF, Affinity, Inverse & UPLC to carry out separation & analysis of sample.

DETAILED SYLLABUS

Course Code	Unit	Course Title/Unit Title	Credits/ Lectures
RPSCHEA301	**QUALITY IN ANALYTICAL CHEMISTRY**		**4**
	I	**Quality in Analytical Chemistry-I**	**`15 L**
		1.1. **Sampling:** Definition, types of sample, sampling plan, quality of sample, sub-sampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of samples. Pre-treatment of samples: soil, food and cosmetics. (8L) **1.2**. **Selection of the Method:** Sources of methods, factors to consider when selecting a	

		method, performance criteria for methods used, reasons for incorrect analytical results, method validation, and quality by design (PAT). (7L)	
	II	**Quality in Analytical Chemistry – II**	**15 L**
		2.1. Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L) **2.2. Signal to noise:** Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction and software methods for noise reduction. (6L) **2.3. Principle, process and application of solid phase extraction and Solid phase micro extraction** (5L)	
	III	**Chromatographic Techniques -I**	**15 L**
		3.1. Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins and their applications for separation of inorganic and organic compounds. (5L) **3.2. Ion chromatography:** Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L) **3.3. Exclusion chromatography:** Theory, instrumentation including new detector technology like Laser light scattering detectors and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular	

		weight of polymers and application to biomolecule (5L) **3.4 Advances in HPLC:** UPLC, 2D LC, Multi-dimensional LC, Automation in LC, New column technologies. Sub 3 micron columns, Core columns, capillary columns, micro LC, Nano LC etc. (4L)	
	IV	**Chromatographic Techniques -II**	**15 L**
		4.1.Supercritical Fluid Chromatography (SFC) and Supercritical Fluid Extraction (SFE): Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, theory behind the separation, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis. (7L) **4.2.Affinity Chromatography:** Principle, instrumentation and applications (3L) **4.3.Chiral Chromatography:** Principle, Instrumentation, chiral columns, applications (3L) **4.4. Inverse gas Chromatography** (2L)	

References:

1. E Prichard, Quality in the analytical chemistry laboratory, John Wiley and sons N.Y(1997).
2. W Funk, V Dammann, G. Donnevert, Quality assurance in analytical Chemistry, VCH Weinheim (1995).
3. Richard Anderson, Sample Pretreatment & Separation, (Open learning).
4. Lalit Singh and Vijay Sharma, Quality by Design (QbD) Approach in Pharmaceuticals: Status, Challenges and Next Steps, Drug Delivery Letters, 2015, 5, 2-8.
5. D. A. Skoog, F. J. Holler and J.A. Niemann, Principles of Instrumental Analysis, 5th Edition (1998).

6. H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr, Instrumental Methods of Analysis, 7th Ed CBS (1986).
7. R. D. Braun, Introduction to Instrumental Analysis, Mc Graw Hill (1987).
8. G. D. Christian, Analytical Chemistry, 4th Ed. John Wiley, New York (1986).
9. D .A. Skoog and D. M. West and F. J. Holler Holt- Saunders, Fundamentals of Analytical Chemistry 6th Edition (1992).
10. J A Dean, Van Nostrand Reinhold, Chemical methods of separation,(1969).
11. J Marcus and A. S. Kertes, Solvent extraction and ion exchange, Wiley INC (1969).
12. Larry Taylor, Supercritical Fluid Extraction, Wiley publishers N.Y.(1996).
13. O Samuelson, Ion exchange separation in analytical chemistry, John Wiley 2nd ed.(1963).

Course Code : RPSCHEA302

Course Title: ADVANCED INSTRUMENTAL TECHNIQUES

Academic year 2021-22

Course Outcomes:

After completion of this course, the learner will be able to,	
CO 1	Make use of the surface analytical techniques(such as SIMS,PIXE) for obtaining information about the surfaces while characterizing the samples.
CO 2	Enlist the advantages of development of hyphenated techniques and will be able to explain the different types of interfaces that are used to achieve this hyphenation.
CO 3	Apply the principle underlying spectroelectrochemistry& the use of optically transparent electrodes to carry out the analysis of samples.
CO 4	Elaborate on the essential principles underlying the applications of thermal methods and radiochemical methods.
CO 5	Develop a working knowledge of various methods used in polarography.
CO 6	Explain anodic , cathodic and adsorptive stripping methods in voltammetry.
CO 7	Select a suitable method of voltammetry for the analysis of a particular sample.

DETAILED SYLLABUS

Course Code	Unit	Course Title / Unit Title	Credits/ Lectures
RPSCHEA302		**ADVANCED INSTRUMENTAL TECHNIQUES**	**4**
	I	**Spectral Methods I**	**15 L**
		1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L) **1.2 Principle, instrumentation and applications of the following:** **a.** ATR-FTIR spectroscopy (2L) **b.** Secondary Ion mass spectroscopy (SIMS) (2L) **c.** X-Ray Photoelectron Spectroscopy (XPS) (2L) **d.** Low-Energy Ion Scattering Spectroscopy (LEIS) and Rutherford Backscattering (2L) **e.** Scanning Probe Microscopy including AFM, CFM (3L) **1.3 Nuclear Quadrupole Resonance (NQR), ENDOR, ELDOR.** (3L)	
	II	**Hyphenated Techniques**	**15 L**
		2.1 Concept of hyphenation, need for hyphenation, possible hyphenations. (1L) **2.2.** Interfacing devices, instrumentation and applications of GC – MS,(Head space GC, Pyrolysis GC), GC -FTIR (3L) **2.3** LC-MS: Interface and Ionization techniques for LC-MS, Thermospray, Particle beam, FAB, and Atmospheric Pressure Ionization (API) Techniques. (3L) **2.4** Different Mass Analyzers, Magnetic Sector,	

