।। 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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E-mail: bos.srtmun@gmail.com

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. Industrial Chemistry Core papers (Third Semester)

Sr. No.	Paper No.	Title	Contact hours	Credits
Industrial Chemistry Core papers				
1.	ICH-321	Unit Operations	60	4
2.	ICH-322	Unit processes in Organic Synthesis	60	4
Practical Courses				
1.	LICH-321	Laboratory Course 1	120	4
2.	LICH-322	Laboratory Course 2	120	4
1.	SICH-321	Seminar	15	1

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

Sr. No.	Paper No.	Title	Contact hours	Credits
Industrial Chemistry Elective papers (any one from the below or courses offered for any other program in school of chemical sciences)				
1.	EICH-321	Organic Spectroscopy	60	4
2.	EICH-322	Industrial pollution and Control	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 rights	60	4

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

Sr. No.	Paper No.	Title	Contact hours	Credits
Industrial Chemistry Core papers				
1.	ICH-421	Transportation Processes in Unit Operations	60	4
2.	ICH-422	Process Industry and Industrial Pollution Management	60	4
Practical Courses				
1	ITCH-401/ RPCH -401	Industrial Training /Research Project	240	8
2	SICH-421	Seminar	15	1

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

Sr. No.	Paper No.	Title	Contact hours	Credits
Industrial Chemistry Elective papers (Any one from the below or courses offered for any other program in school of chemical sciences)				
1.	EICH-421	Agrochemicals and Pesticides	60	4
2.	EICH-422	Synthetic methods in organic chemistry	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	Radiation Chemistry	60	4

Course : Unit Operations (ICH-321) **Credits 4 (60 Contact hrs)**

Course Objectives:

- To learn the concept of unit operations
- To study the basic laws governing the different unit operations in the industry
- To understand the material balance of different unit operations in the industry
- To evaluate the unit operations like evaporation, distillation, extraction, filtration, drying etc.
- To design the equipments for heat and mass transfer operations

Course content

1. **Evaporation:** Definition, principle and theory of evaporation, boiling point elevation, Duhrings rule, single effect evaporator, multiple feed effect evaporator, (forward feed, backward feed and parallel feed) horizontal tube and vertical tube evaporator, forced circulation evaporator, material balance.
2. **Distillation:** Definition, boiling point, Raoult's law, Dalton's law, method of distillation of binary systems, flash or equilibrium distillation, continuous rectification, fractionating column, batch distillation, azeotropes, steam distillation, material balance.
3. **Liquid-liquid extraction:** Liquid-liquid extraction in three step process, ternary system, triangular diagrams, selection of solvent for extraction, mixer-setters, perforated plate, tray-tower, spray towers, packed towers, rotating disk contactor.
4. **Crystallization:** Introduction, solubility and solubility curves, theory of crystallization, Mier's supersaturation theory, caking of crystals, methods of supersaturation, crystallizers-agitate crystallizer, Swenson-Walker Crystalliser, vacuum crystallizer, Oslo crystallizer, Material balance.
5. **Filtration:** Principle of filtration, types of filtration, constant pressure filtration and constant rate filtration, filter medium, filter aids, filtration equipment, pressure filters, plate and frame press, vacuum filters, rotary drum filter, leaf filters and Moore filter.
6. **Sedimentation:** Introduction, mechanism of settling, laboratory batch sedimentation test, thickener, door thickener, settling zones in continuous thickeners.
7. **Drying:** Principle and theory of drying, drying equipments, tray dryers, tunnel dryers, spray dryer, rotary dryer, vacuum dryers.

Home assignments: (1) Centrifugal filtration: Principle of centrifugal filtration, centrifugal equipments, Boul stationary, in imperforate bowl, in rotating perforate basket, suspended batch centrifugal, operating cycle of batch centrifugal machine (2) Size Reduction: Criteria for comminution energy and power requirements in comminucation, Rittenzer's law, Bonds low, classification of size reduction size reduction equipments, Crushers, gyratory crushers, grinders, types of grinders, Ball mill grinders, Numericals on evaporations.

Recommended study materials:

1. Unit operation of chemical engineering by Juliam C. Smith

2. Introduction to chemical Engg. By Badger and Banchero (Mc Graw Hill
3. Mass transfer by Robert E. Treybal. (Mc Graw hill, 1981).
4. Chemical Engg. By Coulson and Richardon, (Vol. I, III, IV, VI) Pergamon Press, 1985.
5. Unit Operations I and II by K. A. Gavhane (Nirali Prakashan).
6. Transport Processes and Unit operation (third edition) by Christie J. geankoplis.
7. Het Marks and Momentum transfer by Benett.
8. Principles of Unit operations by Foust, Wenzel and other (Wiley Interscience).
9. Engineering heat transfer by Gupta and Prakash, Nem Chand and brothers 1989.

