।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
ACADEMIC (1-BOARD OF STUDIES) SECTION
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प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७—२०२०** च्या ठरावानुसार **प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्यात येत आहेत.

01. M.Sc.-II Year-Botany
02. M.Sc.-II Year-Analytical Chemistry
03. M.Sc.-II Year-Industrial Chemistry
04. M.Sc.-II Year-Medicinal Chemistry
05. M.Sc.-II Year-Organic Chemistry
06. M.Sc.-II Year-Physical Chemistry
07. M.Sc.-II Year-Polymer Chemistry
08. M.Sc.-II Year-Computer Application
09. M.Sc.-II Year-Computer Network
10. M.Sc.-II Year-Computer Science
11. M.C.A.-II Year (Master of Computer Applications)
12. M.Sc.-II Year-Environmental Science
13. M.A./M.Sc.-II Year-Geography
14. M.Sc.-II Year-Geophysics
15. M.Sc.-II Year-Geology
16. M.A./M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.A./M.Sc.-II Year-Statistics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक—१/परिपत्रक/पदव्युत्तर(संकुल)—सीबीसीएस अभ्यासक्रम/२०२०—२१/**५१३**

स्वाक्षरित/—
उपकुलसचिव
शैक्षणिक (१—अभ्यासमंडळ) विभाग

दिनांक : ०८.०८.२०२०.

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, सर्व संबंधित संकुले, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

M`. Sc. S. Y. Analytical Chemistry Core papers (Third Semester)

Sr. No.	Paper No.	Title	Contact hours	Credits
Analytical Chemistry Core papers				
1.	ACH-311	Principles of Analytical Chemistry	60	4
2.	ACH-312	Chromatographic Methods of Analysis	60	4
		Practical Courses		
1.	LACH-311	Laboratory Course 1	120	4
2.	LACH-312	Laboratory Course 2	120	4
1.	SACH-311	Literature survey and Seminar	30	2

M. Sc. S. Y. Analytical Chemistry Elective papers (Third Semester)

Sr. No.	Paper No.	Title	Contact hours	Credits
Analytical Chemistry Elective papers (any one from the below or courses offered for any other program in school of chemical sciences)				
1.	EACH-311	Organic Spectroscopy	60	4
2.	EACH-312	Spectrochemical methods of Analysis	60	4
Open elective (any one)				
1.		Open elective from other schools	60	4
2.		MOOCS/SWAYAM/NPTEL courses	60	4
Open electives offered for students from other schools				
1.	OPCH-311	Intellectual property managment	60	4

M. Sc. S. Y. Analytical Chemistry Core papers (Fourth Semester)

Sr. No.	Paper No.	Title	Contact hours	Credits
Analytical Core papers				
1.	ACH-411	Electro-analytical and thermal methods of analysis.	60	4
2.	ACH-412	Applied Analytical Chemistry	60	4
Practical Courses				
1	ITCH-401/ RPCH -401	Industrial Training /Research Project	240	8

M. Sc. S. Y. Analytical Chemistry Elective papers (Fourth Semester)

Sr. No.	Paper No.	Title	Contact hours	Credits
Analytical Elective papers (Any one from the below or courses offered for any other program in school of chemical sciences)				
1.	EACH-411	Quality Assurance and Quality control, method of Analytical Development and Validation	60	4
2.	EACH-412	Techniques for forensic Analysis	60	4

Open elective (any one)				
1.		Open elective from other schools	60	4
2.		MOOCS/SWAYAM/NPTEL courses	60	4
Open electives offered for students from other schools				
1.	OPCH-411	Industrial safety and hazardous management	60	4

CourseTitle : Principles of Analytical Chemistry (ACH-311) Contact hrs.-60 Credit 4

Course Objectives:

- To gain knowledge regarding statistical analysis part in analytical chemistry. To understand the basic terms such as accuracy, precision, errors, standard deviation, reliability of results, confidence level, confidence interval etc. To understand various statistical tests such as student's 't' test, F test, Q test and their applications in analytical chemistry.
- To understand the concept of sampling, sampling procedures, importance of sampling in an analysis, various operations related with proper sampling of an analytical sample etc.
- To learn various acid-base theories, concept of pH, pH scale, theoretical principles underlying determination of pH of weak acid and weak base, buffer solutions, preparation of buffer solutions and various applications.
- To gain knowledge about classical methods of analysis such as volumetric and gravimetric analysis, theoretical principles lying behind these methods of analysis.
- To understand complexometric equilibria, complexation method for determination of concentration of analyte, instrumental methods, principles involved in end point detection such as colorimetry, Potentiometry, amperometry, Polarography etc.

Course Content:

Module 1 Errors, Statistics and Sampling

Introduction, Accuracy, Error, types of errors, systematic and random errors, minimization of errors, precision, mean and standard deviations, reliability of results, confidence limit and confidence interval, comparison of results [student T test, F test, comparison of two samples (Paired T test)]. Introduction to sampling, the basis of sampling, sampling procedure, problems associated with obtaining gross samples (for solids, liquids and gases), operations of drying and preparing solution of analyte, dissolving inorganic solids, dry ashing, wet digestion, numerical problems.

Module 2 Acid Base Equilibria and Buffer Solutions

Introduction, Acid-base theories (Arrhenius, Lowry-Bronsted, Lewis, solvent-system concept and Usanovich concept), Definition of pH & pH scale (Sorenson and operational definitions) and its significance, pH at elevated temperatures, pH for aqueous solutions of very weak acid and base, pH for salts of weak acid and weak bases (derivations). Buffer solutions, buffer capacity, applications of buffers, numerical problems.

Module 3 Theory of Volumetric and Gravimetric Analysis

Introduction, volumetric analysis, titration, fundamental requirements of a titrimetric method, types of titration reactions, standard solutions, preparation of standard solutions, primary standards, secondary standards, detection of end point, indicators, theories of

indicators (Ostwald's theory and Modern Quinoid theory), acid base titrations in non-aqueous media.

Introduction to gravimetric analysis, steps in gravimetric analysis, impurities in precipitates, co precipitation and post precipitation, precipitants and types of precipitants (organic and inorganic), sequestering or masking agents, solubility product, common ion effect, gravimetric calculation (gravimetric factor), limitations of gravimetry, numerical problems.

Module 4 Complexometric equilibria.

Introduction, key points in general complexometric procedure, titration curves, EDTA as versatile reagent, types of EDTA titrations(Direct titration, Back titration, Displacement or substitution titration, alkalimetric titration), methods of end point detection, metal ion indicators, Brief discussion of instrumental methods of end point detection (Spectrophotometric, Amperometric, Potentiometric).

Home assignment:

1. Basic information about operating of instruments such as conductometer, pH meter, polarimeter, colorimeter, IR, NMR, Mass, X-ray, etc. (collect information in a way which will help understanding the working of instrument).
2. Write an essay, prepare posters on topic related with syllabus points such as types of reactions, History of acids and bases etc.
3. Online examination (Two exams of 10 marks each will be taken and marks will averaged for both the test).

