



**JECRC<sup>TM</sup>**  
**UNIVERSITY**  
BUILD YOUR WORLD

**Department of Chemistry**  
**Course Structure and Syllabi**

**Session 2021-22**

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# JECRC UNIVERSITY, JAIPUR

Dated: 15.11.2021

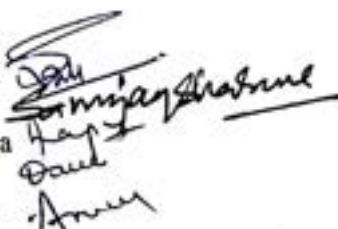
## Minutes of Meeting

A meeting of Board of Studies of Chemistry was conducted on 15 November 2021 at 2.30 pm in Board Room, Engineering Block.

The agenda of meeting was to Revise the syllabi of UG and PG courses in Chemistry.

### Members BOS

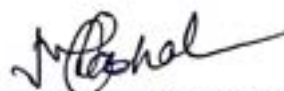
Prof. Sonu Pareek  
Prof. S.K. Sharma  
Prof. Sapna Sharma  
Dr. Saurabh Dave  
Dr. Aruna Sharma



Chairperson  
Member  
Member  
Member  
Member

### External Members:

1. Prof. M.P. Dhobal, Ex-Professor University of Rajasthan, Jaipur
2. Dr Asmita Sharma, Assistant Manager, Research & Development, Pidilite Industries, Mumbai
3. (online)




The recommendations of the members are as follows-

1. A New B.Sc. Chemistry Syllabus was designed as per UGC LOCF in several meetings, proof was approved in pre BOS with minor revisions and finally approved by BOS members in today's BOS meeting.
2. Specialized papers with seven different field of Chemistry were introduced and approved by all to make B.Sc. syllabus more Industry relevant.
3. A new B.Sc. Pass course syllabus of Chemistry was designed as per UGC LOCF in several meetings, proof was approved in pre BOS with minor revisions and finally approved by BOS members in today's BOS meeting.

4. A series of new codes was introduced in which BCH(Chemistry Hons B.Sc.), MCH(M.Sc.), BSC(Pass course)and DCH(open electives and common papers offered by Chemistry Department) was incorporated in new scheme.
5. The suggestions to revise the syllabus of B.Sc. Chemistry Major, M.Sc. Chemistry, which were proposed earlier in Pre BOS meeting on 7.07.2021 were placed before external members.
6. On the basis of the suggestions and feedback given by faculty and students, revisions in syllabus of all the courses was reviewed, relevance of revisions was also discussed in detail incorporated
7. On the basis of the suggestions of faculty other stake holders, Minor revisions were proposed in M.Sc. Chemistry syllabus and all the changes were approved by BOS.

At the end of meeting chairperson expressed gratitude to external members and thanked all the members of Board of Studies.



**Prof. Sonu Pareek**  
**HOD Chemistry**





HOD Chemistry JECRC University &lt;hod.chemistry@jecrcu.edu.in&gt;

**BOS 2021-22 Meeting**

2 messages

Wed, Nov 10, 2021 at 1:33 PM

HOD Chemistry JECRC University &lt;hod.chemistry@jecrcu.edu.in&gt;

To: "Dr. Savita Sangwan" <savita.sangwan@jecrcu.edu.in>, Saurabh Dave <saurabh.dave@jecrcu.edu.in>, "sapna.sharma" <sapna.sharma@jecrcu.edu.in>, "Ms. Bhawana Jangir" <bhawana.jangir@jecrcu.edu.in>, Aruna Sharma <aruna.sharma@jecrcu.edu.in>, "nidhi.bansal ." <nidhi.bansal@jecrcu.edu.in>, "Dr. Poonam hariyani" <poonam.hariyani@jecrcu.edu.in>, "Dr. Vishnu Kumar Khandelwal" <vishnukumar.khandelwal@jecrcu.edu.in>, "Prof. Sanjay K. Sharma" <associatedean.research@jecrcu.edu.in>  
Cc: Dean Science JECRC University <dean.science@jecrcu.edu.in>

Dear All,

BOS 2021-22 Meeting of Department of Chemistry to review and finalize the syllabus will be held on 13.11.2021 in board room, Engineering Block at 2.30 pm. Pls be present and also send suggestions if any change is required in the syllabus of B.Sc. and M.Sc. Though we have reviewed all the syllabus in earlier meetings.