Course Outcomes:

1. Students will acknowledge the basic laws governing the different unit operations.
2. Able to apply their knowledge of material balance of unit operations.
3. They can apply their knowledge of different industrial unit operations like evaporation, distillation, extraction, filtration, drying etc. To the actual performance of these operations.
4. They aid in the design of equipments for heat and mass transfer operations.
5. Students can handle equipments and instruments skill fully in industries and laboratories.

Course: Unit Processes in Organic Synthesis-ICH-322 (60 Lectures, Credits 4)
Course Objective:

- To learn the concept of unit processes.
- To understand various organic processes routinely used in industry
- To evaluate the organic processes like nitration, sulphonation, amination, hydrogenation, alkylation, esterification and oxidation
- To study the Process instrumentation and safety
- Study of the following chemical processes involving process details, production trends, flow sheets, energy conservation measures.

Course content

1. Nitration: Nitrating agents, Batch and continuous nitration, mixed acid for nitrating, D.V.S. calculating, Manufacture of Nitrobenzene and □-nitronapthalene. Process equipment for nitration, batch nitration and continuous nitration.
2. Sulphonation: Sulphonating agents, sulphonation of naphthalene and anthraquinone significance of desulphonation, physical and chemical factors affecting sulphonation, Industrial equipment techniques, Manufacture of benzene sulphonic acid (by batch and continuous process), transition from batch to continuous processing.
3. Amination: Reduction products of nitrobenzene, Bachamp reduction, chemical and physical factors affecting reduction, continuous fluid-bed vapors phase reduction of nitrobenzene, corrosion and pH of autoclave charge, control of ammonia-recovery system.
4. Hydrogenation: Production of hydrogen from hydrocarbons, water gas and electrolysis of water, general principles concerning hydrogenation catalysts, hydrogenation of cotton seed oil, hydrogenation of olefins, technology of fischer-troposch process, purification of synthesis gas.
5. Alkylation: Types of alkylation, Alkylating agent's physical and chemical factors affecting allylation, equipment for alkylation, effect of alkylation manufacture of ethyl benzene and tetraethyl lead, technical alkylation.
6. Etherification: Esterfication of organic acids, catalytic etherification, completing etherification of carboxylic acid derivatives, etherification column, manufacture of ethyl acetate by batch and continuous process, manufacture of vinyl acetate and nitroglycerine.
7. Oxidation: Types of oxidative reactions, oxidizing agents oxidation of aromatic compounds, oxidation of acetaldehyde, oxidation via dehydrogenation, apparatus for oxidation, multiple tube converter, catalytic multiple tube converter, oxidation of naphthalene to phathalic anhydrate.
8. Home assignment: Green chemistry-microwaves, sonication, industrial processes in water and nonorganic media

Recommended study material:

1. Unit process in organic synthesis P. G. Groggins, Tata McGraw Hill, 5th Edition.
2. Transport process and unit-operation 3rd Ed. Christie J. Geankoplis.

Course Outcome:

Students will be able to

1. familiar with concept of unit processes.

   Apply the basics of various processes and designing of experiments.
2. Understand the basic concepts of various processes **like nitration, sulphonation, amination, hydrogenation, alkylation, esterification and oxidation.**

LABORATORY COURSE-1 : LICH-321

Course: Industrial Chemistry Lab-1 **Credits:** 4 **Contact hrs:** 120

Course Objectives:

- To learn the methods of analysis for various chemical components and processes
- To determine the values of particular property of chemical component present
- To study viscosity, refraction, adsorption etc phenomenon
- Investigation of properties by instruments.
- To train students to work on instruments like pH meter, polarimeter etc.
- To habituate students to handle the instruments skillfully
- **To bridge mainstream discipline-market and industry**

Course Content

1. Approximate analysis of a fuel (a) Determination of carbon residue of coal (b) Determination of ash point of coal sample (c) Determination of smoke point of kerosene.
2. Determination of viscosity and fluidity of given oil sample (a) edible oil (b) lubricating oil.
3. Determination of flash point and fire point of a fuel [petrol, diesel, kerosene, 2-Toil] by (a) Cleveland's open cup apparatus (b) Abel's closed cup apparatus (c) Pensky-Martin Claved cup apparatus.
4. Determination of acid value and rancidity of an oil (Lubricating oils, edible oils.
5. Determination of (a) Saponification value (b) Iodine value of an oil
6. Determination of (a) aniline point (b) turbidity point (c) pour point (d) cloud point of a lubricating oil
7. Determination of rate of distillation (a) Simple distillation (b) Steam distillation (c) Vacuum distillation
8. Estimation of surfactant from detergent and soap by method of emulsion.
9. To determine the critical micelle concentration of surfactant (sodium lauryl sulphate, sodium dodecylsulfate etc.) in aqueous solution conductometrically.
10. Study the effect of salts on critical micelle concentration of surfactant conductometrically.
11. Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using acetic acid and chloroacetic acid etc. as a catalyst polarimetrically.
12. To determine the hydrolysis constant of aniline hydrochloride by pH measurements.
13. Determine the percentage composition of given mixture of two liquids by stalagmometer.
14. Investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms.
15. Determine the specific and molar refraction of given liquid by Abbe refractometer.