		Quadrupole, Ion Trap, Time of Flight, FTICR (3L) **2.5** LC-MS/MS: Tandem MS, Triple Quad MS, Collision Induced Dissociation Cell, Different scan events, MRM transitions. Hybrid MS/MS. Applications of Tandem MS. (3L) **2.6** Radiochromatography (2L)	
	III	**Radiochemical And Thermal Methods**	**15 L**
		3.1 Enthalpimetric methods and thermometric titrations. **3.2 Thermal analysis-** Principle, Interfacing, instrumentation and Applications of (a) Simultaneous Thermal Analysis- TG-DTA and TG-DSC **3.3 Evolved gas analysis**- TG-MS and TG-FTIR (8L) **3.4**.**Activation analysis**- NAA, radiometric titrations and radio-release methods,isotope dilution method, introduction, principle, single dilution method, double dilution method and applications. **3.5** Auto, X-ray and Gamma Radiography (7L).	
	IV	**Electroanalytical Methods**	**15 L**
		4.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography, Differential double Pulse Polarography (2L) **4.2 Potential Sweep methods-** Linear Sweep Voltammetry and Cyclic voltammetry. **Potential Step method-** Chronoamperomertry (2L) **4.3 Controlled potential technique-** Chronopotentiometry (2L) **4.4 Stripping Voltammetry-** anodic, cathodic, and adsorption (2L)	

		4.5.Chemically and electrolytically modified electrodes and ultra- microelectrodes in voltammetry, Biosensor (2L) **4.6** Corrosion and electrochemistry, Use of Galvano stat and potentio stat (3L) **4.7 Spectro-electrochemistry** (2L)	

References:

1. D. A. Skoog, F. J. Holler and J.A. Niemann, Principles of Instrumental Analysis, 5th Edition (1998).
2. H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr Instrumental Methods of Analysis, 7th Ed CBS (1986).
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4. G. D. Christian, Analytical Chemistry, 4th Ed. John Wiley, New York (1986).
5. D .A. Skoog and D. M. West and F. J. Holler Holt- Saunders, Fundamentals of Analytical Chemistry, 6th Edition (1992).
6. A. J. Bard and Marcel Dekker, Electroanalytical Chemistry, New York, (A series of volumes).
7. J.J. Lingane, Electroanalytical Chemistry, 2nd Ed Interscience, New York (1958).
8. A. M. Bond, Marcel Dekker, Modern Polarographic Methods in Analytical Chemistry, New York, (1980).
9. KamlaZutski, Introduction to polarography and allied techniques,(2006).
10. R. V. Parish. Ellis Horwood,Chichester, NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry.

Course Code : RPSCHEA303

Course Title: BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS

Academic year 2021-22

Course Outcomes:

After completion of this course,the learner will be able to	
CO 1	Describe the composition of body fluids (blood & Urine).
CO 2	Enlist the physiological and nutritional significance of vitamins & biological macromolecules.
CO 3	Apply the various analytical (microbiological techniques) learned for the analysis of these vitamins and biological macromolecules which in turn will help them in identification and diagnosis of diseases.
CO 4	Explain the mechanism of operation of immune system.
CO 5	Describe the various food preservation techniques that are widely practiced in food industries as quality control measure.
CO 6	Design an experiment to confirm the presence and amount of various components present in different types of food samples for further label claim studies.

DETAILED SYLLABUS

Course Code	Unit	Course Title / Unit Title	Credits/ Lectures
RPSCHEA303	**BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS**		**4**
	I	**Bioanalytical Chemistry**	**15 L**
		1.1. Body Fluids- Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases. (5L) **1.2.** Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals. (5L) **1.3.** Analytical techniques (including microbiological techniques) for vitamins. (5L)	
	II	**Immunological Methods**	**15 L**

		2.1. General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immunoassays. (8L) **2.2. Human Nutrition:** Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids. (7L)	
	III	**Food Analysis – I**	**15 L**
		3.1. Fuel value of food and importance of food nutrients (2L) **3.2. Food Additives –** General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour. (5L) **3.3.Food Contaminants–** Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. Identification and estimation technique use for contamination (8L)	
	IV	**Food Analysis – II**	**15 L**
		4.1. Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L) **4.2.** Processing and Quality requirements of Milk and milk products (cheese, butter and ice cream), vegetables and fruits, meat and meat Products. (6L) **4.3 Analysis of Milk –** Fat content, proteins, acidity, bacteriological quality, milk adulterants and antibiotics.(2L) **4.4. Analysis of Oils and Fats –** Acid value, sap value, iodine value. Determination of rancidity and antioxidants, Unsaturated or saturated fats, triglyceride analysis (2L) **4.5. Analysis of spices** (cloves, cinnamon, pepper, mustard) Determination of volatile oils and fixed oils.(3L) (Emphasis on analytical techniques)	

References:

1. H. Stephen Stoker, General, organic and biological chemistry, Cengage Learning.
2. S. R. Mikkelesen and E. Corton, Bioanalytical Chemistry, John Wiley and sons (2004).
3. D, J. Homes and H. Peck, Analytical Biochemistry, Longman (1983).
4. S.K.Sawhney and Randhir Singh, Introductory practical biochemistry , 1st edition, Narosa Publishing house.
5. S. Sadashivam and A. Manickam ,Biochemical methods, 3rd edition, New age international (P) limited,Publishers.
6. A.Y.Sathe, A first Course in Food Analysis, New age international (P) limited,Publishers.
7. David Pearson, Chemical Analysis of food, 7thedition,Chemical publishing company, New York.
8. Morris B Jacobs, The chemical analysis of Food and Food Products.
9. Gribbin et al, Principles of package development.
10. MacgraWreyco, Modern packaging Encyclopedia and planning guide.