Fri, Nov 12, 2021 at 4:23 PM

HOD Chemistry JECRC University &lt;hod.chemistry@jecrcu.edu.in&gt;

To: "Dr. Savita Sangwan" <savita.sangwan@jecrcu.edu.in>, Saurabh Dave <saurabh.dave@jecrcu.edu.in>, "sapna.sharma" <sapna.sharma@jecrcu.edu.in>, "Ms. Bhawana Jangir" <bhawana.jangir@jecrcu.edu.in>, Aruna Sharma <aruna.sharma@jecrcu.edu.in>, "nidhi.bansal ." <nidhi.bansal@jecrcu.edu.in>, "Dr. Poonam hariyani" <poonam.hariyani@jecrcu.edu.in>, "Dr. Vishnu Kumar Khandelwal" <vishnukumar.khandelwal@jecrcu.edu.in>, "Prof. Sanjay K. Sharma" <associatedean.research@jecrcu.edu.in>  
Cc: Dean Science JECRC University <dean.science@jecrcu.edu.in>

Dear All,

BOS meeting is postponed for Monday, 15.12.2021 due to few other meetings and NAAC related work.

[Quoted text hidden]

Dr. Savita Sangwan  
Saurabh Dave  
Ms. Bhawana Jangir  
Aruna Sharma  
Nidhi Bansal  
Dr. Poonam Hariyani  
Dr. Vishnu Kumar Khandelwal  
Prof. Sanjay K. Sharma  
Dean Science



# JECRC UNIVERSITY, JAIPUR

Dated: 10.11.2021

## CIRCULAR

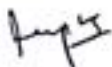
All members of Board of Studies of Chemistry are requested to attend the meeting to revise the syllabi of UG and PG courses in Chemistry on 11 November 2021 at 2.30 pm in Board Room, Engineering Block.



Prof. Sonu Pareek  
Chairperson, Board of Studies  
Department of Chemistry  
JECRC University, Jaipur

### Members BOS

1. Prof. S.K. Sharma
2. Prof. Sapna Sharma
3. Dr. Saurabh Dave
4. Dr. Aruna Sharma



### External Members:

1. Prof. M.P. Dholal, Ex-Professor University of Rajasthan, Jaipur
2. Dr Asmita Sharma, Assistant Manager, Research & Development, Pidilite Industries, Mumbai



### Copy To:

The President- For Information Please  
Registrar  
Dean Engineering & Sciences  
Director, SOS



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**Department of Chemistry**  
**Course Structure and Syllabi**  
**B.Sc. Course**  
**(Chemistry Hons.)**

**Session 2021-22**

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**JECRC University**  
**School of Sciences**  
**Department of Chemistry**  
**B.Sc. (Hons) Chemistry 2021-22**  
**Course Description**

<b>Course Type</b>	<b>Description</b>	<b>Credits</b>
<b>Core Course (CC)</b>	<b>Compulsory Papers from Chemistry</b>	<b>60</b>
<b>Discipline specific Elective (DSE)</b>	<b>Specialized Elective courses from Chemistry (IV-VI Semester)</b>	<b>41</b>
<b>Open Elective</b>	<b>Specialized Elective courses from another Department (III, V &amp; VI Semester)</b>	<b>15</b>
<b>Fundamental Courses</b>	<b>Fundamental Courses from other than Chemistry for Skill Development</b>	<b>16</b>
<b>Foundation Courses</b>	<b>Fundamental Courses from other than Chemistry for ability Enhancement</b>	<b>16</b>