(Any other related experiments may be taken)

Recommended study material:

1. A text book on experiment and calculations Engg. Chemistry Dara S. S. S. Chand and Company Ltd. (1997).

2. Systematic experimental physical chemistry by S. W. Rajbhoj and Dr. T.K. Chondhekar

Course Outcomes:

- Students can experiment about surface phenomenon like physical and chemical adsorption.
- Students can determine the values for specific properties like acid value, saponification value, aniline point, turbidly point, pour point, cloud point of oil.
- Students can handle and performe experiments skillfully on the instruments like conductometer, polarimeter, stalagmometer, pH meter, Abbe refractometer, etc.
- As students are able to handle the instruments they will be offered job in industries.this indicates strong correlation between academics and industries also shows relation theoretical and experimental knowledge.

LABORATORY COURSE-2 : LICH-322

Course: Industrial Chemistry Lab-2 **Credits:** 4 **Contact hrs:** 120

Course Objectives:

- Should be able to interpret spectra, carry out multistep synthesis
- **P**hysical examination of spectra, deduce structure, learn different techniques involved in synthesis.

Course Content:

A. Identification of organic compounds by spectral analysis. Minimum 10 problems based on joint applications of UV, IR, PMR, CMR and mass should be carried out.

B. Two stage preparations of heterocyclic and biologically active molecules: At least 10 preparatives should be carried out on micro scale using 10 mmol of starting material.

1. Acetophenone → Phenacyl bromide → Epoxide
2. Benzaldehyde → Benzalacetophenone → Epoxide
3. Acetophenonephenylhydrazone → 2-Phenyl indole → Bis-indolyl methane
4. Ethylacetoacetate → 6-Methyl-4-oxo-1,2,3,4-tetrahydro-2-thiopyrimidine → 6-Methyl uracil
5. Acetophenone → Chalcone → Pyrazoline
6. Glycine→Hippuric acid → Azlactone
7. Acetophenone → Phenacylbromide → 2-Benzoyl benzofuran
8. Ethylacetoacetate→3,5-diethoxy carbonyl-1,4-dihydro-2,6-dimethyl-4-(m-nitrophenyl)pyridine→3,5-diethoxy carbonyl-2,6-dimethyl-4-(m-nitrophenyl)pyridine
9. 2-Chlorobenzoic → n-Phenylanthranilic → 9-Acridone
10. 2-Aminobiphenyl → o-Formamidobiphenyl → Phenanthridine
11. Fluorenone → Fluorenone oxime → 6-Phenanthridone
12. Anthranilicacid → o-Carboxybenzenediazonium fluoroborate → Xanthone
13. p-Toluidine → 4-(p-tolylamino)pent-3-en-2-one → 2,4,6-Trimethylquinoline
14. Salicylaldehyde → o-Formylphenoxyacetic acid → Benzofuran
15. Diethylmalonate → Barbituric acid → Nitrobarbituric acid →
16. o-Phenylenedimine → Diphenyl quinoxaline → 5,6-diphenylpyrazine-2,3-dicarboxylic acid
17. o-Nitrobenzaldehyde → □□□-Diformamido-o-nitrotoluene → Quinazoline
18. o-Hydroxyacetophenone → Chalcone → Flavonone and Flavonol

Preparation should be carried out on micro scale using 10 mmols or 1.0 gm of starting material and reactions should be monitored by TLC

Course Outcomes:

- Expertise the various techniques of preparation and analysis of organic substances
- Understand the technique invoving drying and crystalyzation
- Students will Understant TLC technique

SEMINAR

SICH-321: **Credit 1**

Course Objectives:

- To enhance the presentation skill and stage courage
- To provide the platform to the students to express them
- To be able to prepare the report component and structure
- To increase knowledge of students in the specific subject

Course Outcome: Students will be able to

- The presentation skill and stage courage of the students will be enhances
- This activity will provide the platform to the students to express them
- prepare report component and structure
- The knowledge of students in the specific subject will be enhanced

EMCH-331: Organic Spectroscopy (60 Lectures) Credits- 4

Course objectives:

The students should learn

1. Different spectroscopic principles
2. Their applications like UV,IR and PMR, CMR and Mass.
3. Different 2D techniques
4. 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.
   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.

Books:

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.

Course 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 characterisation of compounds.