Recommended Study Material

1. General Analytical Techniques. Gurdeep R. Chatwal (Edited by M. Arora), Himalaya publishing house.
2. Analytical Chemistry. Theory and Practice (Third edition). R. M. Verma, CBS Publishers & Distributors PVT Limited.
3. Analytical chemistry (Sixth Edition). G. D. Christian, Wiley publications
4. Fundamental of Analytical Chemistry, 7th Edition (1996). D. A. Skoog and D. M. West, Saunders College Publishing, Philadelphia, Holt, London.
5. Modern Analytical Chemistry. David Harvey, McGraw Hill Higher education.
6. Vogel's Textbook of quantitative Analysis, (Fourth Edition). G. H. Jaffery, J. Bassett, J. Mendham, R. C. Denney, Longman Scientific & Technical Publications.

Outcomes:

- The student will understand importance of statistical analysis and various tests used for analysis and data presentation in analytical chemistry.
- He/she will learn basic principles regarding sampling, will understand importance of sampling in analysis, various operational procedures used in sampling etc.
- He/she will learn various acid-base theories and will understand the improvement occurred in the subject, various concepts related to acid-base chemistry, use of buffer solutions in various fields, determination of pH of weak acid and weak base etc.
- The student will understand minute details necessary for performing analysis of unknown samples using classical methods of analysis such as volumetry and gravimetry. He/she

will learn to apply various theoretical principles involved in these classical methods when needed.

- He/she will understand the use of complex metric method in estimating concentration of analyse, the use of reagent, indicators and instrumental methods in determination of end point of a complexometric titration. He/she will be able to apply the principles wherever needed while analyzing the analytical sample.

Course Title: Chromatographic methods of analysis (ACH-312) **Contact hrs.-** 60
Credit 4

Course Objectives:

- To understand the various types of chromatographic methods and priciple involved in them such as liquid –liquid, liquid solid and Gas liquid chromatography
- To understant the various procedures for quantitative analysis by chromatography.
- To acquire the detail knowledge of types of columnns ,detectors etc employed in modern chromatographic techniques.
- To understand the optimisation of chromatographic parameters and performance of column.
- To master the concepts and application of various chromatogrpahics techniques through numerical problerms solving based on different topics.

Course contents:

Module 1. Introduction to Chromatographic methods

Principles of analytical separation: Theory of chromatography, Plate theory, rate theory, efficiency of chromatographic analysis. Craig concept of counter current .

Module2 Conventional chromatographic methods

Introduction to chromatography, Classification of chromatography. Thin Layer chromatography (TLC), stationary phase, mobile phase, polarity of solvents, retention time, varies steps involved in TLC applications of TLC;. Column chromatography: concept, partition coefficient, capacity factor, selectivity factor, peak width, resolution, flash column chromatography. Applications and limitations of column chromatography.

Module3 Gas Chromatography

Introduction, instrumentation, types of column (packed, open tubular, SCOT, WCOT etc), types of detector in GC (TCD, ID, FID, ECD, element selective detectors), programme temperature gas chromatography (gradient type elution). Derivatisation approach in GC. Methods of quantitative analysis by GC (Internal standard method and standard addition method. Applications and limitations of GC.

Module 4 High performance liquid chromatography

Introduction, Types of liquid chromatography (normal and reverse phase chromatography), high performance liquid chromatography and instrumentation, derivatization and, preparative HPLC. Quantitative analysis by HPLC. Applications and limitations of HPLC.

Module 5 Ion exchange chromatography

Ion exchange chromatography: Introduction, ion exchange equilibria, types of ion exchange resins (strongly acidic, strongly basic, weakly acidic, weakly basic), ion exchange chromatography, instrumentation. **Ion pair chromatography:** Basic principles, separator column, suppressor column, detectors, applications. **Selected** Numerical problems on the topics mentioned above.

Home assignment: Concept, instrumentation and applications of various Hyphenated chromatographic methods such as LC-MS, GC-MS, LC-NMR, LC-NMR-MS. LC-IR etc. Challenging Numerical problems on the topics mentioned above.

Recommended Study materials:

- D. A. Skoog; ;; J. J. Leary; Principles of Instrumental Analysis; Paperback – International Edition, 1992.
- D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, International Edition, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
- R. L. Pecsok, L.D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd (1976), John Wiley & Sons, New York.
- L. R. Shyder and C. H. Harvath, An introduction to separation science, Wiley Interscience.
- H. H. Willard; L. L. Merit; J. A. Dean & F. A. Settle, Instrumental Methods of Analysis (CBS).
- Basic concept of analytical chemistry, S. M. Khopkar.
- Kaur, H. Instrumental Methods of Chemical Analysis, 1st Ed., Pragati Prakashan, 2001. Ewing, G. W. Instrumental Methods of Chemical Analysis, 5th Ed., Mcgraw-Hill, 1985.
- Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 4th Ed., John Wiley and Sons, 1998.
- Settle, F. A. Handbook of Instrumentation.

Course Outcomes :

After completion of this coures

- The students shall be well acquainted with basic concept of chromatographic methods.
- They will be able to understand how to chose the an appropriate method, forsee the possible interferences and circumvents them for the analysis of given challanging analyte sample.
- The student will master the the various chromatographic techniques and enable themselves to be expert in chromatographic methods.
- They will be able to develope the chromatographic method for qualitative and quantitative analysis new sample based on their experties acquired in this course.

LABORATARY COURSE-1 (LACH-311)

Course Title: Analytical Chemistry Lab (LACH-311) Credits: 4 Contact hrs: 120

Objectives:

The basic objectives of this course are:

- To strengthen the knowledge of classical chemical analysis principles
- practical applications of classical separation techniques
- to be able to quantify the analyte in different matrix.

Course Contents:

Note: Perform minimum 8 experiments from the list given below:

- Separation and estimation of Zn^{2+} and Cd^{2+} by Ion exchange chromatography.
- Separation and estimation of Br^- and Cl^- by Ion exchange chromatography.
- Estimation of Zn^{2+} and Mg^{2+} by Ion exchange chromatography.
- Separation by column chromatography (1)
- Separation by column chromatography (2)
- Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).
- Determination of concentration of Fe ion in ferric salicylate complex spectrophotometrically.
- Simultaneous determination of arsenic (III) and antimony (III) by spectrophotometry.
- Simultaneous determination of chromium and manganese by spectophotmetry.
- Determination of sulphate and phosphate by spectrophotometry.
- Quantitative Determination of Cr(III) and Co(II) Using a Spectroscopic H-Point Standard Addition.
- Spectrophotometric determination of pK value of an indicator.
- Determination of moisture content in organic compounds using Karl-Fischer method.

- Determination of glucose from blood serum (enzyme method/folin-Wu-method).
- Determination of normality of given HCl and $CuSO_4$ thermometrically
- Estimation of carbohydrates by Anthrone method.
- Determination of Critical Micelle Concentration of Some Surfactants by UV absorption/fluorescence/conductivity measurements.
- Determination of Anionic Surfactants in Natural and Waste Water.
- Estimation of COD from waste water.
- Determination of sap value and iodine value of oil.
- Analysis of vitamin C in juices and squashes.
- Estimation of Nitrogen from given fertilizer by Kjeldahll method.
- Estimation of Phosphorus from given fertilizer by volumetry.
- Estimation of Potassium from given fertilizer by gravimetry.
- Purification by recrystalization.
- Purification by distillation.
- Calibration of pipette
- Standardization of acid and base solutions.
- Molecular weight of polymer by viscosity measurements.
- Estimation of total carbohydrates by Anthrone method.
- Isolation of casein from milk.
- Estimation of Vitamin-C by 2,6 dichloro-indophenol method.
- Analysis of bauxite with respect to silica, aluminium and iron.
- Analysis of pyrolusite ore with respect to acid insoluble residue iron and $MgCl_2$.
- To determine the amount of copper in brass metal alloy colorimetrically.
- Analysis of cupranickel (monel metal) alloy for copper and nickel content.
- Other suitable experiments.

