Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara

(Autonomous)

(Lead College of Karmaveer Bhaurao Patil University, Satara)

Department of Drug Chemistry

B. Sc. II Syllabus

(As per NEP 2020)

w.e.f. June 2024

1. **Title:** B. Sc. II Drug Chemistry
2. **Year of Implementation:** 2024-2025
3. **Preamble:** This updated syllabus is prepared for second year undergraduate students. At this level, to develop their interest towards drug chemistry as basic science and also to prepare them for the academic and industrial exposure simultaneously. Introduction of microbial techniques with the regular chemistry exercises will help to enhance rational thinking of the students towards drug Chemistry. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at second year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.
4. **General objectives of the course:**
   1. To develop the content of the syllabus according to the UGC norms.
   2. To inculcate fundamental principles of chemical sciences in students.
   3. To establish the link between theory and laboratory practice by conducting laboratory experiments which help students to improve the understanding of the concepts.
   4. To enhance student's sense of enthusiasm for chemistry and to involve them in an intellectually stimulating experience of learning in a supportive environment.
   5. **Duration:** One year
   6. **Pattern:** Semester
   7. **Medium of Instruction:** English
   8. **Structure of Course:**

Level	Sem	Subject -1 Major				Subject-2 Minor		Subject-3 GE/OE		VSEC		AEC, VEC		CC	Total
		DSC		DSE						VSC	SEC	AEC	VEC		
		T	P	T	P	T	P	T	P						
5.0	III	4	4	-	-	2	2	-	-	2	2	4	2	-	22
	IV	4	4	-	-	2	2	-	-	2	2	4	-	2	22

Structure and Titles of the B.Sc. II Course Major Subject: Drug Chemistry			
Semester	**Paper No.**	**Name of Course**	**Units**
III	**I (Theory)**	**Pharmacokinetics (BDCT- 231)**	**Unit I: Drug Targets and Interactions** **Unit II: Drug Absorption and Distribution** **Unit III: Drug Metabolism** **Unit IV: Drug Excretion and Toxicology**
	Practical	**Major Practical Lab-III (BDCP- 232)**	
	II (Theory)	**Physicochemical Properties of Drugs (BDCT- 233)**	**Unit I: Solubility** **Unit II: Bonding and Interactions** **Unit III: Surface Activity** **Unit IV: Case Studies, Applications, Future Trends and Challenges**
	Practical	**Major Practical Lab-IV (BDCP- 234)**	
IV	**III (Theory)**	**Enzymes and Metabolic Processes (BDCT- 241)**	**Unit I: Enzymes** **Unit II: Enzyme Kinetics** **Unit III: Carbohydrate Metabolism** **Unit IV: Lipid Metabolism**
	Practical	**Major Practical Lab-V (BDCP- 242)**	
	IV (Theory)	**Spectroscopic Techniques (BDCT- 243)**	**Unit I: Introduction to Spectroscopy** **Unit II: UV Visible Spectroscopy** **Unit III: Infra-red Spectroscopy** **Unit IV: Nuclear Magnetic Resonance**
	Practical	**Major Practical Lab-VI (BDCP- 244)**	

B.Sc. Drug Chemistry Semester– III Major Paper V Pharmacokinetics (BDCT- 231)		
Course Objectives: Students will be able to… 1. Understand the basic principles of pharmacokinetics. 2. Analyze drug absorption processes. 3. Examine drug metabolism pathways.		
Credits (2)	**SEMESTER– III** **Major Paper – V**	**No. of hours per unit**
Unit – I	**Drug Targets and Interactions**	**(07)**
	1.1 Introduction to drug targets and their interactions. 1.2 Cell structure. 1.3 Drug targets at molecular level. 1.4 Intermolecular bonding forces: Electrostatic bonds, Hydrogen bonds, Van der Waal's interaction, dipole- dipole and ion dipole interaction, Repulsive interactions, Role of water and hydrophobic interactions. 1.5 Drug targets: Lipid as drug target, Carbohydrates as a drug target, Protein and nucleic acid as a drug targets.	
Unit – II	**Drug Absorption and Distribution**	**(07)**
	A) Drug absorption 2.1 Introduction to pharmacokinetics and important terminologies of pharmacokinetics. 2.2 Routes of drug administration. 2.3 Mechanisms of drug absorption through GIT. 2.4 Factors influencing drug absorption though GIT. 2.5 Absorption of drug through intra muscular routes and factors influencing on it. **B) Drug distribution** 2.6 Tissue permeability of drugs. 2.7 Binding of drugs, apparent, volume of drug distribution, plasma and tissue protein binding of drugs. 2.8 Factors affecting protein-drug binding. 2.9 Kinetics of protein binding, Clinical significance of protein binding of drugs	

Unit – III	**Drug Metabolism**	**(07)**
	3.1 Drug metabolism and factors affecting drug metabolism. 3.2 Pathways of drug metabolism: Phase I Reactions pathway, Phase II Reactions- conjugation. 3.3 Major pathways of drug metabolism along with some examples like amphetamine, barbiturates, Sulphonamides, propranolol, diazepam, Ephedrine, Phenmetrazine, Cimetidine, etc. 3.4 Biotransformation, types of biotransformation reactions: Synthetic and non-synthetic reactions. 3.5 Significance of drug metabolism in medicinal chemistry.	
Unit – IV	**Drug Excretion and Toxicology**	**(09)**
	Excretion 4.1 Introduction to excretion, Routes of drug excretion. 4.2 Renal excretion of drugs and factors affecting renal excretion of drugs. 4.3 Renal clearance, Non-renal routes of drug excretion of drugs. **Toxicology** 4.4 History, and Basic Toxicology Terminology. 4.5 Dose and dose-response types of dosage, units, Dose-response relationship. 4.6 Factors influencing toxicity. 4.7 Interaction and types of interactions. 4.8 Toxicity testing methods. 4.9 Toxicity of metabolites.	

Course Outcomes: After completion of the course students will be able to…

1. Explain factors affecting on drug – target binding.
2. Demonstrate the drug metabolism process.
3. Understanding of Pharmacokinetic Principles.
4. Demonstrate Mathematical Modeling.
5. Understanding the role of pharmacokinetics in drug development

References:

1. Gupta A. L. (2019) Medicinal Chemistry, Pragati Prakashan, Meerut
2. Graham L. Patriks, (2018)An introduction to medicinal Chemistry.
3. Heslop Christensen, J.; Andreasen, F. and Jansen, J.A.: Acta Anaesthesiologica Scandinavica. (1981) Pharmacokinetics of Thiopental in caesarian section.

4. Ohnuma, T.; Roboz, J.; Waxman, S. et al.: Cancer Treatment Reports (1980). Clinical pharmacologic effects of thymidine plus 5-FU.
5. Jacobs, C.; Kaiman, S.M.; Tretton, M. et al.: Cancer Treatment Reports (1980). Renal handling of cis-Diamminedichloroplatinum (II).