EICH-322: Industrial Pollution and control (60 Lectures)
Credits 4

Course Objectives:

- To learn about the concept of surface phenomenon and catalyst.
- To understand corrosion phenomenon
- To understand the properties and nature of polymers
- To know about sensor technology.

Course contents:

1. **Adsorption and catalysis**: General properties of catalysis, physical adsorption and chemical adsorption, kinetics of chemisorption, theories of adsorption, catalysis kinetics of heterogeneous catalysis, absolute reaction rate theory, preparation catalyst, catalyst and shape, Poisoning and catalyst fouling, Determination of surface area.
2. **Science of corrosion and corrosion control**: Introduction, economic aspects of corrosion, theories of corrosion, factors affecting corrosion, kinetics of corrosion, Evans diagram, thermodynamics of corrosion, Pourbaix diagram, corrosion testing techniques, Evaluation of corrosion effect: XRD, ESCA, FTIR surface techniques. Corrosion Prevention: Corrosion inhibitors, protective coating, cathodic and anodic protection. Corrosion problem in India.
3. **Mechanical and Rheological Properties of polymers**: Mechanical Properties, tensile strength, stress and strain curves, Maxwell voit model, Boltzmann superposition principle, Impact strength, compressive strength, ultimate polymer properties and structure relationship, Elastomers, Fibers, and Plastics. Rheological Equation of state (RES) fluid – ideal, non-Newtonian, viscous flow, viscoelastic behavior, creep, stress relaxation, dynamic mechanical behavior, Maxwells model, mechanical spectra.
4. **Sensor Technology**: Introduction, recent trends, classification of sensors, Elector analytical sensors, sensor, electrodes, Metal Membrane electrode sensors, Ionic Conductors, Thin film and thick Film Sensors, Nano-sensors, Application of sensors in Industry.

Recommended study materials:

1. Adamson: Surface Chemistry
2. D.D. Deshpande: Polymer science
3. Bilmayer: Polymer Science
4. N. B.Hanny: Solid state chemistry
5. S. Glastone: Physical chemistry
6. J.O.M. Bokries & A.K.N. Reddy: Modern Electrochemistry Vol – I & II
7. J. D. Lee: Inorganic Chemistry.
8. N. N. Greenwood: Chemistry of Elements
9. D. Patranabis: Sensor and Tranducers.

Course Outcomes:

- Students acknowledge about surface phenomenon like physical and chemical adsorption.
- Understand concepts and selection of heterogeneous and homogeneous catalyst in industrial processes.
- To know the properties and synthesis of polymer and its structure needed to fulfill the demands of society.
- To utilize sensor technology for saving electricity, water, etc.

OPCH 311: Intellectual Property Management (60 lectures) 4- credits

Course 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 contents:

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.

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.

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.

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 (Books)

1) **WIPO Publication** on Intellectual property (refer Chapters 1to 6).
2) **Cornish W & Llewellyn D**, intellectual Property: patents, Copyright, trademarks & Allied Rights, Sweet & Maxwell, 2007.
3) **Susan Sell et.al**, *Who Governs the Globe?*, Cambridge University Press, (2010).
4) **Odagiri et.al**, *Intellectual Property Rights, Development, and Catch Up*, Oxford University Press, (2010).
5) **Christopher May & Susan K. Sell,** *Intellectual Property Rights: A Critical History,* Lynne Rienner Publications, (2005).
6) **John Odell (ed.),** *Negotiating Trade: Developing Countries in the WTO and NAFTA*, Cambridge University Press, (2006).
7) **Gustavo Ghidini,** Intellectual Property and competition Law: The Innovation Nexus, Edward Elgar, (2006).
8) **David J. Teece**, *The Transfer and Licensing of Know-how and Intellectual Property*, World Scientific (2008).
9) **Susan K. Sell**, *Private power, public law : The globalisation of IPR*, Cambridge University Press, (2006).
10) **Kenneth L. Port**, Licensing Intellectual Property in the digital age, Carolina Academic Press, (1999).
11) **Merges, Lemley, et.al,** (4th Ed.) Intellectual Property in the new technological age Aspen Publishers, (2007).