## **B.Sc.(Hons) Chemistry**

### **List of Core Courses**

<b>Course Code</b>	<b>Course Title</b>	<b>Semester</b>
BCH001A	Inorganic Chemistry I: Chemical Bonding and Periodicity in Properties	I
BCH002A	Radical Analysis Lab	I
BCH003A	Organic Chemistry I: Reaction Mechanism and Hydrocarbons	I
BCH004A	Functional Group Detection Lab	I
BCH005A	Physical Chemistry-I: States of matter	I
BCH006A	Basic Physical Chemistry Lab	I
BCH007A	Inorganic Chemistry II: Non-aqueous Solvents and Transition and Inner Transition Elements	II
BCH008A	Quantitative analysis Lab-I	II
BCH009A	Organic Chemistry II: Stereochemistry II, Carbohydrates, Aromaticity & Halides	II
BCH010A	Organic Compound Detection Lab	II
BCH011A	Physical Chemistry-II: Electrochemistry and Surface Chemistry	II
BCH012A	Thermo Chemistry & Surface Chemistry Lab	II
BCH015A	Inorganic Chemistry III: Coordination Chemistry and Organometallic Compounds	III
BCH016A	Inorganic Preparations and Estimation of Metal ions (Practicals)	III
BCH017A	Organic Chemistry III: Organic compounds of Hydroxy, Carbonyl, Carboxylic acid functional groups & Biomolecules	III
BCH018A	Organic preparation & Binary mixture separation and analysis lab	III
BCH019A	Physical Chemistry-III: Quantum Mechanics and Phase Equilibria	III
BCH020A	Conductometric analysis& Kinetic study Lab	III
BCH021A	Organic Chemistry IV: Heterocyclic Compounds &Photochemistry	IV
BCH022A	Organic Synthesis &Chromatography Lab	IV
BCH023A	Organic Chemistry V: Spectroscopy	V
BCH024A	Spectroscopic Analysis Lab	V

## **B.Sc. (Hons) Chemistry**

### **Specialization Courses (DSE)\***

**\*Student can choose one specialized course from below given tracks  
(IV-VI Semester)**

- **B.Sc. Chemistry with specialization in Industrial Chemistry  
(BCE027A – BCE036A)**
  - Paper-I Industrial Aspects of Chemistry
  - Paper-II Fossil fuels, cleansing agents, Oils and Fats
  - Paper-III Pharmaceuticals, Fermentation, Pesticides & Perfumes
  - Paper IV Processes in Organic Chemicals Manufacture.
  - Paper-V Chemical Process: Economics and Entrepreneurship.
  - Paper-VI Green Chemistry
  
- **B.Sc. Chemistry with specialization in Pharmaceutical Chemistry  
(BCH0037A – BCH046A)**
  - Paper-I Inorganic Pharmaceutical Chemistry
  - Paper-II Pharmaceutical Chemistry-I (Biochemistry)
  - Paper-III Pharmaceutical Chemistry -II
  - Paper IV Pharmaceutical Chemistry-III: (Medicinal Chemistry - I)
  - Paper-V Pharmaceutical Chemistry - IV(Medicinal Chemistry - II)
  - Paper-VI Pharmaceutical Chemistry – V: (Medicinal Chemistry III)
  
- **B.Sc. Chemistry with specialization in Nano Chemistry and  
Technology (BCH047A-BCH056A)**
  - Paper-I Introduction to Nanoscience and Technology
  - Paper-II Synthesis of Nano materials: Conventional and Green Approaches
  - Paper-III Analysis and Characterization of Nano materials
  - Paper IV Applications of Nano materials
  - Paper-V Nano Toxicology and Environmental concern
  - Paper-VI Green Chemistry
  
- **B.Sc. Chemistry with specialization in Forensic chemistry and  
toxicology BCH087A- BCH096A**

- **Paper-I Bio Inorganic Chemistry; Presence and role of metals in human body and biological system**
- **Paper-II Biochemistry and Forensic Medicines; Drug Analysis**
- **Paper-III Chemistry of Forensic Toxicology and Forensic Ballistics & Explosives**
- **Paper IV Chemical Analysis of Physical Evidence**
- **Paper-V Instrumental Methods in Forensic Chemistry**
- **Paper-VI Green Chemistry**