Credits (2)	B.Sc. II Drug Chemistry Semester – III Major Practical Paper – III (BDCP-232)	No. of hours (60)
Course Objectives: Students will be able to… 1. Understand the Claisen-Schmidt condensation reaction for the synthesis of cinnamic acid. 2. Practice techniques for isolation and purification of organic solids. 3. Explore the pharmaceutical relevance of paracetamol. 4. Learn experimental techniques for assessing bioavailability, such as pharmacokinetic studies.		
1	Preparation of Cinnamic acid from benzaldehyde and malonic acid, determination of its pharmacodynamics properties.	
2	Preparation of Anthraquinone from anthracene and determination of its pharmacodynamics properties.	
3	Preparation of phthalimide from phthalic anhydride and determination of its pharmacodynamics properties.	
4	Preparation of 7-hydroxy-4-methyl coumarin and determination of its pharmacodynamics properties.	
5	Synthesis of paracetamol and determination of its pharmacodynamics properties	
6	Synthesis of Aspirin and determination of its Pharmacodynamics properties.	
7	Synthesis of Ibuprofen and determination of its pharmacodynamics properties	
8	Determination of bioavailability and pharmacodynamics properties of the drug sample.	
9	Synthesis and characterization of phenyl benzoate from phenol by acylation reaction.	
10	To determine absorption half-life and absorption rate constant (Ka) for given data by using methods of residuals.	
11	To determine the order, rate constant and half-life.	
12.	To calculate various pharmacokinetic parameters from the given blood data of IV infusion. (one component model)	
13.	To determine the following pharmacokinetic parameters. 1) Peak plasma concentration 2) Time of Peak Concentration 3) Elimination rate constant 4) Biological	

	half life 5)Area under Curve	
14.	To Report the permeability coefficicent and diffusion rate of paracetamol using cellophane.	
15.	To determine the diffusion rate and permeability coefficient of diclofenac sodium using cellophane membrane or semipermeable membrane.	
16.	To carry out adsorption study for dichlofenc sodium	
17.	To formulate and evaluate transdermal patches of ibuprofen.	
18.	To determine protein binding efficiency of ibuprofen.	
19.	Study the protein binding of ibuprofen by dynamic dilution method.	
20.	To determine Ka,pKa and partition coefficient(pc) value of salicylic acid and study their relationship.	

Note: Any other relevant practical may be added

Course Outcomes: - After completion of the course students will be able to…

1. Successful synthesis of cinnamic acid with high purity.
2. Evaluate the reaction efficiency and yield.
3. Analyze the product's pharmacodynamics properties such as analgesic and antipyretic effects.
4. Interpret the experimental data to conclude the drug's efficacy and safety profiles.

References:

1. Parikh D. M. (2018) Handbook of Pharmaceutical Granulation Technology, Marcel Dekker, INC, New York.
2. Beckett A. H. & Stenlake, J. B. (2000) Practical Pharmaceutical Chemistry Vol I & II 4th edition, Stahlone, Press of University of London.
3. Paye M. Barel A. O, Maibach H., (2001) Handbook of Cosmetic Science and Technology. 1st edition CRC Press.
4. Slørdal L, Spigset O. (2005) Basic pharmacokinetics--absorption Tidsskr Nor Laegeforen.
5. Starkey ES, Sammons HM. (2015) Practical pharmacokinetics: what do you really need to know? Arch Dis Child Educ Pract Ed.

B.Sc. II Drug Chemistry Semester– III

Major Paper VI

Physicochemical Properties of Drug (BDCT- 233)

Course Objectives: Students should be able to…

1. Understand the importance of physicochemical properties in drug design and development.
2. Explain the significance of the partition coefficient in drug distribution.
3. Discuss formulation strategies to optimize drug delivery and efficacy.

Credit (2)	**SEMESTER– III** **Major Paper – VI**	**No. of hours per unit**
Unit – I	**Drug Solubility and Dissolution**	**(07)**
	1.1 Definition and significance of physicochemical properties of the drug and the role in drug design and development. 1.2 Drug Solubility definition, Types of solubility, Factors affecting solubility. 1.3 Drug dissolution, dissolution kinetics. 1.4 Measurement techniques.	
Unit – II	**Partition Coefficient, pH, and pKa**	**(07)**
	Partition coefficient 2.1 Definition and Significance 2.2 Calculation methods 2.3 Impact on drug distribution and permeability **pH and pKa** 2.4 Acid-base properties of drugs 2.5 Henderson-Hasselbalch equation 2.6 Influence on drug absorption and ionization state	
Unit – III	**Drug Stability and Formulation Considerations**	**(07)**
	Drug Stability 3.1 Definition, Significance, and Factors Affecting on Stability of drug (e.g., temperature, pH, light)	

	3.2 Stability testing and prediction 3.3 Degradation pathways (e.g., hydrolysis, oxidation) **Formulation Considerations** 3.4 Dosage forms and routes of administration 3.5 Excipients and their role in formulation 3.6 Strategies to enhance drug solubility, stability, and bioavailability	
Unit – IV	**Case Studies, Applications, Future Trends and Challenges**	**(09)**
	4.1 Application of physicochemical principles in drug development 4.2 Case studies highlighting the importance of property optimization 4.3 Emerging technologies in drug formulation 4.4 Challenges and opportunities in optimizing physicochemical properties	

Course Outcomes: After completion of the course students will be able to…

1. Describe the principles governing drug solubility and dissolution.
2. Evaluate the stability of drugs under different environmental conditions.
3. Analyze the influence of pH and pKa on drug absorption and bioavailability.
4. Understand the factors influencing drug stability.

References:

1. "Physicochemical Principles of Pharmacy" by Alexander T. Florence and David Attwood

2. "Pharmaceutical Biotechnology: Fundamentals and Applications" by Daan J. A. Crommelin, Robert D. Sindelar, and Bernd Meibohm

3. "Physical Chemistry for the Biosciences" by Raymond Chang and Jr. Thoman

4. "Drug-Like Properties: Concepts, Structure Design and Methods from ADME to Toxicity Optimization" by Li Di