12) **Thomas Pogge, Mathew Rimmer, Kim Rubenstein (ed),** Incentives for global public health: Patent law and access to essential medicines, Cambridge University Press (2010).
13) **Debirag E.Bouchoux**: "Intellectual Property". Cengage learning , New Delhi .
14) **M..Ashok Kumar and Mohd.Iqbal Ali**: "Intellectual Property Right" Serials Pub.
15) **Prabhuddha Ganguli**: ' Intellectual Property Rights" Tata Mc-Graw –Hill, New Delhi.
16) **Kerly's** Law of Trade Marks and Trade Names, 14th Edition, Thomson, Sweet & Maxweel.
17) **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.
18) **Marsha A. Echols**, Geographical Indications for Food Products, International Legal and Regulatory Perspectives (2008), Wolters Kluwer.
19) **N.S. Gopalakrishnan & T.G. Agitha**, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow.
20) **W.R. Cornish**, Intellectual Property, Sweet & Maxwell, London (2000).
21) **P. Narayana**, Patent Law, Wadhwa Publication.
22) **Merges**, Patent Law and Policy: Cases and Materials, 1996.
23) **Brian C. Reid**, A Practical Guide to Patent Law, 2nd Edition, 1993.
24) **Brinkhof (Edited),** Patent Cases, Wolters Kluwer .
25) **Prof. Willem Hoyng & Frank Eijsvogels**, Global Patent Litigation, Strategy and Practice, Wolters Kluwer .
26) **Gregory Stobbs**, Software Patents Worldwide, Wolters Kluwer .
27) **Feroz Ali Khader**, The Law of Patents – with a special Focus on Pharmaceuticals in India, LexisNexis Butterworths Wadhwa, Nagpur.
28) **Ajit Parulekar and Sarita D' Souza**, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006.
29) **B. L. Wadehra**; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
30) **P. Narayanan**; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010.

Course 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.

ICH-421 : Transportation Processes in Unit Operation (60 lectures) (4-Credits)

Course Objective:

- To learn about the concept and laws of heat and mass transfer processes
- To understand the construction and working of heat transfer and mass transfer equipments
- To evaluate heat transfer by conduction and radiation
- To study evaluate mass transfer diffusion and gas absorption
- To be able solve numerical on heat and mass transfer processes

Course Contents:

I) Heat Transfer Process

1) Fluid Mechanics:

Nature of fluids, viscosity, Reynolds number, application of Bernoulli's Equation, methods of transportation of fluids, pump characteristics, reciprocating gear and centrifugal pumps, blowers, compressors, frictional losses in pipe fitting (problems).

2) Heat Exchange Equipments:

Introduction, double pipe heat exchanger, shell and tube heat exchanger, fixed tube-sheet exchanger, fixed tube-sheet, 1-2 heat exchanger removable-bundle heat exchanger (problems).

3) Heat Transfer by Conduction:

Introduction, fourier's law, thermal conductivity, compound resistances in series, heat flow through a cylinder, heat flow through sphere (problems).

4) Heat Transfer by Radiation:

General terms involved in radiations – absorptivity, reflectivity, transmissivity, black body, Kirchoff's Law, Steafan-Boltzman Law, radiation heat transfer, concept of black body (problems).

Home Assignment: heat transfer by convection, fluid flow phenomenon.

II) Mass Transfer Operation:

1) Introduction to Mass-Transfer Operation:

Classification of the mass-transfer operations, method of conducting the mass transfer operations.

2) Principles of Diffusional Processes:

Ficks' Law, molecular diffusion, molecular diffusion in liquid, diffusivity of liquid, diffusion in solids, unsteady-state diffusion, types of solid diffusions.

3) Mass-Transfer Equipments:

Mechanical agitated vessels for gas-liquid contact, tray towers, venturi scrubber, packed tower, tower packings and types of packing.

4) Gas Absorption:

Introduction, equilibrium solubility of gases in liquids, two components and multicomponent system, choice of solvent for absorption, material balances one component system, minimum liquids gas ratio, pressure drop in packed columns (problems).

Home Assignment: Leaching

Recommended study materials:

1. Mass Transfer Operation – Robert E. Treybal
2. Unit Operation of Chemical Engineering – Warren L. Mc Cabe, Julian C.Smith
3. Unit Operation I & II – K.A. Gavhane

Course Outcomes:

- Students will understand the basic laws governing the heat and mass transfer operations.
- Students will be able to understand the construction and working of differentequipments used for the heat and mass transfer operations.
- They can help/involve in the design of equipments for heat and mass transfer operations.
- They can apply their knowledge of equipments used for the heat and mass transfer operations when actually working in the industry.

Code: ICH-422 Process Industries/Industrial Pollution (Lecture 60, Credits– 4)

Course Objectives:

- To learn about the concept of unit processes industries like Sugar industry, pulp and paper industry, alkali and chlorine industry etc
- To know about environmental pollution caused by Process industry
- To develop the sense of responsibility about environment in society.
- To know about waste management like solid waste management, bio waste management, e-waste management.
- Familiarize them with different feed preparation, separation and purification steps involved in manufacture of organic and inorganic chemicals.
- To understand the important issues, causes and their abatement principles of indutrial pollution.

Course Contents

I) Process Industries:

1) Sugar Industry:

Introduction, manufacture of cane sugar, extraction of juice, purification of juice, defection, sulphitation and carbonation, concentration, crystallization, separation of crystals, drying, refining, grade, recovery of sugar from molasses, manufacture of sucrose from beet root, testing of sulphur, grading.