Outcomes:

At the end of the course, the student will be

- Understand the importance of classical analysis in chemistry
- Validating their theoretical knowledge through experiments
- Understand when and how to apply classical methods of chemical analysis.
- Able to choose and design appropriate method for chemical analysis.

LABORATORY COURSE : LACH-312

Course Title: Analytical Chemistry Lab- (LACH-312 Credits: 4 **Contact hrs:** 120

Objectives

- To strengthen the knowledge of advanced chemical analysis techniques
- practical applications of sophisticated techniques
- to develop a skill in the handling of instrument.
- To understand and interpret the results.

Course Contents:

Note: Perform minimum 8 experiments from the list given below:

- To determine the amount of each copper and bismuth or copper and iron (III) from the given mixture at 745nm by spectrophotometric titration using standard solution of EDTA.
- Analysis of Fe in water and waste water using colorimetry/spectrophotometry.
- To determine amount of each para nitro-phenol and meta nitro-phenol from the given mixture by spectrophotometric titration using standard solution of NaOH.
- To record ultraviolet adsorption spectrum of acetone in n-hexane and identify the various transition by Spectrophotometry.
- Determination of strength of acetic acid from the commercial vinegar sample by potentiometric tiration and its confirmation by conductometric / pH-metric titration using standard solution of NaOH.
- Determination of magnesium and calcium in tap water by atomic absorption spectroscopy.
- Determination of vanadium in lubricating oil by atomic absorption spectroscopy.
- Determination of Cu and Zn in Tissue Samples using AAS.
- Determination of Calcium in Analgesic Tablets Using Atomic Absorption / flame emission Spectrophotometry.
- Estimation of Na, K and Ca in a mixture using Flame photometer.
- Estimation of calcium/sodium in the sample of dairy whitener by flame photometry.
- The Analysis of riboflavin (vitamin B_2) in Urine by Fluorescence.
- Determination of aspirin, phenacetin and caffeine in a given mixture by using HPLC.
- To estimate the amount of paracetomol and dichlofenac sodium in caftol tablets (USP) by HPLC technique.
- Determination of alcohol in beverages by gas chromatographic technique.
- Quantitative analysis of mixture by Gas Chromatography a) Chloroform and carbon tetrachloride b) methanol and ethanol.
- Determination of aluminium by using GC.
- Analysis of the DSC spectra of standards.
- Estimation of Ca and Mg from the mixture of their carnonate/oxalate by recording their TGA curve.
- Estimation of CuSO4 and NaCl in a mixture using a TGA curve.
- Determination of Carbon Monoxide in Automobile Exhaust by FT-IR Spectroscopy.
- Using Infrared Spectroscopy Measurements to Study Intermolecular Hydrogen Bonding.

- Quantitative Analysis by FT-IR: Thin Films of Copolymers of Ethylene and Vinyl Acetate.
- Turbidimetric Determination of Sulfate in Water.
- Determination of amount of chloride from the given sample solution by Nephelometric/ Turbid metric titration using standard solution of AgNO3.
- To study the oxidation of Ferrocene and reduction of K3 [Fe(CN)6] by Cyclic Voltammetry.
- Determination of phosphoric acid in cola beverages by pH titration.
- Determination of concentration of mixture of halide ion(s) in the given solution potentiometrically.
- Estimation of bicarbonate and carbonate by potentiometric method.
- Determination of moisture content in food sample by Karl fisher reagents.
- The interpretation of the chemical structure from the UV-vis, ^{1}H NMR and IR spectroscopic data.
- The interpretation of the chemical structure from the ^{1}H & ^{13}C NMR and IR spectroscopic data.
- The interpretation of the chemical structure from the NMR, IR and mass spectroscopic data.
- Any other relevant experiment

Outcomes:

After completion of this course, the student will

- Understand the principle of instrumental analysis in chemistry
- Validating their theoretical knowledge through experiments
- Understand when and how to apply instrumental methods for analysis.
- Able to choose and design appropriate method for chemical analysis.

SEMINAR

SACH-311 : **Credit 1**

Course Objectives:

- To enhance the presentation skill and stage courage
- To have idea about various research journals and publications
- To train student for surveying the research literature.
- To be able to prepare the report component and structure
- To further enhance the knowledge of students in the specific subject

Outcome:

Through this course the students will be able to

- The present the topic of seminar chosen in real scientific way.
- Student will be familiar with different literature ressourses
- This activity will provide the platform to the students face the expert in the subject
- Thew will acquire knowekledge as to how to prepare report component and its structure.

Course Title : Organic Spectroscopy (EACH-311) contact hrs-60 Credits 4

Course Objectives:
Student should learn

- Different spectroscopic principles
- Their applications like UV, IR,and PMR , CMR and Mass .
- Different 2 D techniques
- Emerging trends in spectroscopy

Course contents:

1 UV, IR and PMR: Elementary ideas (recapitulation)
2. PMR (Advanced ideas)
3. Spin couplings, different spin systems, factors affecting coupling constants, rate processes, different types of couplings, methods used for simplification of PMR spectra. NOE, Two dimensional (2D) NMR techniques (COSY < HETCOR etc.)
4. CMR- elementary ideas, instrumental problems, advanced idea, chemical shift features of hydrocarbons, effect of substituent on chemical shifts, different types of carbons.
5. Mass spectrometry-theory, instrumentation, rules of fragmentation, fragmentations of different functional groups, factors controlling fragmentation.
6. Problems based on joint applications of UV, IR, PMR, CMR and Mass.
7. Home assignment: Applications of PMR in biological systems, structural assignments of complex molecules based on given structure and joint applications of UV, IR, PMR, CMR and Mass.

Recommended Study materials:

1. Introduction to spectroscopy by Donald L. Pavia Gary M. Lampman, George S. Kriz (Harcourt college publications) 3rd Edition.
2. Spectrometric Identification of organic compounds by – R. M. Silverstein, T. C. Morril, G. C. Basseler.
3. 13 C-NMR spectroscopy by – G. C. Levy, R. L. Lichter, G. L. Nelson (Wiley).
4. Spectroscopic methods in organic chemistry by –D. H. Williams and Ian flemming.
5. Absorption spectroscopy of organic molecules by-V. M. Parikh.

Outcomes:

- **The learner should be able to**
  1 Understand the different spectroscopic principles
  2 Interpret different spectra
  3 Elucidate the structure of organic compounds
  4 Apply the knowledge in charecterisation of compounds

Course Title : Spectrochemical methods of analysis (EACH-312) contact hrs.-60 credit-4

Course Objectives:

- To understand the basics concepts of different spectrochemiocal methods of analysis such as atomic absorption and emmision and luminesecence spectrochemical methods.
- To understand in detail the instrumentation and applications of abovbe methods.
- To understand the suitability of appropripate methods depending upon the acacurracy desired and economical aspect of the method.
- To master the course by solving challenging numerical problems based on the above topics.
-

Course contents:

Module 1. Spectrochemical methods of analysis.