5. Alsenz J, Kansy M (2007) High throughput solubility measurement in drug discovery and development.

Credits (2)	B.Sc. II Drug Chemistry Semester – III Major Practical Paper – IV (BDCP-234)	No. of hours (60)
Course Objectives: Students will be able to… 1. Explore the influence of temperature, polarity, and other factors on solubility. 2. Understand the concept of pKa and its significance in acid-base equilibria. 3. Learn experimental techniques for conducting stability studies, such as accelerated stability testing or stress testing. 4. Study the principles behind the Henderson-Hasselbalch equation.		
1	Determination of solubility using various solvents and techniques	
2	Determination of partition coefficient of benzoic acid and Cinnamic acid.	
3	Experimental determination of pKa using potentiometric or spectrophotometric methods.	
4	Conducting stability studies under different conditions (e.g., temperature, pH) and analyzing the results.	
5	Measurement of rheological properties using techniques like viscometry	
6	Preparation of buffer solutions of different pH values and determination of buffering capacity. (Acidic buffer)	
7	Preparation of buffer solutions of different pH values and determination of buffering capacity. (Basic buffer)	
8	Determination of partition coefficient of isolated paracetamol	
9	Determination of PKa value by half neutralisation/ Henderson-Hasselbalch equation.	
10	To determine the partition coefficient of iodine between carbon tetra chloride and distilled water.	
11	To determine the Bulk Density, True Density and Porosity for the given sample of powders.	
12	To determine the complex stability constant and donor acceptor ratio of caffeine and para amino benzoic acid (PABA) by solubility method	
13	To determine the complex stability constant (log β) and donor acceptor ratio (n) of Copper - Glycine complex pH by titration method	
14	To determine the pka value of a weak acid by titrating it against base potentiometrically (using a pH meter)	
15	To determine the solubility of inorganic salt at room temperature	
16	To determine the viscosity of given unknown liquid.	
17	To determine the percentage adsorption of oxalic acid by charcoal method.	

	Note: any other relevant practicals may be added.	

Course Outcomes: - After completion of the course students will be able to…

1. Analyze the solubility trends and factors affecting solubility.
2. Interpretation of pKa values in terms of acid-base properties and chemical structure.
3. Evaluate the drug stability under various conditions through visual inspection, chemical analysis, or spectroscopic methods.
4. Prepare the buffer solutions with specified pH values using appropriate acid-base pairs.

References:

1. Parikh D. M. (2018) Handbook of Pharmaceutical Granulation Technology, Marcel Dekker, INC, New York.
2. Beckett A. H. & Stenlake, J. B. (2000) Practical Pharmaceutical Chemistry Vol I & II 4th edition, Stahlone, Press of University of London.
3. Paye M. Barel A. O, Maibach H., (2001) Handbook of Cosmetic Science and Technology. 1st edition CRC Pres.
4. Alsenz J, Meister E, Haenel E (2007) Development of a partially automated solubility screening (PASS) assay for early drug development.
5. Arnott JA, Planey SL (2012) The influence of lipophilicity in drug discovery and design.

B.Sc. II Drug Chemistry Semester– IV

Major Paper VII

Enzymes and Metabolic Pathways (BDCT- 241)

Course Objectives: Students should be able to…

1. Understand the nature of enzymes as biological catalysts and their significance in metabolic reactions.
2. Learn parameters such as Km, Vmax, and catalytic efficiency.
3. Understand the fundamental principles of enzyme structure and function.
4. Explore the various mechanisms by which enzymes catalyze biochemical reactions.

Credits (2)	**SEMESTER– IV** **Major Paper – Enzymes and Metabolic Pathways**	**No. of hours per unit**
Unit – I	**Enzymes**	**(09)**
	1.1 Definition, Explanation of terms- Holoenzyme Apoenzyme, Coenzyme, prosthetic group, cofactor. 1.2 Classification of enzymes into six classes with one example of each class EC number of enzymes. 1.3 Enzyme as a catalyst concept of the activation energy in enzyme-catalyzed reaction units of enzyme activity, specific activity, turnover number. 1.4 Enzyme specificity, types of specificity, the active site of the enzyme, and its features. 1.5 Theories of the mechanism of enzyme action lock, key and induced fit theory. 1.6 Factors affecting enzyme activity substrate concentration, pH, temperature.	
Unit – II	**Enzyme Kinetics**	**(05)**
	2.1 Derivation of Michalis Menten equation, plot advantages, disadvantages significance of Km and Vmax. 2.2 Line Weaver Burk equation and plot, Advantages, disadvantages. 2.3 Enzyme inhibition, types of inhibition (competitive, non-competitive, uncompetitive, substrate inhibition, allosteric inhibition). 2.3 Isoenzymes (lactate dehydrogenase, Creatine	

	phosphokinase, Alkaline phosphatase, Alcohol dehydrogenase)	
Unit – III	**Carbohydrate Metabolism**	**(07)**
	3.1 Major pathways of carbohydrate metabolism. 3.2 Recapitulation of carbohydrates Glycolysis – Pathway, energetics and significance 3.3 Citric acid cycle- Pathway, energetics and significance. 3.4 HMP shunt and its significance. 3.5 Glucose-6-Phosphate dehydrogenase (G6PD) deficiency. 3.6 Glycogen metabolism Pathways and glycogen storage diseases (GSD). 3.7 Gluconeogenesis- Pathway and its Significance.	
Unit – IV	**Lipid Metabolism**	**(09)**
	4.1 Introduction Classification of lipids and functions of lipids 4.2 ß- Oxidation of fatty acid (Palmitic acid): activation of fatty acid, carnitine transport system, ß oxidation cycle, significance, energetic; 4.3 Biosynthesis of fatty acid (Palmitic acid) & significance, 4.4 Structure of Fatty acid synthetase complex (Eukaryotes).	

Course Outcomes: After completion of the course students will be able to…

1. Explain factors affecting enzyme activity, such as pH, temperature, and substrate concentration.
2. Identify key metabolic pathways, including glycolysis, the citric acid cycle, and oxidative phosphorylation.
3. Understanding Enzyme Structure and Function.
4. Understand the principles of enzyme kinetics, including Michaelis-Menten kinetics, Lineweaver-Burk plots, and factors affecting enzyme activity

References:

1. Dr. Jain J. L., (2016) Fundamentals of Biochemistry, 7th edition S. Chand & Company Ltd. New Delhi.

2. Barar F. S., (2000) Essentials of Pharmacotherapeutics, S. Chand & Company Ltd. New Delhi

3. Gaud R. S. & Dr. Gupta G. D, (2007) Practical Pharmaceutics, CBS Publishers and Distributors, New Delhi.

4. Choudhary N. C. And Gurbani N. K., (2014) Pharmaceutical Chemistry. Vallabh Prakashan, Delhi

5. Jain N. K,(2009) Textbook of Professional Pharmacy, 5th Vallabh Prakash, Delhi

Credits (2)	B.Sc. II Drug Chemistry Semester– IV Major Practical Paper – (BDCP-242)	No. of hours (60)
Course Objectives: Students will be able to… 1. Understand the Enzyme Kinetics. 2. Study Enzyme Inhibition and Activation. 3. Investigate Metabolic Regulation. 4. Analyze Clinical Relevance.		
1	Qualitative analysis and determination of types of Carbohydrates- a) Glucose b) Sucrose c) Starch d) Cellulose.	
2	Qualitative analysis of Proteins- a) Hemoglobin b) Insulin c) Collagen d) Immunoglobulin	
3	Qualitative analysis of Lipids- a) Triglycerides b) Phospholipids c) Cholesterol d) Steroid.	
4	Determination of Enzyme Kinetics for the Hydrolysis of Sucrose by Surcease	
5	To estimate Glucose by DNSA method	
6	Estimation of fructose by Resorcinol method.	
7	Isolation of pectin from fruit	
8	Isolation of casein from milk	
9	Quantitative analysis of reducing sugar	
10	Quantitative analysis of proteins.	
11	Enzymatic hydrolysis of starch	
12	Determination of salivary amylase activity	
13	Study the effect of temperature on the salivary amylase activity	
14	Study the effect of substrate concentration on the salivary amylase activity	
	Note: Any other relevant Practical may added	
Course Outcomes: - After completion of the course students will be able to… 1. Apply Enzyme Kinetics Principles. 2. Demonstrate Proficiency in Enzyme Assays. 3. Understand Metabolic Pathway Regulation. 4. Evaluate Clinical Implications.		

References:

1. Parikh D. M. (2018) Handbook of Pharmaceutical Granulation Technology, Marcel Dekker, INC, New York.

2. Beckett A. H. & Stenlake, J. B. (2000) Practical Pharmaceutical Chemistry Vol I & II 4th edition, Stahlone, Press of University of London.

3. Paye M. Barel A. O, Maibach H., (2001) Handbook of Cosmetic Science and Technology. 1st edition CRC Press.

4. Bairoch A. (1994) The ENZYME data bank. Nucleic Acids Res.

5. Bairoch A, Boeckmann B. The SWISS-PROT protein sequence data bank: current status. Nucleic Acids Res. 1994

B.Sc. II Drug Chemistry Semester– IV

Major Paper VIII

Spectroscopic Techniques (BDCT- 243)

Course Objectives: Students should be able to…

1. Develop an appreciation for the role of spectroscopy in advancing scientific research, technology, and industry.
2. Recognize the characteristic absorption bands in UV spectra and their correlation with molecular structure.
3. Identify the characteristic absorption bands in IR spectra corresponding to different functional groups.
4. Understand the principles of nuclear spin, magnetic resonance, and NMR spectroscopy.

Credits (2)	**B.Sc. II Drug Chemistry Semester– IV Major Paper – VIII**	**No. of hours per unit**
Unit – I	**Introduction to Spectroscopy**	**(09)**
	1.1 Meaning of spectroscopy, Nature of electromagnetic radiation: wavelength, frequency, energy, amplitude, wave number and their relationship. 1.2 Different units of measurement of wavelength and frequency, Different regions of electromagnetic radiations. 1.3 Interaction of radiation with matter: absorption, emission, fluorescenceand scattering. 1.4 Types of spectroscopy and advantages of spectroscopic methods, Energy types and energy levels of atoms and molecules	
Unit – II	**UV Visible Spectroscopy**	**(05)**
	2.1 Electronic transitions, chromophores, auxochromes, spectral shifts, solvent effect on absorption spectra. 2.2 Beer and Lambert's law, Derivation and deviations. 2.3 Instrumentation- Sources of radiation, wavelength selectors, sample cells, detectors-Photo tube, Photomultiplier tube, Photo voltaic cell, Silicon Photodiode. 2.4 Applications Spectrophotometric titrations, Single component, and multi-component analysis	
Unit – III	**Infra-red Spectroscopy**	**(07)**
	3.1 Introduction, Principle of IR Spectroscopy. 3.2 IR Instrumentation, schematic diagram- Fundamental modes of vibrations types and calculation – Condition for absorption of IR radiations Regions of IR Spectrum, fundamental group region, fingerprint region. 3.3 Hooks Law for Calculation of vibrational frequency, Factors affecting on IR absorption frequency. 3.4 Characteristic of IR absorption of following functional groups a] Alkanes, alkenes, alkynes b] Alcohol and phenols c] Ethers d] Carbonyl compounds e] Amines f] Nitrocompounds g] Aromatic Compounds	

Unit – IV	Nuclear Magnetic Resonance	(09)
	4.1 Introduction, Principles of PMR Spectroscopy. 4.2 NMR -Instrumentation, Schematic diagram 4.3 Magnetic and nonmagnetic nuclei. 4.4 Chemical shift- definition, measurement, calculation, Factors affecting Chemical shift, Shielding & deshielding, Peak Integration. 4.5 Merits of TMS as PMR reference compounds. 4.6 Coupling Constant, Types of Coupling Constant, Spin-spin splitting (n +1 rule), Applications	

Course Outcomes: After completion of the course students will be able to...

1. Appreciate the importance of spectroscopy in elucidating the structure, composition, and properties of materials at the molecular level.
2. Explore the applications of UV spectroscopy in organic chemistry, pharmaceuticals, environmental analysis, and materials science.
3. Explain the principles of vibrational and rotational transitions in molecules and their interaction with IR radiation.
4. Illustrate the principles of nuclear spin, magnetic resonance, and NMR spectroscopy.

References:

1. Dr. Jain J. L., (2016) Fundamentals of Biochemistry, 7th edition S. Chand & Company Ltd. New Delhi.

2. Barar F. S., (2000) Essentials of Pharmacotherapeutics, S. Chand & Company Ltd. New Delhi

3. Gaud R. S. & Dr. Gupta G. D, (2007) Practical Pharmaceutics, CBS Publishers and Distributors, New Delhi.

4. Choudhary N. C. And Gurbani N. K., (2014) Pharmaceutical Chemistry. Vallabh Prakashan, Delhi

5. Jain N. K,(2009) Textbook of Professional Pharmacy, 5th Vallabh Prakash, Delhi

Credits (2)	B.Sc. II Drug Chemistry Semester– IV Major Practical Paper – BDCP-244	No. of hours (60)
Course Objectives: Students will be able to… 1. Learn instrument handling skill and related calculations 2. Enhance skill in structural illustration from IR spectra 3. Study structure interpretation by ^{1}H NMR 4. Learn to find out structure of compounds by X-ray crystallography		
1	To measure the absorbance of $KMnO_4$ by using Colorimeter (UV. Spectrophotometer)	
2	To measure the absorbance of $CuSO_4$ by using Colorimeter (UV. Spectrophotometer)	
3	Structural illustration of Alcohol functional group by IR: a) Ethanol b) Butanol.	
4	Structural illustration of Phenol functional group by IR: a) α-Napthol b) β-Napthol.	
5	Structural illustration of Ether functional group by IR: a) Methyl-Ethyl ether b) 2-Methoxy, 2 Methyl propane	
6	Structural illustration of Ester functional group by IR: a) Ethyl-ethanoate ester b) Ethyl propanoate	
7	Structural illustration of Aldehyde functional group by IR: a) Acetaldehyde b) Propanealdehyde	
8	Structural illustration of Ketone functional group by IR: a) Methyl phenyl ketone b) Acetone	
9	Structural illustration of Amine functional group by IR: a) Aniline b) Trimethyl amine	
10	Structural illustration of Nitro functional group by IR: a) Tri-nitro phenol b) Tri-nitro toloune	
11	Find the structure of NaCl and KCl by X-ray Diffraction	
12	Structural illustration by ^{1}H NMR	
Course Outcomes: - After completion of the course students will be able to… 1. Find the absorbance of given compounds by using a colorimeter 2. Expertise to find out structure by X-ray crystallography 3. Become skilled in interpreting IR spectra 4. Evaluate the structural interpretation of the compound by ^{1}H NMR		