Course Code : RPSCHEAEC-I 304

Course Title : ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS

Academic year 2021-22

Course outcomes:

After completion of this course, the learner will be able to	
CO 1	List the major sources of different types of pollutants.
CO 2	Classify the different types of pollutants.
CO 3	Estimate the pollutants present in air.
CO 4	Outline the role of pollution control boards in monitoring and controlling pollution.
CO 5	Apply the methods learned in sampling of these pollutants to procure a sample for analysis.
CO 6	Indicate appropriate measures to reduce/or minimize the effects of these pollutants on environment.
CO 7	Evaluate the quality of potable water based on the guidelines laid down by the regulatory bodies.
CO 8	Acquire awareness of the principles of green chemistry.
CO 9	Plan out the synthesis of a sample by incorporating benign and environmentally safe solvents.

DETAILED SYLLABUS

Course Code	Unit	Course Title/Unit Title	Credits/ Lectures
RPSCHEAEC-I 304	**ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS**		**4**
	I	**Air Pollution**	**15 L**
		1.1. Sources, classification, pollutants and permissible limits.(2L) **1.2** Sampling methods for air, flew gas, Industrial Exhaust, stag samples etc. (2L) **1.3.** Importance of automobile exhaust control and its limits New BS VI regulations(2L) **1.4.** Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors. SPM analysis on ESP (3L) **1.5**. Carbon credit and global issues related to air pollution. (3L) **1.6.** Greenhouse gases and their substitutes. (1L) **1.7.** Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC. (2L)	
	II	**Water Quality Standards**	**15 L**
		2.1 Water: quality and requirements of potable water, direct and indirect pollutants for potable water reservoirs, quality of potable water from natural sources. (4L) **2.2** TOC, DO, BOD, COD and TN measurement in water (2L) **2.3.** Bore well water quality and analytical parameters. Quality of bottled mineral water (3L) **2.4**. Process of purification of bore well water to bottled mineral water. (2L) **2.5** Regulatory requirements for packaged drinking water	

		(4L)	
	III	**Other Types Of Pollution**	**15 L**
		3.1 Soil pollution and Soil Analysis : sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long term effect on soil quality. (6L) **3.2 Noise Pollution :** sources, effects, methods of measurements and control measures.(2L) **3.3 Thermal Pollution:** definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy (3L) **3.4 Radioactive pollutants:** source, exposure hazards, precautions in handling and safety, Long term effects. (2L) **3.5 Environmental Audits:** concept of audit, authorities, evaluation methodology, benefits and certification (2L)	
	IV	**Green Chemistry**	**15 L**
		4.1. Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity (4L) **4.2. Organic solvents:** environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents (4L) **4.3 Emerging Green Technologies:** photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. (4L) **4.4. Designing Greener Processes:** Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring. (3L)	

References:

1. A. K. De, Environmental Chemistry, 2nd Edition. Wiley (1989).
2. S. M. Khopkar, Environmental Pollution Analysis, John Wiely (1993).
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7. Simon Parsons, Bruce Jefferson, Introduction to Potable Water Treatment Processes, Paperback publication.
8. Guidelines for drinking-water quality, Third edition, (incorporating first and second addenda). WHO report.
9. S.G. Misra and Dinesh Mani, Soil pollution, APH Publishing Corporation, (2009).
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11. Donald F Anthrop, Noise Pollution, Lexington Books, (1973)
12. N. Birsen, Kairat K. Kadyrzhanov, Environmental Protection Against Radioactive Pollution Springer publication , (2003).
13. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002).
14. K. G. Das, Dekker, Pesticide Analysis, (1981).
15. S. L Chpra, J.S Kanwar, Analytical, Agricultural Chemistry Kalyani publication.

Course Code : RPSCHEAEC-II 304

Course Title : PHARMACEUTICAL AND ORGANIC ANALYSIS

Academic year 2021-22

Course Outcomes:

After completion of this course, the learners will be able to,	
CO 1	Categorize the different types of drugs and dosage forms.
CO 2	Outline the role of FDA in pharmaceutical industry.
CO 3	Make use of the different methods learned to estimate the amount of drug present in a sample.
CO 4	Apply the concept of impurity profiling, stability studies, limit tests, bioavailability and bioequivalence while ensuring the uniformity in standards of quality , efficacy & safety of pharmaceutical products.
CO 5	Elaborate on the role of analytical chemistry in forensic laboratories.
CO 6	Identify and estimate the amount of the toxins found at crime scenes.
CO 7	Evaluate the quality of the cosmetic products by carrying out their analysis using the methods learned.