Analog and Digital Electronics A. Linear IC's and Analog Signal Handling B. Interfacing Circuits C. Computer Control and Automation Sensors and Transducers A. Detectors for Electromagnetic Radiations and Ions . Laser-based Detectors Other Sensors and Transducers. Optimization of Electronic Measurements A. Signal to Noise B. Modulation and Demodulation C.Signal to Noise Enhancement, Fourier Transform Techniques, Spectrometry Time Domain and Frequency Domain Spectra, Basic Principle , Physical Significance Fourier Transform IR and Raman Spectroscopy. Hyphenated Techniques and Data Systems FTIR/Chromatography B. GC, HPLC- and CE-MS Systems The Advantages and Problems of Hybridization , The Interface The Data System.

Module 2. Molecular Absorption and luminescence spectrophotometry

Ultraviolet-Visible: Introduction, Lambert, Beer's law, deviations, quantitative analysis, Theory of spectrometry and colorimetry, instrumentation, classification of methods of colour measurements, standard curve /calibration graph method, derivative spectrometry and applications, standard addition method, qulitative and quantitative Applications.

Infrared Spectrophotometry: Instrumentation, Quantitative Applications, Qualitative Applications, Characterization Applications.

Introduction, theory, fluorescence, phosphoserence, Instrumentation and applications, Molecular Fluorescence and Phosphorescence Spectra, Instrumentation, Quantitative Applications Using Molecular Luminescence.

Module 3. Atomic Absorption spectrometry

Principle, instrumentation, burners, production of atoms and ions, Electrothermal Atomizers, cold-vapor method, detectors, HCL, EDL, background correction method and application, interferences, Minimizing Interference, advantage and disadvantage of AAS.

Module 4. Atomic emission and Mass spectrometry

Atomic emission spectroscopy: Flame Emission spectrometry: introduction, elementary theory, instrumentation, type of burners, fuel-oxident composition, interferences, internal standard method. Atomic Emission spectroscopy: Introduction, equipment, qualitative and quantitative analysis with AES, plasma emission spectrometry, direct current plasma, inductively coupled plasma, ICP-AES, high energy sources (plasma, arc, and spark), sample introduction and measurements. Atomic Mass spectrometry: Introduction, mass spectrometer interface, mass analyzers, transducers, interface in ICP MS, applications

Recommended study material:

- D.A. Skoog, D.M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, (2004), Thomsan Brooks/Cole, Cengage Learning Ind. Pvt. Ltd, New Delhi.
- Ewing's Analytical Instrumentation Handbook, Ed. J. Cazes, (2005), Marcel Dekker, Inc., New York.
- G.H. Morrison and H. Freiser, Solvent Extraction in Analytical Chemistry, 1st Edition (1958), John Wiley, New York.
- B.L. Karger, L.R. Snyder and C. Howarth, An Introduction to Separation Science, 2nd Edition (1973), John Wiley, New York.
- E.W. Berg, Chemical Methods of Separation, 1st Edition (1963), McGraw Hill, New York.
- D.G. Peters, J.M. Hayes and C.M. Hieftj, Chemical Separation and Measurements, 2nd Edition (1974), Saunders Holt, London.
- J.D. Seader and E.J. Henley, Separation Process Principles, 1st Edition (1998), John Wiley & Sons. Inc., New York.

Outcomes:

After learning this course the students shall able

- To understand th principle, operation and applicatiosn of different spectrochemical methods of analysis .
- To develop the method of quantification for a given sample of analyte.
- understand to make a judicious choise of the analytical methods from the available methods as per requisite of situation.

Course Title :Intellectual Property Management (OPCH-311) Contact hrs.-60 Credit-4

Course objectives Objectives:

- Greatest teacher, philosopher of India ***Chanakya*** has once quoted "*create wealth from knowledge and Knowledge is Power*". Intellectual Property Rights has got importance in the economic development of India. A renewed awakening of the role of intellectual property in the countries of the various regions of the world has led more recently to the adoption of national legislation on Intellectual Property Rights (IPR) as well as to the establishment or modernization of Government structures that administer such legislation. The present module has been designed keeping in view the above opportunities and challenges to give in-depth knowledge of IPR to the postgraduate students. The course is designed to introduce fundamental aspects of Intellectual Property Rights to teachers, students who are going to play a major role in development of modern economy of India.

- University Grants Commission Bahadur Shah Zafar Marg New Delhi. 110 002. letter to Universities about inclusion of intellectual Property rights curriculum in universities.
- Intellectual Property rights (http://www.ipindia.nic.in/#content) Office of the controller general of patents, designs & Trade marks.
- *"What are intellectual property rights?". World Trade Organization. World Trade Organization. Retrieved 2016-05-23.*
- Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications. B L Wadehra
- MANUAL OF PATENT OFFICE PRACTICE AND PROCEDURE THE OFFICE OF CONTROLLER GENERAL OF PATENTS, DESIGNS & TRADEMARKS Controller General of Patents, Designs and Trademarks Mumbai.

Course content

Module 1 Introduction to Intellectual Property

- What is Intellectual Property (IP)? Types of IP meaning of the concept of Copyright, Trademark, Patent, Industrial Designs, Geographical Indications, traditional Knowledge etc.
- Significance and importance of IP in the business.
- Significance and importance of IP in Teaching Field.
- Patents Overview - What is a patent? – Importance of Patents in the knowledge economy
- Historical evolution of patents, Why protect inventions by patents? Searching a patent, Drafting of a patent specification, Filing of a patent, Types of patents Divisional, and Provisional applications.

Module 2 Legal Aspects of Intellectual Property

- Indian Patent laws, International convention relating to Intellectual Property, Establishment of WIPO – Mission and Activities – History – General Agreement on Trade and Tariff (GATT) – TRIPS Agreement.
- Indian Position Vs WTO and Strategies – Indian IPR legislations – commitments to WTO-Patent
- Ordinance and the Bill – Draft of a national Intellectual Property Policy – Present against unfair competition.
- What is infringement? – Direct and Indirect infringement.
- What is PCT? PCT provisional or full specification, where to file? PCT application and detailed procedure.

Module 3 Intellectual Property Management

- Patenting in Academics – Why should academics patent?
- What should academics patent? - Do patents affect research quality?
- History of academic patenting and exploitation.
- Land mark patents form academics and exploitation – Are universities abusing patent system?
- Encouraging patenting culture in Indian Academia, particularly in State Universities.

Module 4`Transfer of Technology

- Basic concepts of technology transfer, meaning of know-how and technical expertise technological knowledge for installation, operation and functioning managerial expertise.
- Role of universities (University Teachers and Researchers), research institutions (Scientists) and industries (Industrialist) in international technology transfers.
- Types of technology transfer agreements, difference between license and transfer, types of licenses and transfer agreements, technology transfer agreements and competition Law

Home Assignment:

Research and practical based Home Assignment (Beyond Class Room Activity)

Compilation of report on various case studies related to IPR involving techno-scientific and legal issues therein for patent, trade mark and geographical indicators etc (Referring various case studies and compilation to be done by students) and Open discussion of the report (among the students).