References:

1. Parikh D. M. (2018) Handbook of Pharmaceutical Granulation Technology, Marcel Dekker, INC, New York.

2. Beckett A. H. & Stenlake, J. B. (2000) Practical Pharmaceutical Chemistry Vol I & II 4th edition, Stahlone, Press of University of London.

3. Paye M. Barel A. O, Maibach H., (2001) Handbook of Cosmetic Science and Technology. 1st edition CRC Press.

4. Spectrochemical analysis, (1988) James D. Ingle, Stanly R. Crouch, Prentice Hall

5. Chemical Instrumentation: A Systematic Approach, Howard A. Strobel, William R. Heineman, Wiley Interscience, 3rd Ed., 1989

Structure and titles of the B.Sc. II Course Minor Subject: Chemistry			
Semester	**Paper No.**	**Name of Course**	**Units**
III	**I (Theory)**	**Name Reactions and Synthetic Reagents (BDCT- 235)**	**Unit I: Oxidizing Agents** **Unit II: Reducing Agents** **Unit III: Name Reactions** **Unit IV: Stereochemistry**
	Practical	**Minor Practical Lab-III (BDCP- 236)**	
IV	**II Theory**	**Organic Chemistry (BDCT- 245)**	**Unit I: Reactive Intermediates** **Unit II: Nucleophilic Substitution Reaction** **Unit III: Electrophilic Substitution Reaction** **Unit IV: Amines and Diazonium salt**
	Practical	**Minor Practical Lab-IV (BDCP- 246)**	

B.Sc. II Drug Chemistry Semester III Minor Subject: Chemistry		
Credits 2	**Course V: Name Reactions and Synthetic Reagents** **Course Code: (BDCT-235)**	**No. of Hrs. 30**
	Course Objectives: Students should be able to… **1.** Understanding Molecular Structure and Bonding. **2.** Know the principles of stereochemistry including chirality, enantiomers, diastereomers, and meso compounds. **3.** Learn the synthetic applications of various reagents in organic synthesis. **4.** Understand the significance of chirality in biological systems and drug design.	
Unit I	**Oxidizing Agents**	**08**
	Preparation and Applications of the following reagents. 1.1 Osmium Tetraoxide (OsO_4) 1.2 Ceric Ammonium nitrate (CAN) 1.3 Selenium dioxide (SeO_2) 1.4 2,3 - Dichloro - 5,6 - dicyano –1,4-benzoquinone (DDQ) 1.5 Ozone (O_3) 1.6 Potassium Permanganate ($KMnO_4$) 1.7 Chromic acid (Cr_2O_3) 1.8 Nitrous acid (HNO_2)	
Unit II	**Reducing Agents**	**08**
	2.1 Nitric acid (HNO_3) 2.2 Sodium borohydride ($NaBH_4$) 2.3 Lithium aluminum hydride ($LiAlH_4$) 2.4 Raney Nickel (Ra-Ni) 2.5 Grignard reagent (RMgX) 2.6 Sodium amalgam (Na-Hg) 2.7 Lindlar catalyst 2.8 Zinc (Zn)	
Unit III	**Name Reactions**	**08**
	3.1 Perkin reaction 3.2 Knoevenagel condensation 3.3 Mannich reaction 3.4 Reformatsky reaction 3.5 Pinacol pinacolone rearrangement 3.6 Wolff- kishner reduction 3.7 Baeyer Villiger oxidation	

	3.8 Reimer- Tiemann reaction 3.9 Claisen Condensation reaction 3.10 Clammensen reduction reaction	
Unit IV	**Stereochemistry**	**06**
	4.1 Concept of stereochemistry 4.2 Types of stereoisomerism 4.3 Chiral and achiral compounds 4.4 Optical isomerism in tartaric acid 4.5 Enantiomers and Dasteriomers 4.6 Geometrical isomerism 4.7 Nomenclature of stereoisomerism D, L, CIP rule: R/S, E and Z (cis-trans), Erythro and Threo	

Course Outcomes: After completion of the course students will be able to…

1. Predict the stereo-chemical outcome of organic reactions.
2. Explain the driving forces and factors influencing the reaction outcomes.
3. Recognize chiral centers in organic molecules and identify their stereo chemical configurations (R/S nomenclature).
4. Classify organic reagents based on their functional groups and chemical properties.
5. Predict the outcome of reactions based on the choice of reagents and reaction conditions.

References:

1) Morrison & Boyd Organic Chemistry 7th Edn.
2) Peter Sykes A Guidebook to Mechanism in Organic Chemistry 6th Edn.
3) Mukherjee S.M., Singh S. P. Organic Chemistry, Vol. I. 21
4) Eliel E. L Stereochemistry of Carbon compounds. 5. Kalsi P.S. Stereochemistry Conformation & Mechanism 9th Edn.
5) Bansal Raj. K. A Textbook of Organic Chemistry.
6) Ahluwalia V. K. Organic Reaction Mechanism 4th Edn

Credit 2	**B.Sc. II Drug Chemistry Semester III** **Practical Course** **Minor Lab III** **BDCP-236**	No. of Hrs. 60

Course Objectives: Students should be able to…

1. Gain proficiency in qualitative and quantitative analysis techniques for organic compounds.
2. Apply theoretical knowledge of organic chemistry principles in practical scenarios
3. Enhance critical thinking, problem-solving, and data interpretation skills through experimental design and analysis.
4. Understand the importance and relevance of organic chemistry in various scientific disciplines and real-world applications.