DETAILED SYLLABUS

Course Code	Unit	Course Title / Unit Title	Credits/ Lectures
RPSCHEAEC-II 304		**PHARMACEUTICAL AND ORGANIC ANALYSIS**	**4**
	I	**Pharmaceutical Analysis**	**15 L**
		1.1 General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations, classification of dosage forms. Role of FDA in pharmaceutical industries.(5L) **1.2** Sources of impurities in pharmaceutical products and raw materials. (3L) **1.3** Standardization of finished products and their characteristics, official methods of quality control. (3L)	

		1.4. Pharmaceutical Legislation: Introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration. (4L)	
	II	**Drugs**	**15**
		2.1. Analysis of compounds based on functional groups, instrumental methods for analysis of drugs, assays involving chromatographic separations, proximate assays, assays of enzyme containing substances, biological and microbiological assays and tests. (6L) **2.2** Limit tests, solubility tests, disintegration tests, stability studies (4L) **2.3** Bioequivalence and bioavailability studies. (2L) **2.4** Impurity profile of drugs (2L) **2.5**.Polymers in pharmaceuticals and novel drug delivery systems.(1L)	
	III	**Forensic Science**	**15**
		3.1 Analytical Chemistry in Forensic Science: General idea.(2L) **3.2 Forensic Analysis:** Blood, DNA profiling, Hair analysis, Finger printsAlcohol in body fluids, systematic drug identification.(5L) **3.3 Analytical Toxicology:** Isolation, identification and determination of: **3.3.1 Narcotics:** Heroin, morphine and cocaine. **3.3.2 Stimulants:** Amphetamines and caffeine. **3.3.3 Depressants:** Benzodiazepines, Barbiturates and Mandrax. **3.3.4 Hallucinogens:** LSD and Cannabis. **3.3.5** Metabolites of drugs in blood and urine of addicts.	

		3.3.6 Viscera, stomach wash, vomit and postmortem blood for poisons like – cyanide, arsenic, mercury, insecticides and pesticides. **3.3.7 Analysis of explosives** (8L)	
	IV	**Cosmetic Analysis**	**15**
		4.1. Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis.(2L) **4.2. Deodorants and antiperspirants:** Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.(3L) **4.3. Face powder:** Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L) **4.4. Hair tonic:** 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers) (3L) **4.5 Creams and Lotions:** Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (2L) **4.6 Lipsticks:** General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents.(2L)	

References:

1. Kenneth Antonio Connors, Text book of Pharmaceutical Analysis, Wiley, (2001).
2. Indian Pharmacopeia, Volume I and II.
3. M L Mehra, The Handbook of Drug Laws, University Book Agency, Ahmedabad,(1997).
4. Takeru Higuchi, Chemical Analysis of Drugs, Interscience Publishers, (1995).
5. Foster Dee Snell et al, Encyclopedia of Industrial Chemical Analysis, Interscience Publishers,(1967).
6. Official methods of analysis of AOAC international,18th edition 2005,AOAC international.
7. Suzanne Bell, Forensic Chemistry, Pearson Prentice Hall Publication,(2006).

8. David E Newton, Forensic Chemistry, Infobase Publishing,(2007).
9. Harry's Cosmetology, 7th Ed, Longman Scientific Co.
10. Edward Sagarin, Cosmetic Technology, Interscience Publishers,(1957).
11. Edgar George Thommsen, Francis Chilson, Modern Cosmetics, Drug and Cosmetic Industry,(1947).
12. Government of India Publications of Food, Drug and Cosmetic Act and Rules.
13. Encyclopedia of Analytical Chemistry, Volume 3, Academic Press,(1995).

SEMESTER – III

Practical

RPSCHEA3P1	Group A		Credits
	1.	Determination of the pK value of an indicator.	**02**
	2.	Determination of aniline and ethanolamine in a mixture of two in acetonitrile by potentiometric titration.	
	3.	Determination of mixture of halides potentiometrically.	
	4.	Estimation of strong acid, weak acid and salt in the given mixture conductometrically.	
	5.	Analysis of mixture of carbonate and bicarbonate using pH metry	
	6.	Simultaneous determination of mixture of metal ions (copper and lead) by electrogravimetry.	
	7.	Separation of parabenes using HPLC. Find number of theoretical plates	
	8.	Separation of alcohol / ester by GC.	
RPSCHEA3P2	**Group B**		**Credits**
	1.	Estimation of drugs by non aqueous titration: Pyridoxine hydrochloride, Mebendazole.	**02**
	2.	Determination of percent purity of methyleneblue.	
	3.	Estimation of cholesterol and Uric acid in the given sample of blood serum	
	4.	Estimation of Glucose by Folin-Wu method.	
	5.	Estimation of fluoride in a tooth paste	
	6.	Estimation of Ca in Ca-pentathonate/calcium lactate tablets**.**	
	7.	HPTLC separation of amino acids.	

RPSCHEA 3P3	Group C		Credits
	1.	Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method.	**02**
	2.	Analysis of lactose in milk	
	3.	Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method	
	4.	Analysis of oil sample for the determination of SAP value, Iodine value.	
	5.	Estimation of aldehyde in lemon oil / Cinnamon oil	
	6.	Analysis of milk for its Ca, P and Fecontent.	
	7.	Caffeine in tea by HPLC and UV.	
RPSCHEA 3P4	**Group D**		**Credits**
	1.	Determination of Silica by molybdenum blue method.	**02**
	2.	Estimation of copper by extractive photometry.	
	3.	Estimation of Glycine by Sorensen formol titration .	
	4.	Separation of Ni(II) and Co(II) using anion exchanger column.	
	5.	Estimation of vitamin C using $KBrO_3$ method.	
	6.	Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity.	

References:

1. G H Jeffery, J Bassett, J Mendhem, R C Denney, Vogel's Textbook Of Quantitative Chemical Analysis, 3rd Edition, Longman Scientific & Technical,(1989).
2. Official methods of analysis of AOAC international,18th edition 2005,AOAC international.

MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40% (40 Marks)

Presentation: 20 Marks

Continuous Internal Assessment (CIA): 20 Marks

For each paper, learners are evaluated from their presentation based on the topic selected from syllabus. The assessment of presentation is as follows:

Sr. No	Evaluation type	Marks
1	Presentation content	10
2	Presentation skills	05
3	Viva	05
4	Continuous Internal Assessment (CIA) e.g. Test, Group discussion, assignment, open-book tests etc.	20
	Total	40

B) External examination - 60 %

Semester End Theory Assessment - 60 marks

1. Duration - These examinations shall be of **2.5 hours** duration.
2. Paper Pattern:
   2.1 There shall be **04** questions each of **15** marks. On each unit, there will be one question.
   2.2 All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1) A)	Any 3 out of 5	12	Unit I
Q.1) B)	Any 1 out of 2	3	
Q.2) A)	Any 3 out of 5	12	Unit II
Q.2) B)	Any 1 out of 2	3	
Q.3) A)	Any 3 out of 5	12	Unit III
Q.3) B)	Any 1 out of 2	3	
Q.4) A)	Any 3 out of 5	12	Unit IV
Q.4) B)	Any 1 out of 2	3	

Practical Examination Pattern:

Semester End Practical Examination: 50 marks

Experimental work	**40**
Viva	**05**
Journal	**05**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	**301**			**302**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical			**50**			**50**	**100**
Course	**303**			**304**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical			**50**			**50**	**100**

Total: 600 marks

SEMESTER-IV
Course Code : RPSCHEA 401
Course Title : SEPARATION TECHNIQUES AND INDUSTRIAL MATERIALS
Academic year 2021-22

Course Outcomes:

After completion of this course, the learners will be able to,	
CO 1	Identify and design the suitable membrane separation technique for intended problem.
CO 2	Elaborate on the importance of concept of pH ½ in solvent extraction.
CO 3	Select an appropriate method for the processing, extraction using different techniques and standardization of the herbal materials as per WHO cGMP guidelines.
CO 4	Recommend methods for the biodegradation of insecticides and pestiscides.
CO 5	Judge the quality of the detergents by making use of the various methods which are used in industries for carrying out their analysis.
CO 6	Enlist properties of an ideal fuel.
CO 7	Determine the calorific value of fuels using the methodologies learned.
CO 8	Separate & estimate the amount of biomolecules using appropriate electrophoretic technique.

DETAILED SYLLABUS

Course Code	Unit	Course Title/Unit Title	Credits/ Lectures
RPSCHEA 401	**SEPARATION TECHNIQUES AND INDUSTRIAL MATERIALS**		**4**
	I	**Separation Science**	**15**
		1.1.Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis. (6L) **1.2**.Recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, microwave assisted extraction. (4L) **1.1 Concept of pH 1/2**, expression for pH ½ and its significance (2L)	

		1.4 Craig countercurrent extraction : Theoretical treatment and application in biological sample.(3L).	
	II	**Electrophoresis**	**15 L**
		2.1. Electrophoresis: Introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) (7L) **2.2 Techniques of Electrophoresis:** low and high voltage, SDS-PAGE, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis, 2D gel electrophoresis and miceller electro kinetic capillary chromatography, instrumentation, detection and applications. (8L)	
	III	**Separation, Analysis and Standardization of Herbal based products.**	**15 L**
		3.1. Herbs as a raw material: Definition of herb, herbal medicine, herbal Medicinal products, herbal drug preparation. Sources of herbs. Selection, identification and authentication of herbal materials, drying and processing of herbal raw materials, drying and processing of herbal raw material.(6L) **3.2 Extraction of herbal materials:** Choice of solvent for extraction, methods used for extraction and principles involved in extraction.(3L) **3.3** Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, physical, chemical, spectral and toxicological standardization, qualitative and quantitative estimations.(6L)	
	IV	**Industrial Materials**	**15 L**
		4.1 Insecticides, Pesticides: Definition, classification of insecticides pesticides. Biodegradation of insecticides and pesticides (5L). **4.2 Soaps and Detergents:** Classification and composition, qualitative analysis, quantitative analysis of detergents-alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents (5L)	

		4.3 Petrochemical products: Crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, corrosion test, carbon residue and impact on environment. (5L)	

References:

1. Kaushik Nath , Membrane Separation Processes , 2nd edition, Prentice Hall of India Private limited, (2008).
2. G. D. Christian, Analytical Chemistry, 4th Ed. John Wiley, New York (1986).
3. D. A. Skoog and D. M. West and F. J Holler Holt- Saunders, Fundamentals of Analytical Chemistry, 6th Edition (1998).
4. J.B.Harborne,Phytochemical Methods-A Guide to modern techniques in plant analysis, 3rdedition,Chapman & Hall.
5. O.P.Varmani,A.K.Narula, Industrial chemistry, Galgotia.
6. O.P.Varmani,A.K.Narula, Applied Chemistry Theory and practice, 2nd edition, New age international publishers.
7. Upadhyay,Nath, Biophysical chemistry Principles and techniques ,Himalaya Publishing House.
8. Maureen Melvin , Electrophoresis , (Analytical Chemistry by Open learning).