➤ **B.Sc. Chemistry with specialization in Biochemistry  
(BCH057A-BCH066A)**

- Paper-I Introduction of Bio molecules
- Paper-II Enzymology
- Paper-III Metals and their role in Biology and Mineral Metabolism
- Paper IV Metabolism of carbohydrates and lipids
- Paper-V Biochemical Techniques
- Paper-VI Green Chemistry

➤ **B.Sc. Chemistry with specialization in Environmental Chemistry  
(BCH067A – BCH076A)**

- **Paper-I Chemistry of Environmental pollutants**
- **Paper-II Atmospheric Chemistry and Climate concerns**
- **Paper-III Water and Air Pollution monitoring and Control Technology**
- **Paper IV Solid and Hazardous Waste Management**
- **Paper-V Environmental Policies, Conventions and Protocols**
- **Paper-VI Green Chemistry**

➤ **B.Sc. Chemistry with specialization in Food Chemistry & Technology  
(BCH077A-BCH086A)**

- **Paper-I Basic Food Constituents**
- **Paper-II Chemistry of Food additives & Beverages**
- **Paper-III Food Contamination & Preservation Techniques**
- **Paper IV Indian traditional food storage practices and their relevance**
- **Paper-V Food Standards, Quality Assurance and Evaluation**
- **Paper-VI Green Chemistry**



**JECRC UNIVERSITY**  
**FACULTY OF SCIENCE**  
**SESSION 2021-2022**

**Details of Scheme for B.Sc.(Hons.) with various Courses & their credits with contact Hours**

S. No.	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1.	BCH001A	Inorganic Chemistry I: Chemical Bonding and Periodicity in Properties	4	-	2	4			4	Core
2.	BCH002A	Radical Analysis Lab						1	1	
3.	BCH003A	Organic Chemistry I: Reaction Mechanism and Hydrocarbons	4	-	2	4		1	4	Core
4.	BCH004A	Functional Group Detection Lab							1	
5.	BCH005A	Physical Chemistry-I: States of matter	4	-	2	4		1	4	Core
6.	BCH006A	Basic Physical Chemistry Lab							1	
7.	DCA001A	Web Development	2	0-	0	2	0	0	2	Fundamental
8.	DCA002A	Web Development Lab	0	0	2	0	0	1	1	Fundamental
9.	DEN001A	Communication Skills	2	0	2	2	0	1	3	Foundation
10.	DIN001A	Culture Education -I	2	0	0	2	0	0	2	Foundation
8.	DCH001A	Environment Studies	3		2*	3	0	1	4	Fundamental
			21		12	21		6	27	

**Semester I\*Field/ Project Work and Report**

*[Handwritten signatures and marks]*

## Semester II

No.	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1.	BCH007A	Inorganic Chemistry II: Non-aqueous Solvents and Transition and Inner Transition Elements	4	-	2	4		1	4	Core
2.	BCH008A	Quantitative analysis Lab-I							1	
3.	BCH009A	Organic Chemistry II: Stereochemistry II, Carbohydrates, Aromaticity & Halides	4	-	2	4			4	Core
4.	BCH010A	Organic Compound Detection Lab							1	
5.	BCH011A	Physical Chemistry-II: Electrochemistry and Surface Chemistry	4	-	2	4		-	4	Core
6.	BCH012A	Thermo Chemistry & Surface Chemistry Lab							1	
7.	DCA003A	Project Management Lab	0	0	2	0	0	1	1	Fundamental
8.	DEN002A	Professional Skills	2	0	2	2	0	1	3	Foundation
9.	DIN002A	Culture Education-2	2	0	0	2	0	0	2	Foundation
10.	BCH013A	Core Course 7 (Basic Analytical Chemistry)	4	-	2	4		1	5	CORE
11.	BCH014A	Analytical Chemistry Lab								
			20		12	20		6	26	