Recommended Study Material

- **WIPO Publication** on Intellectual property (refer Chapters 1to 6).
- **Cornish W & Llewellyn D**, intellectual Property: patents, Copyright, trademarks & Allied Rights, Sweet & Maxwell, 2007.
- **Susan Sell et.al**, *Who Governs the Globe?*, Cambridge University Press, (2010).
- **Odagiri et.al**, *Intellectual Property Rights, Development, and Catch Up*, Oxford University Press, (2010).
- **Christopher May & Susan K. Sell,** *Intellectual Property Rights: A Critical History,* Lynne Rienner Publications, (2005).
- **John Odell (ed.),** *Negotiating Trade: Developing Countries in the WTO and NAFTA*, Cambridge University Press, (2006).
- **Gustavo Ghidini,** Intellectual Property and competition Law: The Innovation Nexus, Edward Elgar, (2006).

- **David J. Teece**, *The Transfer and Licensing of Know-how and Intellectual Property*, World Scientific (2008).
- **Susan K. Sell**, *Private power, public law : The globalisation of IPR*, Cambridge University Press, (2006).
- **Kenneth L. Port**, Licensing Intellectual Property in the digital age, Carolina Academic Press, (1999).
- **Merges, Lemley, et.al,** (4th Ed.) Intellectual Property in the new technological age Aspen Publishers, (2007).
- **Thomas Pogge, Mathew Rimmer, Kim Rubenstein (ed),** Incentives for global public health: Patent law and access to essential medicines, Cambridge University Press (2010).
- **Debirag E.Bouchoux**: "Intellectual Property". Cengage learning , New Delhi .
- **M..Ashok Kumar and Mohd.Iqbal Ali**: "Intellectual Property Right" Serials Pub.
- **Prabhuddha Ganguli**: ' Intellectual Property Rights" Tata Mc-Graw –Hill, New Delhi.
- **Kerly's** Law of Trade Marks and Trade Names, 14th Edition, Thomson, Sweet & Maxweel.
- **A. K. Bansal**, Law of Trade Marks in India (2009 Edition) Institution of Constitutional and Parliamentary Studies and Centre for Law, Intellectual Property and Trade, New Delhi. Christoher Wadlow, The Law of Passing Off, 1995.
- **Marsha A. Echols**, Geographical Indications for Food Products, International Legal and Regulatory Perspectives (2008), Wolters Kluwer.
- **N.S. Gopalakrishnan & T.G. Agitha**, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow.
- **W.R. Cornish**, Intellectual Property, Sweet & Maxwell, London (2000).
- **P. Narayana**, Patent Law, Wadhwa Publication.
- **Merges**, Patent Law and Policy: Cases and Materials, 1996.
- **Brian C. Reid**, A Practical Guide to Patent Law, 2nd Edition, 1993.
- **Brinkhof (Edited),** Patent Cases, Wolters Kluwer .
- **Prof. Willem Hoyng & Frank Eijsvogels**, Global Patent Litigation, Strategy and Practice, Wolters Kluwer .
- **Gregory Stobbs**, Software Patents Worldwide, Wolters Kluwer .
- **Feroz Ali Khader**, The Law of Patents – with a special Focus on Pharmaceuticals in India, LexisNexis Butterworths Wadhwa, Nagpur.
- **Ajit Parulekar and Sarita D' Souza**, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006.
- **B. L. Wadehra**; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
- **P. Narayanan**; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010.

Outcomes:

- Intellectual Property (IP) is one of the most important assets of a leading edge technology company. Whether it be patents, copyrights, trademarks, trade secrets or know-how, it is critically important to identify it, document it, protect it and in some cases, register it. Good IP management also requires the development of a strategy in order to balance the

cost involved in registering IP against the protection that will be required in markets you are in or plan to develop.

- Another important part of managing IP is keeping tabs on what your competitors are doing. Any time a competitor is awarded a patent, you should be examining it to ensure that you are not infringing on their IP. If you are familiar with your competitors' IP, you can design around it. Reasons for Patenting Your Inventions Patents provide the exclusive rights**, Strong market position** - Through these exclusive rights, **Higher returns on investments, Opportunity to license or sell the invention, Increase in negotiating power, Positive image for your enterprise.**

  The Introduction of an institutional/university/college level elective course aims to facilitate the protection and valorization of intellectual properties generated during the research pursuit in the Institute/university/college and offer scope for wealth generation, alleviation of human sufferings and betterment of human life. University urges all faculty, staff and students to document their IP, so that they can be protected and applied to the gain of the country, the institute/university/college and the concerned inventors. This elective course can facilitate faculties and staff of institute/university/college in a proactive manner in the generation, protection and transaction of Intellectual Properties which offer potential and scope for shared benefits to society, institute/university/college and inventors.

Course Title : Electroanalytical and Thermal methods of analysis (ACH-411)
contact hrs.- 60 Credit 4

Objectives:

- To understand the basic concept of electronics involve in various electroanalytical equipments.
- To understand the various volatmetric techniques such as polarography, cyclic voltametry striping volametry and chronopotentiometry.
- To understand the Faradys laws of electrolysis and concept, principle instrumentation involved in coulometry.
- To understand the concept, principle and instumenation involved in various thermal methods of analysis such as TGA, DTA, DSC DMA etc.
- **Course contents**

Module 1 Introduction to Voltammetric methods of analysis

- Introduction to various voltametric techniques such as polarography, cyclic voltametry, striping volametry and chronopotentiometry.

Module -2 Polaragraphy

Principles, Instrumentation (different types of microelectrode such as dropping mercury electrode (DME), the static drop mercury electrode, rotating disc and ring disc electrode, supporting electrolyte, factors affecting on polarographic wave, advantages and disadvantages of DME, Heylosky and Ilkovic Equation, polarographic maxima and maxima suppresors, interference due to dissolved oxygen, Methods of quantitative analysis (calibration curve, piolot ion method and standard addition methods), applications and limitations . Pulse Polarography:

different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography and applications.

Module 3 Hydrodyamic and cyclic voltametry

Hydrodynamic voltametry and applications of hydrodynamic voltametry (volatametric detectors in chromatography and flow injection analysis, Voltametric oxygen sensors, amperometric titration). Cyclic Voltametry: Principle of cyclic Voltammetry, illustration of CV with reference to K3[Fe(CN)6], and parathion, criteria of reversibility of electrochemical reactions, quasireversible and irreversible processes, applications.

Module 4 Coulometry

Current voltage relationship during an electrolysis, Operating cell an at fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiostatic coulometry-Instrumentation and applications, coulometric titrations (Amperostatic coulometry)-Apparatus and applications, advantages and limitations, problems.

Module 5 Thermal methods of analysis

Principle, operations and applications of different methods of thermal analysis, Thermo gravimetric methods of analysis: Instrumentation, thermogram and information from thermogram, factors affecting thermogram, applications TGA for quantitative analysis (TG analysis of CaC_2O4 H_2O, $CuSO_45H_2O$, dolomite ore, etc.) and problems based TGA. Differential Thermal Analysis (DTA): Instrumentation, general principles, differential thermogram, DT and TG curve together. **Home Assignment:** Differential Scanning Calorimetry (DSC): Principle, Instrumentation, and Applications), thermometric titrations.