1.	**Organic qualitative analysis:** a) Salicylic acid b) Phthalic acid c) Cinnamic acid d) Oxalic acid e) β-naphthol f) Succinic acid g) p-Nitro phenol h) o-Nitro aniline i) m-Nitro aniline j) Diphenylamine k) Acetamide l) Ethyl methyl Ketone m) Acetophenone n) Benzophenone o) Benzaldehyde p) Ethyl acetate	
2.	**Organic Estimation:** a) Estimation of Acetone b) Estimation of glycine c) Estimation of Vitamin C	
3.	**Organic Preparations:** a) Preparation of Benzoic acid b) Preparation of p-Nitro acetanilide c) Preparation of Benzamide Preparation of Dihydropyrimidone	

Course Outcomes: After completion of the experiments students will be able to…

1. Differentiate acidic and basic compounds
2. Accurate determination of the concentration or quantity of specific organic compounds
3. Synthesize organic compounds through laboratory techniques such as refluxing, distillation, extraction and recrystallization.
4. Evaluation of the efficiency of the synthetic methods in terms of yield, purity, and environmental impact (e.g., green synthesis).

References:

1) Vogel's Textbook of Practical Organic Chemistry 5th Edition 5th Edition
2) Morrison & Boyd Organic Chemistry 7th Edn.
3) Peter Sykes A Guidebook to Mechanism in Organic Chemistry 6th Edn.
4) Mukherjee S.M., Singh S. P. Organic Chemistry, Vol. I. 21
5) Eliel E. L Stereochemistry of Carbon compounds. 5. Kalsi P.S. Stereochemistry Conformation & Mechanism 9th Edn.
6) Bansal Raj. K. A Textbook of Organic Chemistry.
7) Ahluwalia V. K. Organic Reaction Mechanism 4th Edn.

Credits 2	B.Sc. II Drug Chemistry Semester IV Minor Course: Chemistry Course VI: Organic Chemistry Course Code: (BDCT- 245)	No. of Hrs. 30

Course Objectives: Students should be able to…

1. Understand the concept of reactive intermediates and their importance in organic chemistry.
2. Understand reaction mechanisms including substitution, elimination, addition, and rearrangement reactions.
3. Describe the generation of electrophiles and their role in various electrophilic substitution reactions.
4. Discuss the principles and mechanisms of aromatic nucleophilic substitution reactions.

Unit No.	Title and Syllabus	Hrs. Allotted
Unit I	**Reactive Intermediates**	**07**
	1.1 Introduction of Reactive Intermediates 1.2 Carbocation 1.3 Carbanion 1.4 Carbon free radical 1.5 Nitrene 1.6 Arynes	
Unit II	**Nucleophilic Substitution Reaction**	**06**
	2.1 Introduction to nucleophilic substitution reaction 2.2 SN^1 reaction 2.3 SN^2 reaction 2.4 SN^i reaction 2.5 Aromatic nucleophilic substitution reaction	
Unit III	**Electrophilic Substitution reaction**	**08**
	3.1 Introduction of electrophilic reaction 3.2 Generation of Electrophile 3.3 Aliphatic electrophilic substitution reaction 3.4 Aromatic electrophilic substitution reaction	
Unit IV	**Amines and Diazonium salt**	**09**
	4.1 Amines (aliphatic and aromatic): up to 5 carbons 4.2 Preparations: form alkyl halides 4.3 Gabriel's Phthalimide Synthesis 4.4 Hoffmann bromamide reaction 4.5 Carbylamines test, Hinesburg test, reaction with	

	HNO_2 4.6 Schotten-Baumann reaction 4.7 Electrophilic substitution reaction of aniline (Nitration, Bromination, Sulphonation) 4.8 Diazonium salts: Preparation from aromatic amines. 4.9 Reactions: conversion to benzene and phenol	

Course Outcomes: After completion of the course students will be able to…

1. Identify conditions that favor or inhibit the desired reaction pathways.
2. Students will be able to describe the concept of reactive intermediates and their significance in organic chemistry.
3. differentiate between SN^1, SN^2, and SN^i mechanisms
4. Classify and name amines, including aliphatic and aromatic amines.

References:

1) Morrison & Boyd Organic Chemistry 7th Edn.
2) Peter Sykes A Guidebook to Mechanism in Organic Chemistry 6th Edn.
3) Mukherjee S.M., Singh S. P. Organic Chemistry, Vol. I. 21
4) Eliel E. L Stereochemistry of Carbon compounds. 5. Kalsi P.S. Stereochemistry Conformation & Mechanism 9th Edn.
5) Bansal Raj. K. A Textbook of Organic Chemistry.
6) Ahluwalia V. K. Organic Reaction Mechanism 4th Edn

B.Sc. II Drug Chemistry Semester IV		
Credit 2	**Practical Course** **Minor Lab IV: BDCP- 246**	**No. of Hrs. 60**

Course Objectives: Students should be able to…

1) Understand the mechanism and conditions involved in the preparation of Benzilic acid from Benzil.
2) Differentiate between various acids (cinnamic acid, Succinic acid, Oxalic acid) based on their chemical properties and reactions.
3) Discuss the importance of green chemistry principles in organic synthesis and their impact on reducing waste generation, energy consumption, and environmental pollution.
4) Apply knowledge of organic reactions and mechanisms to propose efficient synthetic routes for the preparation of target compounds.

1.	**Organic Preparations:** a) Preparation of Benzilic acid from Benzil b) Preparation of diazonium salt. c) Preparation of Bromine solution. d) Preparation of dibenzalacetone (Green synthesis)	
2.	**Organic qualitative analysis:** (Minimum 8 compounds **a)** Benzoic acid b) acetyl salicylic acid c) aniline d) o- toluidine e) N,N dimethylaniline f) Chlorobenzene g) Bromo benzene h) Nitrobenzene i) M-dinitrobenzene j) Naphthalene k) Thiourea	
3.	**Preparation of derivatives:** a) Picrate derivative of anthracene & beta naphthol. b) Oxime derivative of acetone and acetophenone c) 2:4DNP of acetaldehyde and acetophenone. d) Iodoform (acetone). e)Oxalate derivative of urea.	

Course Outcomes: Students will be able to…

1) Perform the synthesis of benzilic acid from benzil using appropriate reagents and conditions.

2) Synthesize dibenzalacetone from benzaldehyde derivatives using an eco-friendly catalyst.

3) Identify and differentiate between various organic compounds through qualitative tests.

4) Perform calculations to determine the amount of glycine present based on experimental data and stoichiometry.

References:

1) Vogel's Textbook of Practical Organic Chemistry 5th Edition 5th Edition
2) Morrison & Boyd Organic Chemistry 7th Edn.
3) Peter Sykes A Guidebook to Mechanism in Organic Chemistry 6th Edn.
4) Mukherjee S.M., Singh S. P. Organic Chemistry, Vol. I. 21
5) Eliel E. L Stereochemistry of Carbon compounds. 5. Kalsi P.S. Stereochemistry Conformation & Mechanism 9th Edn.
6) Bansal Raj. K. A Textbook of Organic Chemistry.
7) Ahluwalia V. K. Organic Reaction Mechanism 4th Edn.