2) Pulp and Paper Industry:

Introduction, manufacture of pulp, sulphate pulp, soda pulp, sulphite pulp, rag pulp, beating, refining filling, sizing and colouring, manufacture of paper, calendaring.

3) Alkali and Chlorine Industry:

Introduction, common salt, method of manufacture of salt, caustic soda, cells used- diaphragm cell, Hooker diaphragm cell, Castner Kellner cell, physico-chemical principle.

Home Assignment: Adhesive, glass, paints and pigment industries.

II) Industrial Pollution:

1) Environmental Chemistry:

Environmental segments, atmospheric structure, photochemical smog, global warming, green house effect, consequences of global warming, ozone layer depletion and its effects:

2) Air Pollution:

Introduction, classification of air pollutant, sources and effect of air pollution on human and environment, industry and energy related air pollution particulate matter, sulphur oxide, transport related air pollution – CO_2, NO_2 and atmospheric lead, effect of CO, NO and lead control of automobile emission, acid rain.

3) Water Pollution:

Water Resources, classification of water pollutants and their effect (including heavy metals), analysis of industrial effluents – general physiochemical measurement like temp, colour, odour, suspended solid, dissolve solids, pH, acidity, alkalinity, DO, COD, BOD, basic and advanced waste water treatment-coagulation, settling, floatation, filtration, cation exchange membrane, separation process, electro-chemical process:

Home Assignment:

Pollution Management:- Solid waste management, R and D, pilot plant, scale up process, inventory control, toxic effect of hazardous chemicals, safety and health management.

Soil Pollution: Sources, effect of soil pollution, agricultural pollution, pesticides, pollution control.

Recommended study materials:

1. Industrial chemistry – B.K.Sharma
2. sEnvironmental chemistry – Banerji Samir K.
3. Environmental Water Pollution – Mishra, S.G. Prasad, D Gaur H.S.
4. Environmental Pollution Causes Effect and Control – Sethi I, sethi M.S., Eqbal S.

Course Outcomes:

- To achieve desired product by the process industry like manufacturing of sugar by sugar industry, paper by paper industry, salts by alkali and chlorine industry to obtain these products by various chemical reactions, it liberates polluted affluent and gases instead of dumping these directly into environment students are treating it or dumping at safe place or using very diluted solution in order to avoid environmental pollution
- Understand the stages involved in the development of a process model.
- Apply their knowledge in controlling the pollution in process industries.
- Understanding of different types of pollution and apply knowledge for the protection and improvement of the envir**-**

Subject Code: ITCH-401/RPCH-401: Industrial training, research project (Lecture – 240 Credits – 8)

Course Objectives:

Students who are enrolled will learn the manufacturing processes, testing methods, and checking the finished goods before sending into the market. It will gain the insight for him about the difference between laboratory preparation method to industrial large scale manufacturing process. It will be experience plus inspiration for him to think about his own business plam.

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

- ❖ 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.
- ❖ 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.

SICH-421 : Seminar **Credit - 1**

Course Objectives:

- To enhance the presentation skill and stage courage
- To provide the platform to the students to express them
- To be able to prepare the report component and structure
- To increase knowledge of students in the specific subject

Course Outcomes:

- The presentation skill and stage courage of the students will be enhances
- This activity will provide the platform to the students to express them
- prepare report component and structure
- The knowledge of students in the specific subject will be enhanced

Subject Code:ElCH-421: Agrochemicals and Pesticides (60 Lectures)
Credits 4
Course Objectives:

- To know about effects caused by pesticides and agrochemicals.
- To study the use and development of organic compounds as pesticides
- To know various types of pesticides and agrochemicals
- To create social awareness about the pollution caused by pesticides and agrochemicals.
- To know about the biocontamination caused by pesticides and agrochemicals

Course contents

1. General introduction: Pests and pesticides, chemical and biological pesticides, properties of pesticides: toxicity, selectivities their residues and metabolites, bioaccumulation, biomagnification, classifications based on chemical nature and types of targets. Systematic and nonsystematic pesticides development of pesticide industries in India.
2. Chemistry of Pesticides: Following classes of pesticides are to be studied with respect to their synthesis, chemical reaction, action on pest, metabolites environmental fate, formulations, possible uses as insecticides herbicides, fumigants, rodenticides etc.
3. Organochlorine pesticides: Halogen derivatives of aliphatic hydrocarbons, uses as fumigants, CH_3Br, Dalapan. Halogen derivatives of alicyclic hydrocarbons, Lindane 2,4-D, butachlor, Dicofol. Polychlorocyclodienes, Heptachlor, Aldrin, Dieldrin, Endrin and Mirex. Haloaromatics, Chlorobenzones and chloronapthalenus BHc, PCNB, DDT and its analogues. Persistence in environment and biota, resistance by pest.
4. Pyrethrin, synthetic analogues and other natural pesticides: Alicyclic carboxylic acids and their derivatives pyrethrins and their synthetic analogues
5. Nitro and amino compounds, ureas hydrazines aco compounds, phenolic compounds, and thiocynate as pesticides.
6. Substituted ureas and thioureas as pesticides, mercaptans sulphides and thiocyanate derivatives, nitro and phenolic compounds used as pesticides, hydrazine and aro compounds. Pesticides, belonging to all the above type. Captan Isoptoruron, propanil, paraquat, Nitrofen and Tetradifon.