Suggested Books and Reference materials

1) D. A. Skoog; D. ,M. West; J. J. Leary; Principles of Instrumental Analysis; Paperback – International Edition, 1992.
2) R.D. Braum, Introduction to Instrumental Analysis

3) Willard, Deritt, Dean and Settle, Instrumental methods of Analysis.
4) F. J. Welcher, standard Methods of chemical Analysis Vol.3, Part A & B.
5) G.W. Ewing, Instrumental Methods of Analysis 4th and 5th editions.
6) Chatawal and Anand, Instrumental Methods of Analysis.
7) Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantititative Inorganic Analysis.
8) Electro-analytical chemistry, edited by H.W.Nurnberg.

Course **Outcomes:**

After learning this course, the students shall able to

1 Understand the basic concept of varies electroanalytical and thermal methods of analysis.

2 Understand working and applications of of different analytical techniques as mentioned above.

3 Understand the various procedures of qualitative and quantitatiuve analyis employing above techniques.

4 To understand how to chose appropraite technique, possible interferences and how to eliminate them and also to kono the merits and demerits of each technique.

5 Solve various numerical problems based on each topic and theryby mastereing the course to greatest extent.

Course Title: Applied Analytical Chemistry (ACH-412) Credits 4, Contact hrs: 60
Objectives:

1 To understand the basic terms related to metallurgy such as minerals, ores, extraction of ores, electromagnetic separation, hydraulic washing, leaching process, froth floatation, calcination and roasting, reefing of impure metals etc.
2 To learn various procedures used in the analysis of ores such as bauxite, hematite, dolomite, inorganic phosphate and galena etc.
3 To learn basic information regarding alloys such as alloy, mechanism of alloy formation, applications of various alloys etc. Analysis of various alloys such as bronze, brass, steel, German silver, solder and gun metal using various volumetric and gravimetric methods.
4 To understand basic terms such as soil, soil pH, importance of soil pH, measurement of soil pH and to learn various method of soil analysis.
5 To learn basic information regarding coal, types of coal, proximate analysis of coal, advantages of proximate analysis of coal sample, ultimate analysis of coal etc.

Module I Introduction to metallurgy

Introduction to Minerals and ores, Types of ores, Naming of ores, Extraction of ores, Crushing and grinding of ores, Concentration of ores (electromagnetic separation, hydraulic washing, leaching process, hand picking method, froath flotation process), Calcination and roasting of ores, difference between calcination and roasting, Reduction of metal oxide to metal, Purification or refining of impure metals.

Module 2 Minerals and Ores

Bauxite: Introduction, purification (Baeyer's process, Hall-Heroult's process), Analysis of bauxite ore (loss on ignition, estimation of impure silica, total iron oxide, titanium oxide, aluminium oxide), **Haematite:** Introduction, Extraction of Fe from hematite ore, Analysis of hematite ore (loss on ignition, estimation of impure silica, iron, aluminium and manganese from the ore sample), **Dolomite:** Introduction, properties, uses, analysis of dolomite (estimation of calcium and magnesium from dolomite sample), **Galena:** Introduction, uses, analysis of galena ore (loss on ignition, estimation of lead and sulphur from the ore sample), **Inorganic phosphate:** Introduction, importance of phosphate measurement, biochemical importance of phosphate, analysis of phosphate.

Module 3 Alloys

Introduction, **Bronze:** Introduction, types of bronze, properties, applications, analysis of bronze alloy (estimation of copper and tin from alloy sample), **Brass:** Introduction, applications, analysis of brass alloy (estimation of tin, lead, copper, iron and zinc from alloy sample), **German silver:** Introduction, analysis (estimation of tin, copper, iron and nickel from alloy sample), **Gun1 metal:** Introduction, analysis (estimation of tin),

Module 4 **Solder and type metal:** Introduction, analysis (estimation of tin, lead and antimony from alloy sample), **Steel:** Introduction, stainless steel, properties, applications, estimation of nickel and tin from steel sample.

Module 5 Soil and Coal Analysis

Introduction, Determination of moisture, pH, conductivity, total nitrogen, phosphorous, silica, lime, magnesium, manganese, sulphur, Determination of metals such potassium, calcium,

Magnesium and sodium using flame photometer, Soil alkalinity, determination of soil alkalinity. Coal, types of coal, Proximate analysis of coal (determination of moisture, volatile carbonaceous matter, ash, fixed carbon content), advantages of proximate analysis, Ultimate analysis of coal (determination of carbon and hydrogen, nitrogen, sulphur, ash and oxygen content).

Home assignment

1. Methods for refining of impure metals such as microbial leaching method, electro-refining methods, chemical methods etc. (Collect at least two-three examples of each method).
2. Write an essay; prepare posters on topic related with syllabus points such as soil analysis, History of ores and alloys etc.
3. Online examination (Two exams of 10 marks each will be taken and marks will averaged for both the test).

Recommended Study Material (Books/Handbooks/Encyclopedia)

1) A Text-book of Practical Chemistry (Part I: quantitative analysis). V. V. Nadkarny, A. N. Kothare, Y. V. Lawande, Popular Prakashan, Bombay.
2) Analytical Chemistry. Alka L. Gupta, Pragati Prakashan.
3) Applied Chemistry. Theory and Practice (Second edition). O. P. Vermani and A. K. Narula, New Age Internationals (P) Limited, Publishers.
4) Analytical Agricultural Chemistry (4^{th} Edition). S. L. Chopra and J. S. Kanwar, Kalyani Publishers.
5) Chemical Methods of Rock Analysis (Third Edition, Pergamon series of Analytical Chemistry, volume 4). D. Hutchison and P. G. Jeffery, Pergamon Press.
6) Chemistry of the Soil (2^{nd} Edition). F. E. Bear (1964), Reinhold Publishing Corporation, New York.
7) Methods of Soil Analysis. Part 3. Chemical Methods (Soil Science Society of Americal Book Series No. 5). Donald L. Sparks.
8) Analytical methods for ores and Minerals (First Edition). B. H. Khawas, I. K. International Publishing House.
9) Analytical Chemistry of mineral. A. I. Samchuk and S. V. Ponomarenko, 1987. VNU Science Press.

Course outcome
After completion of this course, the students shall

1. Understand basic information regarding the branch of chemistry metallurgy, mineral and ores, difference between them, various techniques used in analysis of ore samples, theoretical principles lying behind analysis of ore samples.
2. gain all the necessary basic information regarding ores and alloys, extraction of metals from ores, estimation of metals or non metals present in ore or alloy samples.
3. learn each and every minute detail necessary for performing analysis of ores and alloys samples using classical methods of analysis.

4 understand theoretical principles involved in the analysis of soil sample, importance of soil analysis, various procedures used for analysis of soil sample, each and every minute detail of all the procedures used for soil analysis.

5 nderstand theoretical principles involved in the analysis of coal sample, importance of proximate and ultimate analysis of coal sample, various types of coal, determination of calorific value of coal.

SEMINAR

SACH-431 : **Credit 1**

Objective:

- To enhance the presentation skill and stage courage
- To have idea about various research journals and publications
- To train student for surveying the research literature.
- To be able to prepare the report component and structure
- To further enhance the knowledge of students in the specific subject

Outcome:

Through this course the students will be able to

Pesent the topic of 0seminar chosen in real scientific way.

- Student will be familiar with different literature ressourses
- This activity will provide the platform to the students face the expert in the subject
- Thew will acquire knowekledge as to how to prepare report component and its structure.