Course Code : RPSCHEA 402
Course Title : ADVANCED INSTRUMENTAL TECHNIQUES
Academic year 2021-22

Course Outcomes:

After completion of this course, the learners will be able to,	
CO 1	Explain the basic theory of 1H NMR spectroscopy & Raman Spectroscopy.
CO 2	Describe the working of the different components of NMR spectrophotometer & Raman spectrometer and will be able to explain how the spectrum is recorded.
CO 3	Apply ^{1}H ,^{13}C, $^{31}P$and ^{19}F NMR spectroscopy techniques in combination with other spectroscopic data to carry out structure determination.
CO 4	Explain the mechanism of formation and fragmentation of ions in gas phase.
CO 5	Interpret the information contained in the mass spectra.
CO 6	Apply the basic working principles involved in the spectroscopic techniques learned for carrying out identification and analysis of samples.
CO 7	Make use of the phenomenon of chemiluminescence for varied applications.
CO 8	Elaborate on the concept of ORD & CD.
CO 9	Discuss the principle , instrumentation involved in Photoacoustic spectroscopy and will be able to use it for the trace analysis of solid , liquid and gaseous samples.

DETAILED SYLLABUS

Course Code	Unit	Course Title/ Unit Title	Credits/ Lectures
RPSCHEA402	**ADVANCED INSTRUMENTAL TECHNIQUES**		**4**
	I	**Spectral Methods II**	**15 L**
		NMR Spectroscopy **1.1.** Theory and Instrumentation- recapitulation, FTNMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR).Application of NMR in structural elucidation (9L) **1.2** Radio waves in imaging- principle instrumentation and applications of MRI(1L) **1.3.** Application of NMR to other nuclei ^{13}C, ^{31}P and ^{19}F	

		spectroscopy (3L) **1.4 Electron spin resonance spectroscopy (ESR)**: basics, instrumentation and applications (2L)	
	II	**Spectral Methods III**	**15 L**
		2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecularstructure- EI and CI Ionization, Instrumentation, and Fragmentation. interpretation of mass spectra, analytical information derived frommass spectra-molecular identification, meta stable peaks, Fragmentation Reactions (9L) **2.2 Raman spectroscopy:** Theory, Mechanism of Raman and Rayleigh Scattering,Instrumentation, Applications. Resonance and Surface enhanced Raman Spectroscopy.(4L) **The problems based on MS, NMR and IR Spectra (2L)**	
	III	**Spectral Methods IV**	**15 L**
		Principle, Instrumentation, and Applications of **2.1. Atomic Emission Spectroscopy-** based on plasma and electrical discharge sources, quantitation with Inductively couple plasma spectroscopy. (5L) **2.2.** Background correction in Graphite Furnace AAS and Correction of spectral interference in ICP. (4L) **2.3** Quantitative analysis by AAS and ICP using external standard and standard addition method. (3L) **2.4 ICP-MS:** Instrumentation, Interface and applications for trace level analysis of elements. (3L)	
	IV	**Miscellaneous Techniques**	**15 L**
		Principle, Instrumentation and Applications of: **4.1. Chemiluminesescence Methods:** Principle, Apparatus, Quantitative Chemiluminescence - Gas phase and liquid phase chemiluminescent analysis and titrations(application for detection of S and N) (3L)	

		4.2.Chirooptical Methods : ORD, CD (special application for Bioanalysis) (5L) **4.3. Photoacoustic spectroscopy** (3L) **4.4. Laser Induced Fluorescence (LIF) Spectroscopy** (4L)	

References:

1. G. D. Christian, Analytical Chemistry, 4th edition. John Wiley, New York (1986).
2. D. A. Skoog and D. M. West and F. J Holler Holt- Saunders, Fundamentals of Analytical Chemistry, 6th Edition (1998).
3. D. A. Skoog, F. J. Holler and J.A. Niemann, Principles of Instrumental Analysis, 5th edition.
4. H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A, Instrumental methods of Analysis,.
5. P. J. Haines, Thermal methods of Analysis, Blackie Academic & Professional, London (1995).
6. W. W. Wendlandt, Thermal Analysis, 3rd Edition , John Wiley, N.Y. (1986).
7. E. P. Bertain, Principles and Practices of X-ray spectrometric Analysis, 2nd edition, Plenum Press, NY, (1975)
8. D. Bane, B. Forkman, B. Persson, Nuclear Analytical Chemistry, Chartwell - Bratt Ltd (1984).
9. Roger S. Macomber, A Complete Introduction to Modern NMR Spectroscopy,1st Edition
10. Robert. M.Silverstein, Spectrometric Identification of Organic Compounds Hardcover , Wiley.

Course Code : RPSCHEA 403

Course Title : ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS

Academic year 2021-22

Course Outcomes:

After completion of this course, the learner will be able to,	
CO 1	Elaborate on the various physical , chemical and biological processes which are used in CETP to remove the contaminants from wastewater.
CO 2	Apply the concept of recycling, reuse & reclamation in managing solid waste in real life.
CO 3	Classify the different types of plastics.
CO 4	Outline the importance of additives in plastic.
CO 5	Estimate the amount of metallic impurities in plastics.
CO 6	Describe the composition of paints.
CO 7	Make use of the methodologies learned to carry out the analysis of each and every component present in paints.
CO 8	Develop an understanding of zone refining and vacuum fusion and extraction techniques.
CO 9	Classify the kinds of elements that can be purified by the process of zone refining.
CO 10	Suggest a method for analyzing different elements present in ores & alloys.

DETAILED SYLLABUS

Course Code	**Unit**	**Course Title/Unit Title**	**Credits/ Lectures**
RPSCHEA 403	**ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS**		**4**
	I	**Effluent Treatment**	**15 L**
		1.1.Effluent treatment: primary secondary and tertiary (2L) **1.2** Plant general construction and process flow charts(3L) **1.3** Treatment and disposal of sewage.(3L) **1.4.** Effluent parameters for metallurgical industry Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent.(2L) **1.5** Recycle and reuse of process and treated (effluent) water.	