Structure and titles of the B.Sc. II Course Vocational Skill Course (2 Credits)			
Semester	**Paper No.**	**Name of Course**	**Units**
III	**(Practical)**	**Synthesis of hygienic and antiseptic Compounds**	**Practical**
IV	**(Practical)**	**Skin and Hair Care products**	**Practical**

B.Sc. II Drug Chemistry Semester III Vocational Skill Enhancement Course: Synthesis of Hygienic and Antiseptic Compounds		
Credit 2	**Practical Course: Vocational Skill Enhancement Course** **(BDCP-VSC I)**	**No. of Hrs.60**

Course Objectives: Students should be able to…

1. Understand and implement standard safety procedures and protocols
2. Gain a comprehensive understanding of health and hygiene principles
3. Acquire hands-on skills in formulating various hygiene products.
4. Integrate the principles of Good Manufacturing Practices (GMP) throughout the practical sessions.

1.	To learn a standard operating procedure to wear the PPE kit	
2.	To study & understand the health & Hygiene.	
3.	To creating hygienic lotions: formulation and techniques.	
4.	Hands-on hygiene: crafting and understanding hygienic gels	
5.	Preparation of soap to improve saponification skills	
6.	Creams of cleanliness: formulating and making hygienic creams	
7.	To prepare hygienic creams.	
8.	To prepare antiseptic hand sanitizer.	
9.	To prepare antiseptic wipes.	
10.	Crafting an effective hand wash solutions.	
11.	To prepare antiseptic sprayer.	
12.	To prepare antiseptic disinfectant.	
13.	To prepare chlorhexidine an antiseptic powder.	
14.	To prepare hygiene citrus pine disinfectant.	
15.	To prepare hygiene lemon pine disinfectant.	
16.	To prepare hygiene lavender pine disinfectant.	
17.	To prepare hygiene floor maintainer.	
18.	To prepare hygiene pine disinfectant.	
19.	To prepare oral antiseptics.	
20.	To prepare antiseptic gargle and mouth wash.	
	Note: any other relevant practicals may be added.	

Course Outcomes: After completion of the experiments students will be able to…

1. Proficiency in adhering to and implementing standard safety protocols for personal protective equipment (PPE)
2. Acquired hands-on proficiency in formulating a variety of hygiene and antiseptic products
3. Demonstrate competence in implementing quality control measures to ensure the efficacy and safety of hygiene and antiseptic products
4. Understand the applications of hygienic and antiseptic compounds in healthcare settings.

References:

1. Garner JS, Favero MS. 1996 CDC Guideline for handwashing and hospital environmental control.
2. Uttley AH, Simpson RA. 1994 Audit of bronchoscope disinfection: a survey of procedures in England and Wales and incidents of mycobacterial contamination
3. Uttley AH, Simpson RA. 1994 Audit of bronchoscope disinfection: a survey of procedures in England and Wales and incidents of mycobacterial contamination. J. Hosp. Infect.
4. Zaidi M, Angulo M, Sifuentes-Osornio J. 1995 Disinfection and sterilization practices

in Mexico. J. Hosp. Infect.
5. Spach DH, Silverstein FE, Stamm WE. 1993 Transmission of infection by gastrointestinal endoscopy and bronchoscopy. Ann. Intern. Med.

Credit 2	**B.Sc. II Drug Chemistry Sem IV** **Practical Course: Skin and Hair Care Products** **BDCP-VSC II**	No. of Hrs.30

Course Objectives: Students should be able to…

1. Gain proficiency in qualitative and quantitative analysis techniques for organic compounds.
2. Apply theoretical knowledge of organic chemistry principles in practical scenarios
3. Enhance critical thinking, problem-solving, and data interpretation skills through experimental design and analysis.
4. Understand the importance and relevance of organic chemistry in various scientific disciplines and real-world applications.

1.	To formulate and prepare an effective and marketable shampoo.	
2.	Advanced Formulation Techniques: Creating vibrant and safe hair dyes.	
3.	Nourish and Flourish: Crafting enriching hair oils for radianttresses.	
4.	To prepare conditioner for silky and shiny hairs.	
5.	Moisture Mastery: Formulating luxurious skin elixirs	
6.	Lotion Alchemy: Creating Indulgent Body Bliss	
7.	Almond Elegance: Artisanal face massage oil delight	
8.	Sun-Kissed Defense: Whipping up radiant sunscreen lotions.	
9.	Purity Unveiled: The art of skin cleanser creation	
10	Face Freshness Fusion: Crafting invigorating face wash marvels	
11.	To prepare a primer.	
12.	To prepare a tonner for the dry skin.	
13.	To prepare herbal mehendi for shiny hairs. (black & brown)	
14.	To prepare colour corrector for dark spots.	
15.	To prepare aloe-vera gel.	
16.	To prepare a hair serum.	
17.	To prepare a face scrub.	
18.	To prepare gulabjal.	
19.	To prepare vaselline.	
20.	To prepare herbal face mask.	
	Note: any other relevant practicals may be added.	

Course Outcomes: After completion of the experiments students will be able to…

1. Understand the principles of formulation, including the role of key ingredients.
2. Apply knowledge to select and combine ingredients that promote hydration, skin barrier function, and overall skin health.
3. Master the art and science of formulating cosmetic products, utilizing appropriate techniques for blending, emulsification, and stabilization.
4. Apply theoretical knowledge through hands-on experiences, gaining practical skills in the creation of hair conditioners, moisturizers, body lotions, face massage oils, sunscreen lotions, skin cleansers, and face washes.

References:

1. TAKAHASHI, Motoji. 2015 "Skin Care Products and the Skin." Journal of the Japan Society of Colour Material.
2. NISHIYAMA, Shoji, and Yoshimaru KUMANO. 1996 "Skin Care Products and the Skin."
3. Kuller, Joanne McManus. 1993 "Infant Skin Care Products."

4. Robbins CR. 2013 Chemical and Physical Behavior of Human Hair.
5. Madnani N, Khan K. 2013 Hair cosmetics. Indian J Dermatol Venereol Leprol.

Structure and Titles of BSc II Course Skill Enhancement Course			
Semester	**Paper No**	**Name of Course**	**Units**
III	**Practical**	**Practical Course for purification techniques in Drug Chemistry**	**Practical**
IV	**Practical**	**Advance Analytical Techniques**	**Practical**

Credits (Total Credits 2)	B.Sc. II Drug Chemistry Semester- III Skill Enhancement course Purification Techniques in Drug Chemistry (BDCP-SEC II)	No of Hours 60

Course Objectives: Students should be able to…

1. Know different methods of purification.
2. Understand the importance of purification techniques in practical skill.
3. Learn the purified compound.
4. Study the purification techniques for drugs.