Home assignment:
Recommended study materials:

1. N. N. Melnilcov, chemistry of pesticides (English) springer.
2. R. Cremlyn Pesticides.
3. N. H. Buchel : Chemistry of Pesticides.
4. J. Miyamoto P. C. Kearney Pesticide chemistry Vol. IV Pergaman.
5. G. A. Matheus : Pesticides Application methods : Longmans.
6. Handbook of Agrochemicals by Royal Society (UK).
7. Environmental chemistry by A. K. De.

Course Outcomes:

Learning outcome upon successful completion of the course by students is as below:

- Students are knowing about classification of can classify pesticides and agrochemicals and know their physical and chemical popeties, its toxic effects on metabolism, bio accumulation and bio magnification
- The To administer pesticides and agrochemicals are used as to kill pests insescts various bio diseases which are on crops and plants, vegatables and

fruits etc

- The To administer organic pesticides which are used are oganochloine pesticides, aliphatic hydrocabon, halogen derivaties oF alicyclic hydocabons pcnb and ddt
- Use of pesticide creates environmental pollution, ai pollution, soil pollution which acts as poision instead of using it excesiely some environmental friendly organic pesticide invented

EICH-422: Synthetic Methods in Organic Chemistry (60 Lectures Credits 4)
Course Objectives: The students should

1. Understand synthetic strategies and retro synthesis
2. Apply them for synthesis of new molecules
3. Use different protection and deprotection techniques
4. Know enamines and their applications

Course Contents:

1.Umpolung in organic synthesis.

2. Synthetic Strategies I

Synthetic Strategies; Introduction, Terminology: target, synthon, synthetic equivalent, functional group interconversion (FGI), functional group addition, functional group elimination.Criteria for selection of target. Linear and convergent synthesis. Retrosynthetic analysis and synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations. .Order of events in synthesis by retrosynthetic approach, explanation with examples Ssalbutamol, Propoxycaine and Dinocap. Introduction to one group C-C and C-X disconnections. One group C-C disconnections, Alcohols and carbonyl compounds. One group C-X disconnections, Carbonyl compounds, alcohols, ethers and sulphides.

3. Synthetic Strategies II

Introduction to two group C-C and C-X disconnections, Two group C-X disconnections; 1,1-difunctionalised, 1,2-difunctionalised and 1,3-difunctionalised compounds. Two group C-C disconnections; Diels-Alder reaction, 1,3-difunctionalised compounds, 1,5- difunctionalised compounds, Michael addition and Robinson annulation. Control in carbonyl condensations, explanation with examples oxanamide and mevalonic acid. Strategic bond: definition, choosing disconnection/ guidelines for disconnection; disconnection of C-X bonds, disconnect to greatest simplification, using symmetry in disconnection, disconnection corresponding to known reliable reaction, high yielding steps and recognizable starting materials. Other approaches to retro.

4. .Protecting and deprotecting groups for hydroxyl, amino carboxyl and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide.peptide synthesis: actiation coupling, reversible blocking of amino and carboxylic groups, solid phase peptide synthesis.

5.Enamines in organic synthesis.

Home assignment:New Synthetic reactions

1. Metal mediated C-C and C-X coupling reactions: Suzuki, Heck, Stille, Sonogishira cross
coupling, Buchwald-Hartwig and Negishi-Kumada coupling reactions.
2. C=C Formation Reactions: Shapiro, Bamford-Stevens, McMurrey reactions, Julia-Lythgoe
olefination and Peterson's stereoselective olefination.
3. Multicomponent Reactions: Ugi, Passerini, Biginelli, Hantzsch and Mannich reactions.
4. Ring Formation Reactions: Pausan-Khand reaction, Bergman cyclisation, Nazerov cyclisation.
5. Click Chemistry: Criteria for Click reaction, Sharpless azides cycloadditions.
6.Metathesis: Grubb's 1st and 2nd generation catalyst, Olefin cross coupling metathesis(OCM),
ring closing metathesis(RCM), ring opening metathesis(ROM), applications.
7. Other important synthetic reactions: Baylis-Hilman reaction, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction, .