Course Title:: Industrial training, research project (ITCH-401/RPCH-401)
Contact hrs-240 credit 8

Objectives :

1 Students should design the overall project scope, goals, objective of work, determine what literature review needs to be done.

2 Design the specific experimental procedures, determine what materials need to be obtained, determine all safety issues in advance and obtain the requisite training, MSDS sheets, etc.

Important stages in the dissertation process include:

No	Work plan activity for research proposal
a)	Choosing a topic
b)	Developing a research question & literature survey on topic
c)	Conducting the experiments/data collection from fields/collaborators
d)	Drafting the report as per format & getting approval from teacher
e)	Reporting the research findings (writing the dissertation and presenting in front of committee).

The student(s) can choose a state-of-the-art problem of their own interest based on the recent trends in Polymer Science in consultation with the supervisor. They shall work on the designated problem either individually or in groups (maximum **two** students per group).

The student is required to prepare a **work plan** (for both semesters III & IV) immediately after the allotment of the project. Students should submit a neatly typed and spiral bound ***research proposal*** before the end of the third semester.

A dissertation is a particular kind of academic task. The faculty addresses the task of planning and conducting a small research project, for an undergraduate or masters' level dissertation. It aims to help students to develop a clear sense of direction early on in the project, and to support you in organizing, planning, and monitoring the research project. Student will usually be asked to generate a topic for them self; to plan and execute a project investigating that topic; and to write-up what you did and what your findings were.

3 Write a Research Project Report (dissertation), on a computer A4 size paper both sides of paper and must submit soft copy and hand copy. Font Times New Roman, font size 12 and a line spacing of 1.5 lines.

4 It will be checked for plagiarism

The dissertation report should be broadly divided into the following sections:

No	Research Project Report (dissertation) format
1)	Project title (include Title, Student Names, Class, Year, Date of Submission)
2)	Declaration & Approval
3)	Acknowledgement
4)	Abstract (Graphical and Text)
5)	Table of Contents
6)	Introduction
7)	Origin of the problem
8)	Literature review of research and development at national & international level
9)	Significance of the problem
10)	Objective of research work

11)	Experimental (Methodology)
12)	Details of collaboration (if any)
13)	Results and Discussion
14)	Conclusions & future scope of research work
15)	References
16)	Conferences/workshop/seminar attended during this period /published or communicated papers on the work

Student(s) can do the research in department or in collaboration with other departments or other university, or research institute or industry within India or abroad. Submit the research dissertation to department and copy to supervisor. Following list of research institutes near-by area (guideline purpose only) students can search other research institutes also.

Outcomes : Research Project (dissertation)

5 Research project is capability to work independently and think critically. Producing your dissertation or project is a much bigger task than writing a typical essay, and is often an unfamiliar exercise in several respects. The expectation is that you, the learner, take responsibility for your own learning and that you produce a literature review, you choose a method for undertaking a study, write up your findings and discuss the outcomes in a discussion section. The dissertation offers you the opportunity to further develop your subject expertise,, intellectual and organizational skills: The preparation and writing of the dissertation makes you take responsibility, with the support of a tutor, for your own learning, for the whole process of personal, independent study, time management, and the clear and methodical presentation of the results of your research.

Course Title: Quality Assurance and Quality Control method of Analytical development and validation.(EACH-411) contact hrs.-60 credit 4

Course Objectives:

1 To understand the importance of Standards/reference Materials in Analytical chemistry.

2 To understand the concept of Analytical Method DevelopmenKnow how to validate the developed Analytical methods.

3 To study the concept of Quality Assurance and Quality Control.

4 To learn various statistical methods to monitor and implement QC system in various industries.

Course content:

Module 1 Reference Materials

Analytical standards, primary and secondary standards, high purity substances, reference materials, use of RMs in statistical control schemes and in intercomparisons, role of certified reference materials (CRMs), production and requirements, obtaining reference value and certified value.

Module 2. Development of Analytical Method

Theory and factors affecting resolution – a reminder of the importance of resolution, separation factor (selectivity), retention factor (capacity factor) and column efficiency). Selecting the HPLC separation mode (reversed-phase, normal-phase *etc.*) Selecting the most appropriate detector

Gradient/isocratic operation, Selecting the column for analysis, Selecting and optimising the mobile phase, The effect of pH, considering pKa of the analyte

Requirements for a stability-indicating analytical method, Anticipation of likely degradation products, From experience with compound, From forced degradation (stress testing) of drug substance, as per ICH guidance, Note findings of stress-testing industry comparison , degradation products and their enantiomers or diastereoisomers, calculation of mass balance and its significance

Module 3. Validation of Analytical Method

Introduction to ICH guidelines: ICH Q2(R1), A detailed discussion on the parameters to be validated, Specificity: peak purity determination (Diode array and MS detectors), Linearity, Range, Accuracy, Precision, Detection Limit, Quantitation Limit, Robustness

Extent of validation: how much work at each phase of development, Acceptance criteria, Validation procedures and protocols, Dealing with validation failures, Method Validation Example in HPLC

Module 4. Quality Assurance and Quality Control

Quality characteristics of chemical analysis, errors occurring at the start, during or by the end of analysis, interpretation and presentation of results, Shewhart Chart, CUSUM chart and EWMA chart; QA schemes, experimental designs for optimization studies and ruggedness testing, system management; Water quality field sampling QA/QC program, QA/QC documentation, QA project plan, designing a water quality monitoring plan, Site selection, sampling frequency and sample size, cost considerations, training of field personnel, field trip preparations, Water quality sampling, toxic chemicals in bottom sampling and biota, bacterial sample collection, sequential triplicate sampling, sample

handling, preservation, storage and transport, chain of custody, field safety, field audit program, laboratory QC procedures inter- and intra-laboratory QC, detection limits, reporting of analytical results, data handling and data management

Home Assignment: Numerical and Case studies based on syllabus.
Prerequisite: Principles of Analytical Chemistry and Chromatographic methods of Analysis.

Recommended Study Material:

1 D. A. Skoog , D. M. West and F.J.Holler, Fundamentals of Analytical Chemistry, 2nd Ed., Saunders College Publishing, 1991.

2 R.A.Day and A.L.Underwood, Quantitative Analysis, 6th Ed., Prentice-Hall of India Pvt.Ltd., 1993.

3 Gas Chromatography, Open Book Learning Series

4 Larry Hargis, Analytical Chemistry. Principles and techniques
5 Encyclopedia of Analytical Chemistry.
6 ICH guidelines: ICH Q2(R1)

Outcomes:

After completion of this course student will be able to:

1`To utilize primary/secondary and various standards of Reference Materials.

2Able to develop competent Analytical Methods.

3Shall be able to Validate the new analytical methods.

4Able to implement, administer and monitor QA/QC Programm

Course Title: Techniques in Forensic Analysis (EACH-412) contact hrs-60 Credits 4

Course Objectives:

1 This course reviews the various modern analytical techniquers to be employed in the forensic science.

2 The main emphasis will on the importance of sound scientific knowledge and ethics in collecting the forensic evidence and in the reporting of the findings of such analyses.

Course contents:

Module 1 Forensic Analysis Overview:

Overview, historical forensic science, Analisis of Arsenic and nicotine, Destructive and Nondestructive techniques, Data interpretation. Destructive techniques: Mass spectroscopy, Thermal Analysis, Ion Chomatography, etc. Nondestructive techniques: SEM, TEM, XRF, IR, etc.