1.	Purification of the sample by the process of crystallization.	
2.	To demonstrate ammonium chloride sublimes.	
3.	To separate the given mixture of amino acids (glycine & valine) using paperchromatography.	
4.	Separate the components of the solution by simple distillation method.	
5.	Separate the components of the solution by steam distillation method.	
6.	Separate the components of solution by vacuum distillation method.	
7.	Separate the component of solution by Fractional distillation method.	
8.	Give a practical of Filtration methods.	
9.	Experiment of soil of sedimentation.	
10.	To assess the effectiveness of recrystallization in purifying a solid compound anddetermining its purity.	
11.	To separate a mixture of two or more volatile liquids with significantly different boilingpoints.	
12.	To quantify the yield of recrystallization and assess its efficiency.	
13.	To demonstrate the ability of recrystallization to remove impurities from a sample.	
14.	To separate a mixture of two or more volatile liquids with significantly different boilingpoints.	

Course Outcomes: Students will be able to…

1. Extract the oil from the distillation method.
2. Explain the different filtration methods.
3. Identify the different purified compounds.
4. Discuss the methods of crystallization**.**

References:

1) Lombardino J. G.; Lowe J. A. 2004 A guide to drug discovery: the role of the medicinal chemist in drug discovery—then and now. Nat. Rev. Drug Discovery.

2) Newman S. G.; Jensen K. F. 2013 The role of flow in green chemistry and engineering. Green Chem.

3) Berton M.; Huck L.; Alcazar J. 2018 On-demand synthesis of organozinc halides under continuous flow conditions. Nat. Protoc.

4) Jensen K. F. 2017 Flow chemistry—microreaction technology comes of age. *AIChE J.*

5) Weeranoppanant N. 2019 Enabling tools for continuous-flow biphasic liquid–liquid reaction. *Reaction Chemistry & Engineering.*

Credits	B.Sc. II Drug Chemistry Semester- IV	No of
(Total Credits 2)	Skill Enhancement course Advance Analytical Techniques (BDCP-SEC III)	Hours 60 hrs

Course Objectives: Students should be able to…

1. Monitor the temperature of the distillation apparatus
2. learn techniques for isolating and purifying individual compounds from the fractions collected during chromatography
3. Analyzing experimental data obtained from chromatographic experiments
4. Develop skills in troubleshooting chromatographic separations**.**

1.	To assess the effectiveness of recrystallization in purifying a solid compound anddetermining its purity.	
2.	To optimize the recrystallization conditions for a specific compound by varyingparameters such as solvent choice, temperature, and cooling rate.	
3.	To demonstrate the ability of recrystallization to remove impurities from a sample.	
4.	To quantify the yield of recrystallization and assess its efficiency.	
5.	To compare the effectiveness of recrystallization with alternative purification methods.	
6.	To separate a mixture of two or more volatile liquids with significantly different boiling points.	
7.	To extract volatile compounds, particularly essential oils, from plant materials.	
8.	To separate azeotropic mixtures, where the components form a constant boiling mixture.	
9.	To separate and identify the components in a mixture using HPLC.	
10.	To determine the concentrations of components in a mixture using HPLC.	
11.	To separate a mixture of compounds into individual components using columnchromatography.	
12.	To optimize the conditions for column chromatography to achieve better separation andpurification of compounds.	
13.	To isolate and identify compounds from natural products using columnchromatography.	
14.	To identify unknown compounds present in a mixture using column chromatography.	

Course Outcomes: Students will be able to…….

1. Note the appearance of the impure solid compound before recrystallization
2. Determine the mass of the recrystallized compound obtained after the process.
3. Identify the different purified compounds.
4. Discuss the methods of crystallization.

References:

1) Alfassi, Z. B. (ed.) (1990). Activation Analysis. 2 vols. Boca Raton, CRC Press.

2) Ahuja, S. (2003). Chromatography and Separation Science. Amsterdam, Academic Press.

3) Aitchison, J. (1986). The Statistical Analysis of Compositional Data. London, Chapman and Hall.

4) Aitken, M. J. (1990). Scientific Dating Techniques in Archaeology. London, Longman.

5) Allen, R. O. (ed.) (1989). Archaeological Chemistry IV. Advances in Chemistry Series 220

Structure and titles of the B.Sc. II Course Value Education Course			
Semester	**Paper No.**	**Name of Course**	**Units**
III	**(Theory)**	**Environmental Awareness for DrugChemistry (BDCT-VEC II)**	**Unit I: Environmental Issues** **Unit II: Environmental Laws and Ethics** **Unit III: Sustainable Development Goals and Drug Policy** **Unit IV: Roll of Drug Chemistry in Meeting the Sustainable Development Goals**

Credit 2	B.Sc. II Drug Chemistry Semester III Value Education Course: Environmental Awareness for Drug Chemistry (BDCT-VEC II)	No. of Lectures per unit
Course Objectives: 1. Understand Environmental Impact of Drug Chemistry. 2. Explore Green Chemistry Principles. 3. Examine Pharmaceutical Regulations and Policies		
Unit I	**Environmental Issues**	**08**
	Pollution (Air, Water and land) Fresh water overuse, Natural disasters, Fuel and Energy shortage due to overuse, Increase in the wasteland, Biodiversity loss, Global warming and climate change (Causes and intensity of the problem), role of Drug chemistry in creation of environmental issues.	
Unit II	**Environmental Laws and Ethics**	**08**
	Environmental protection act wildlife protection act forest conservation act prevention and control of pollution action (air, water and land) from unsustainable to sustainable development responsibilities of an environmentally aware citizen.	
Unit - III	**Sustainable Development Goals and Drug Policy**	**07**
	End Poverty, End Hunger, Achieve food security and improved nutrition, and promote sustainable agriculture. Ensure healthy lives and promote well-being for all ages. Achieve gender equality and empower all women and girls, Sustainable use of terrestrial ecosystem	
Unit-IV	**Roll of Drug Chemistry in Meeting the Sustainable Development Goals**	**07**
	No poverty, Zero Hunger, Good health and well-being, Clean Water and sanitation, Affordable and clean energy, Industry innovation and infrastructure, Responsible consumption and reproduction. Descent work and economic growth, Climate Action, life below water, life on land, peace justice and strong institutions, partnership for the goals.	
Course outcomes: Students will be able to……. 1. Environmental Awareness. 2. Knowledge of Green Chemistry Principles. 3. Ability to Assess Environmental Risks. 4. Understand the regulatory frameworks and guidelines governing environmental aspects of drug chemistry.		
References: 1)Astas and Werner (1998)- Brief discussion of resource depletion under Sustainability. 2)Shrivastva and Sanghi (2005) - Green Chemistry for Sustainable Future. 3)Matlack (2010) - Sustainable Future but the brutland report was excluded from the list of additional reading discussion on Sustainable agriculture excluded. 4) Dr Gurav Jangra – (2012)People polity and Environment 5) j Krishnamurthy and T.S Sunil- (2014)Society Environment and Development		