		(2L) **1.6** Recovery of metals from effluent, modern methods – electrodialysis, electrodeposition and Ion Exchange etc.(3L)	
	II	**Solid Waste Management**	**15 L**
		2.1. Solid waste types and characteristic (2L) **2.2.** Solid waste management: objectives, concept of recycle, reuse and recovery (3L) **2.3.** Methods of solid waste disposal.(2L) **2.4.** Treatment and disposal of sludge / dry cake (3L) **2.5** Managing non-decomposable solid wastes (2L) **2.6** Bio- medical waste : Introduction , Classification and methods of disposal (3L)	
	III	**Plastics and Polymers**	**15 L**
		3.1.Plastics: Classification of plastic, determination of additives, molecular weight distribution, analysis of plastic and polymers based on styrene, vinyl chloride,ethylene, acrylic and cellulosic plastics. (5L) **3.2** Metallic impurities in plastic and their determination, (2L) **3.3** Impact of plastic on environment as pollutant.(2L) **3.4 Paints and pigments:** Types of paints pigments, determination of volatile and non - volatile components, Flash point (significance and method of determination), separation and analysis of pigments, binders and thinners.(3L) **3.5** Role of Organo silicones in paints and their impact on environment.(3L)	
	IV	**Metallurgy**	**15 L**
		4.1. Ores and minerals: Dressing of ores, pollution due to metallurgical processes (ore dressing, calcination, smelting) (3L) **4.2.** Chemical analysis of ores for principal constituents :Galena,Pyrolusite, Bauxite, Hematite, Monazite (4L) **4.3 Alloys:** definition, analysis of Cupronickel, Magnelium, Steel And Stainless Steel, Bronze, Gun metal.(4L)	

		4.4 Techniques of purification: Zone refining, analysis of high puritymaterials like silicon, vacuum fusion and extraction techniques. (4L).	

References:

1. H.R.Singh, Environmental Biology, S.Chand& Company Ltd.
2. P.S.Sindhu, Environmental Chemistry, New age international (P) limited Publishers.
3. Balram Pani, Textbook of Environmental Chemistry, I.K. International Publishing House Pvt.Ltd (2007).
4. Sameer.K.Banerji , Environmental Chemistry, 2nd edition, Prentice Hall of India Private Limited.
5. K Sasikumar and SanoopGopi Krishna, Solid waste management, PHI publication (2009).
6. Surendrakumar, Solid waste management, Northen Book Center (2009).
7. G. S. Sodhi , Fundamental Concepts of Environmental Chemistry,2nd edition, Alpha Science, (2005).
8. Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines,(1979).
9. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
10. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology &Engineering (1960).

Course Code : RPSCHEAOC-I 404

Course Title : INTELLECTUAL PROPERTY RIGHTS & CHEMINFORMATICS

Academic year 2021-22

Course Outcomes:

After completion of this course, the learner will be able to:	
CO 1	Be well versed with the concept of intellectual property and the terms involved with respect to Indian Patent Law.
CO 2	Distinguish between patents and copyrights.
CO 3	Elaborate on the economical impact and legislature involved in Intellectual property rights.
CO 4	Make use of the software tools pertaining to Cheminformatics and Molecular Modelling.
CO 5	Conduct structure and sub-structure search online, determine SMILES codes for various molecules.
CO 6	Gain knowledge about the application of the research based tools.

DETAILED SYLLABUS

Course Code	Unit	Course Title / Unit Title	Credits/ Lectures
RPSCHEAOC-I 404	**INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS**		**4**
	I	**Introduction to Intellectual Property - I**	**15 L**
		1.1 Introduction to Intellectual Property:[2L] Historical Perspective, Different types of IP, Importance of protecting IP. **1.2 Patents:[5L]** Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India. **1.3 Industrial Designs:[2L]** Definition, How to obtain, features, International design registration. **1.4.Copyrights:[2L]** Introduction, How to obtain, Differences from Patents. **1.5 Trade Marks:[2L]**	

		Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. **1.6 Geographical Indications:[2L]** Definition, rules for registration, prevention of illegal exploitation, importance to India.	
	II	**Introduction to Intellectual Property-II**	**15 L**
		2.1 Trade Secrets:[2L] Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. **2.2IP Infringement issue and enforcement:[2L]** Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. **2.3 Economic Value of Intellectual Property:[5L]** Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. **2.4 Different International agreements:[6L]** **2.4.1 World Trade Organization (WTO):**General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement.General Agreement on Trade Related Services (GATS) Madrid Protocol.BerneConvention**.**Budapest Treaty **2.4.2 Paris Convention: WIPO** and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity.	
	III	**Cheminformatics-I**	**15 L**

		3.1 Introduction to Cheminformatics[5L] History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. **3.2 Representation of molecules and chemical reactions:[5L]** Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. **3.3 Searching Chemical Structures:[5L]** Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	
	IV	**Cheminformatics-II**	**15 L**
		4.1 Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra. **4.2** Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand-based and Structure based Drug design, **4.3** Application of Cheminformatics in Drug Design.	

References:

1. Vivien Irish, Intellectual Property Rights for Engineers, 2nd Edition, British Library, (2008).
2. David I. Bainbridge, Intellectual Property, 8th Edition, Pearson, (2010).
3. Stephen Elias and Richard Stim, Patent Copyright & Trade Mark, 8th Edition, Nolo and Richard, (2013).
4. Johann Gasteiger and Thomas Engel, Chemoinformatics, Wiley-VCH, (2003).
5. Andrew R. Leach, Valerie J. Gillet, An Introduction to Chemoinformatics, Springer,(2007).
6. Barry A. Bunin, Jurgen Bajorath, Brian Siesel and Guillermo Morales, Chemoinformatics- Theory, Practice and Products, Springer, (2007).