Module 2 Body fluid and hair analysis:

Blood Analysis: Blood preservation and ageing effects, Analysis of blood components and exogenic substances, blood stain analysis., DNA Profiling : DNA and its polymorphism, DNA typing procedures-RFLP, PCR, MVR-PCR, Dot-blot, AMP-FLP, STR, other methods, paternity testing, applications, interpretation and practical use. Hair analysis: Structure and composition of hair, morphological examination, Chemical analysis of hair components and components remaining on or in hair. Determination of alcohol: Legal background, Sampling and sample preservation, analysis-GC, IR, enzymatic and other methods. Fingerprint analysis: Latent fingerprints; optical, physical, physico-chemical & chemical detection methods; fingerprints in blood, fingerprint detection sequences.

Module 3 Systematic Drug Identification:

Classification and categories of compounds involved, analytical strategy-EMIT, FPIA, TLC, LC, GC-MS, etc., requirements for identification, possibilities & limitations of selected techniques, isotope detection method with numericals, new drug groups.

Module 4 Materials of interest for Forensic studies:

Arson Residues : nature of arson evidence, chemical evidence, properties of liquid accelerants, sampling and sample pre-treatment, laboratory examination of suspect arson evidence, evidential value. Explosives: Types, analytical methods for identification of low and high explosives in post-blast debris. Gunshot Residues : Composition of sources, detection on hands & its limitations, determination of

muzzle-to-target distance, elemental & inorganic analysis, numericals on estimation of energy released by combustion reactions, etc.

Module 5 **Forensic analysis of Fibre, paints and varnishes**

Fibres: Fibres encountered at crime scene, identification of types, dye extraction and analysis, colour matching, analysis for metals, additives and contaminants-SEMEDX, XRD, XRF. Paints, Varnishes and Lacquers : Formulation of paints, types of sample, Sample pre-treatment prior to analysis, colour measurements, Analysis by SEM, SEM-SPMA, TEM, TLC/HPTLC, PyrGC, IR, Raman, UV-Vis-Flu, XRF, AES, TG-DTA. Glass: As forensic evidence, measurement of physical properties, elemental analysis-XRD, NAA, etc., interpretation of results, casework examples.

Home assigenment : Research and practical based home assignment (Laboratory and beyond classroom activity)

Suggested books and Reference materials:

1. Instrumental Methods of Analysis-G-Chatwal and S. Anand (Himalaya Publication;1988)
2. Thermal Analysis-Wendland
3. Physical Methods for Chemists-R.S.Drago.
4. 'Forensic Chemistry' by Suzanne Bell, Pearson Prentice Hall Publishers, 2006
5. Allan Cury, Irvins Sunshine, Forensic Analysis, Academic Press Publications.
6. E.G.J.Clarics, Isolation and Identification of drugs, Pharmaceutical Press.
7. C.J.Creswell, C.A.Runquist and M.M.Campbell, Spectral Analysis of Organic Compounds.
8. F.J.Welcher, Robert E,Standard Methods of Chemical Analysis, A series of volumes.
9. Hawk's Physiological Chemistry.
10. W.G. Eckert, Introduction to Forensic Sciences, Second Edition, Elsevier, New York, 1992.
11. R. Saferstein, Criminalistics: An Introduction to Forensic Science, Seventh Edition, Prentice-Hall, Upper Saddle River, 2001.

12. Outcomes:

3 After learning this paper, the students must understand the basic principle and operation of commonly employed techniques in forensic laboratory.

4 In addition, they must be familiar with precession and accuracy needed in this filed during analysis so as to collect the authentic data in support of the forensic evidences.

Course Title: INDUSTRIAL SAFETY AND HAZARDOUS MANAGEMENT (OPCH-411)

Contact hrs.-60 credit 4

COURSE OBJECTIVES:

1 **To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models**
2 **To understand about fire and explosion, preventive methods, relief and its sizing methods**
3 **To analyze industrial hazards and its risk assessment**

Course contents:

Module 1 Industrial safety

Introduction: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Seven Significant Disasters. Toxicology: Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values, National Fire Protection Association (NFPA) Diamond

Module 2 Industrial hygiene in chemical industry

Industrial Hygiene: Government Laws and Regulations, OSHA: Process Safety Management, EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS) Industrial Hygiene: Anticipation and Identification, Evaluation, Control. Source Models: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis

Module 3 Fire and explosions

Fires and Explosions: The Fire Triangle, Distinction between Fires and Explosions, Definitions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram, Ignition Energy , Autoignition , Auto-Oxidation , Adiabatic Compression, Ignition Sources, Sprays and Mists, Explosions Concepts to Prevent Fires and Explosions: Inerting, Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Miscellaneous Concepts for Preventing Fires and Explosions.

Module 4 Hazards identification

Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews, Other Methods, Risk Assessment: Review of Probability Theory, Event Trees, Fault Trees, QRA and LOPA

Home Assignment : Research and practical based Home Assignment (Laboratory and Beyond Class Room Activity)

Compile report on (at least one) industrial accidents happened in past in chemical or allied industry for each student. Highlight the reason for accident and precautions, safety to be taken to avoid such accidents in future. Submit the report to supervisor for approval.

Recommended Study Material (Books/Handbooks/Encyclopaedia)

1 Occupational health and safety law: text and materials by **Brenda Barrett, Richard Howells** Second edition first published in Great Britain 2000 by Cavendish Publishing Limited, The Glass House, Wharton Street, London WC1X 9PX, United Kingdom.
2 Practical guide to industrial safety methods for process safety professionals **Nicholas cheremisinoff** 2001 Marcel Dekker, Inc. ISBN:0-8247-0476-2.
3 Essentials of health and safety at work **Crown** 2006
4 KlING'S SAFETY IN THE PROCESS INDUSTRIES Second Edition Ralph King, Ronald Hirst and Glynne Evans Wuerz Publishing Ltd, Canada second edition ISBN 0 340 67786 4 ISBN 0 920063 75 6 (Wuerz) 1996.
5 Managing Health and Safety by **Jacqueline Jeynes** , 2007 Elsevier Ltd. All rights reserved
6 Health and Safety at Work: Key Terms by Jeremy Stranks, An imprint of Elsevier Science,2002.
7 Workplace Safety Volume 4 of the Safety at Work Series Edited by **John Ridley and John Channing**,1999.
8 Environmental and health &safety management guide to compliance by **Nicholas cheremisinoff, Madelyn l. graffa**, 1955.
9 Health Safety Fifth Edition Introduction to Work by **Phil Hughes**,2011.
10 A Quick Guide to Health and Safety by **Ray glibort**, 2008.
11 D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
12 R.K. Sinnott, Coulson & Richardson's, Chemical Engineering, Vol. 6, Elsevier India, 2006.
13 2. Fawcett H.H. and W.S.Wood, Safety and accident prevention in Chemical operations 2 nd editon John Wiley and Sons Inc. (1982).

Course outcomes

After completion of this course , the student shall

1 Understand how to analyze the effect of release of toxic substances

2 Understand the industrial laws, regulations and source models.

3 How to Apply the methods of prevention of fire and explosions.?

4 Understand the relief and its sizing methods.

5 Understand the methods of hazard identification and preventive measures