Books:

1. Modern synthetic reactions By – H. O. House and Benjamin.
2. Organic Chemistry By – Clayden, Greeves, Warren and Wothers (Oxford press).
3. Designing organic synthesis by S. Warren (Wiley).
4. Some Modern methods of organic synthesis by – W. Carruthers (Cambridge)
5. Organic synthesis by – M. B. Smith
6. Organometallics in organic synthesis by – J. M. Swan and D. C. Black (Chapman and Hall).

Course Outcomes : The learner would be able to

1. Perform Retrosynthesis of a given molecule.
2. Design synthesis using suitable building blocks.
3. Confirm the product structure.
4. Apply enamines in organic synthesis.

OPCH-411: Radiation Chemistry

Credits- 4 **(60 contact hours)**

Course Objective:

- To understand the concepts of radiation chemistry
- To study and understand the nuclear reactions and reactors
- To understand the elements of radiation chemistry
- To understand effects of radiation on matter
- To understand the applications of radioisotopes in different fields

1. Radioactivity and radioactive decay

Introduction, neutron-proton ratio and nuclear stability, nuclear stability and binding energy, various modes of decay, natural radioactivity, successive radioactivity decay, growth kinetics, radioactive equilibrium, half life, half life of mixed radioisotopes, decay scheme, its determination by experimental methods decay kinetics, units of radioactivity, parent daughter growth relationship.

2. Nuclear Reactions and Reactors

Nuclear Reactions: Definition and Bethes notation, threshold energy of nuclear reaction, energetic of nuclear reactions, conservation in nuclear reactions, conservation of protons and neutrons, conservation of momentum and conservation of energy, various types nuclear reactions, special nuclear reactions, photonuclear, thermonuclear reaction.

Nuclear Reactors: Three stage nuclear program of India, mass and charge distribution, release of energy and neutrons, spontaneous fission, nuclear reactors and their use for power production, Thermal and fast breeder nuclear reactors, nuclear fusion.

3. Interaction of radiations with matter and detectors

Interaction of gamma radiation with matter by photoelectric, Crompton and pair production, Interaction of beta particles, neutrons and heavy charged particles with matter. Units of measuring radiation absorption.

Gas filled counter, Ionization chamber, Proportional and G. M. Counter, Scintillation counter, and solid state detector Ge(Li), Si(Li) and HPGe.

4. Effects of radiation on matter

Measurement of dose, units of dose, chemical dosimeter (Fricke dosimeter and Ceric sulphate dosimeter), experimental determination of dose, radiolysis of water and aqueous solution, redox reactions due to irradiated crystals, radiation induced colour centers in crystal, radiation effect on organic compound, polymer and nitrate, Thermoluminence.

5. Application of radioactivity

Typical reactions involved in the preparation of radioisotopes: Scillard Chalmers reactions. Typical application of radioisotopes as tracers in: Chemical investigation, physio-chemical research, analytical applications, medical applications, agricultural applications, industrial applications, radioisotopes as a source of electricity and carbon dating.

Home assignment:

a) Discovery of radioactivity, properties of nucleons and nuclei, nuclear models, shell model, liquid drop model, Fermi gas model, collective model and optical model b) Nuclear fusion and nuclear fission c) Nuclear reactors, classification of nuclear reactors and waste management d) detection and measurement of radioactivity, ionization chamber, GM counter.

Recommended study material:

1. Source of atomic energy, S. Glasstone, D. Van Nestrated Co. Inc.

2. Essentials of Nuclear Chemistry, H. J. Arnikar, New Age International P. Ltd
3. Introduction to Nuclear Physics and Chemistry, B. G. Harvey.
4. Nuclear Chemistry, M. G. Arora & M. Singh Anmol Publications.
5. Elements of Nuclear Chemistry, A. K. Srivastav, P. C. Jain, S. Chand & Co.
6. A Text book of nuclear chemistry, C. V. Shekar, Eminent publications & Distributions, New Delhi.
7. Radiochemistry & Nuclear Chemistry, G. R. Chpppin, J. Liljenzin, J. Rydberg, Butterwerth-Heinemann.
8. Nuclear chemistry, M. N. Shastri.
9. Modern Nuclear Chemistry, W. Loveland, DJ Morrissey, GT Seaborg, John Wiley and Sons.

Course Outcomes:

- The student will be able to understand the different concepts of radiation chemistry.
- The student can distinguish different nuclear reactions and explain construction and working of the nuclear reactor.
- The student will be able to describe the elements of radiation chemistry.
- The students will understand the details of the effects of radiation on matter
- The students will be able to discuss application of radioisotopes in different fields
- The students can apply their knowledge in the nuclear reactions if selected in such institutions.