Course Code : RPSCHEAOC-II 404
Course Title : RESEARCH METHODOLOGY
Academic year 2021-22

Course Outcomes:

After the completion of this course, the learner will be able to:	
CO 1	Know basics of research methodology
CO 2	Get the technical know-how of research from developing a problem.
CO 3	Write a research paper, study formats of existing research papers and review papers.
CO 4	Be aware about importance of lab-safety and the safety protocols in R&D laboratories.

DETAILED SYLLABUS

Course Code	Unit	Course Title / Unit Title	Credits/ Lectures
RPSCHEAOC-II 404		**Research Methodology**	**4**
	I	**Review of Literature**	**15 L**
		1.1 Print:[5L] Primary, Secondary and Tertiary sources. **1.2 Journals:** Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. **1.3 Digital:[5L]** Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar,	

		ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. **1.4 Information Technology and Library Resources:[5L]** The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	
	II	**Data Analysis**	**15 L**
		2.1 The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. **2.2 Analysis and Presentation of Data:** Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	
	III	**Methods of Scientific Research and Writing Scientific Papers**	**15 L**
		3.1 Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation. **3.2 Writing Scientific Papers:** Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work,	

		writing ethics, avoiding plagiarism.	
	IV	**Chemical Safety & Ethical Handling of Chemicals**	**15 L**
		4.1 Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure. **4.2** Safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	

References:

1. C. R. Kothari, Research Methodology- Methods and techniques, New Age International (P) Limited Publisher, (2004).
2. Yogesh Kumar Singh, Fundamental of Research Methodology and Statistics, New Age International (P) Limited Publisher, (2006).
3. Carol Ellison, Concise Guide to Writing Research Ppaers, McGraw-Hill,(2016).
4. Prem S. Mann, C. Jay Lacke, Introductory Statistics, 7th Edition, John Wiley and Sons,(2010).
5. Andrew A. Jawlik, Statistics From A to Z – Confusing Concepts Clarified,John Wiley and Sons,(2016).

SEMESTER – IV

Practical

RPSCHEA4P1	Group A		Credits
	1.	Analysis of tamrabhasma by AAS and UV	**02**
	2.	Estimation of Na+ in dairy whitener by flame photometry	
	3.	Spectrophotometric determination of pH of buffer solution.	
	4.	Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method	
	5.	Estimation of Aspirin by conductometrically.	
	6.	Recording and interpretation of IR spectra of given compound.	
	7.	Identification of components of essential oils by GCMS.	
	8.	Determination of water in organic solvent by Karl Fischer method.	
RPSCHEA4P2	**Group B**		**Credits**
	1.	To analyze Pyrolusite for: Fe by redox titration and / or Mn by colorimetry.	**02**
	2.	To analyze galena for: Pb by Complexometric	
	3.	Analysis of Cupronickel alloy by electrogravimetry.	
	4.	To analyze Magnelium for Mg titrimetrically.	
	5.	To analyze Bronze for Zn by volumetric method	
	6.	To analyze Steel for: Ni and Cr	
RPSCHEA4P3	**Group C**		**Credits**
	Interpretation of spectral data (UV, IR, PMR, CMR, Mass spectra, XRD, Thermal) A learner will be given UV, IR, PMR, CMR, Mass spectra, of a compound from which preliminary information should be reported within first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc **(Minimum 8 spectral analysis)**		**02**
RPSCHEA4P4	**Group D**		**Credits**
	Project Evaluation		**02**

References:

1. G H Jeffery, J Bassett, J Mendhem, R C Denney, Vogel's Textbook Of Quantitative Chemical Analysis, 3rd Edition, Longman Scientific & Technical,1989.
2. Official methods of analysis of AOAC international,18th edition 2005,AOAC international.

MODALITY OF ASSESSMENT

Theory Examination Pattern:

B) Internal Assessment - 40% - 40 Marks

Presentation: 20 Marks

Continuous Internal Assessment (CIA): 20 Marks

For each paper, learners are evaluated from their presentation based on the topic selected from syllabus. The assessment of presentation is as follows:

Sr. No	Evaluation type	Marks
1	Presentation content	10
2	Presentation skills	05
3	Viva	05
4	Continuous Internal Assessment (CIA) e.g. Test, Group discussion, assignment, open-book tests etc.	20
	Total	40

B) External examination - 60 % - 60 Marks

Semester End Theory Examination - 60 marks

i. Duration - These examinations shall be of **2.5 hours** duration.

ii. Paper Pattern:

1. There shall be **04** questions each of **15** marks. On each unit there will be one question.
2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 3 out of 5	12	Unit I
Q.1)B)	Any 1 out of 2	3	
Q.2)A)	Any 3 out of 5	12	Unit II
Q.2)B)	Any 1 out of 2	3	
Q.3)A)	Any 3 out of 5	12	Unit III
Q.3)B)	Any 1 out of 2	3	
Q.4)A)	Any 3 out of 5	12	Unit IV
Q.4)B)	Any 1 out of 2	3	
	Total	**60**	

Practical Examination Pattern:

Semester end practical examination: 50 marks

Experimental work	**40**
Viva	**05**
Journal	**05**
Total	**50**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	**401**			**402**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical			**50**			**50**	**100**
Course	**403**			**404**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical			**50**			**50**	**100**

Total: 600 marks