## Semester III

S.No	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1.	BCH015A	Inorganic Chemistry III: Coordination Chemistry and Organometallic Compounds	4	-	2	4		-	4	Core
2.	BCH016A	Inorganic Preparations and Estimation of Metal ions (Practicals)						1		
3.	BCH017A	Organic Chemistry III: Organic compounds of Hydroxy, Carbonyl, Carboxylic acid functional groups & Biomolecules	4	-	2	4		1	5	Core
4.	BCH018A	Organic preparation & Binary mixture separation and analysis lab								
5.	BCH019A	Physical Chemistry-III: Quantum Mechanics and Phase Equilibria	4	-	2	4		1	5	Core
6.	BCH020A	Conductometric analysis & Kinetic study Lab								
7.	DCA004A	Advanced Spread Sheet Lab		-	2			1	1	Fundamental
8.	DEN003A	Life Skills – I (Personality Development)	1	0	2	1	0	1	2	Foundation
9.	DIN003A	Value Education	1	0	0	1	0	0	1	Foundation



		and Ethics -I								
10		Open Elective-I	3	0	0	3	0	0	3	Interdisciplinary
11		Open Elective-II	3	0	0	3	0	0	3	Interdisciplinary
			20		10	20		5	25	

#### Semester IV

No	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1.	BCH021A	Organic Chemistry IV: Heterocyclic Compounds & Photochemistry	4	-	2	4		1	5	Core
2.	BCH022A	Organic Synthesis & Chromatography Lab								
3.	BCH025A	Discipline Elective 1 [Green Chemistry]	4	-	2	4		1	5	DE
4.	BCH026A	Lab								
5.	BCH027A-BCE036A	Discipline Elective 2	4	-	2	4		1	5	DE
6.	BCH027A-BCE036A	Lab								
7.	DCA005A	Python programming	2	0	0	2	0	0	2	Fundamental
8.	DCA006A	Python programming Lab	0	0	2	0	0	1	1	Fundamental
9.	DMA011A	Life Skills - 2 (Aptitude)	1	0-	2	1	0	1	2	Foundation
10	DIN 004A	Value Education and Ethics	1	0	0	1	0	0	1	Foundation
11	REM001	Research Methodology	3	1	0	3	1	0	4	Interdisciplinary
									25	

## Semester V

S.No	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1.	BCH023A	Organic Chemistry V: Spectroscopy	4	-	2	4		1	5	Core
2.	BCH024A	Spectroscopic Analysis Lab								
3.	BCH037A-BCH046A	Discipline Elective 3	4	-	2	4		1	5	DSE
4.	BCH037A-BCH046A	Lab								
5.	BCH047A-BCH056A	Discipline Elective 4	4		2	4		1	5	Specialized
6.	BCH047A-BCH056A	Lab								
7.		Open Elective III	3	-	-	3			3	Interdisciplinary
8.	BCH058A	Project							6	Discipline Specific
									24	

Semester VI: \*\*Note: In 6th Semester Student has a Choice either he can go for offered Courses or he may avail Internship in some reputed Institute/Industry or In-House Dissertation

S.No	Course Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1	BCH057A-BCH066A	Discipline Elective 5	4	-	2	4		1	5	Discipline Specific Elective
2	BCH057A-BCH066A	Lab								
3	BCH067A-BCH076A	Discipline Elective 6	4	-	2	4		1	5	Specialized
4	BCH067A-BCH076A	Lab								
5	BCH077A-BCH086A	Discipline Elective 7	4	-	2	4		1	5	Discipline Specific Elective
6	BCH077A-BCH086A	Lab								
7		Open Elective-IV	3	-	0	3		0	3	Interdisciplinary
8		Open Elective-V	3		0	3		0	3	Interdisciplinary

*[Handwritten signatures and marks]*



		18		6	18	3	21		
<b>Total Credits</b>									
<b>Credits</b>	<b>I Sem</b>	<b>II Sem</b>	<b>III Sem</b>	<b>IV Sem</b>	<b>V Sem</b>	<b>VI Sem</b>	<b>Total</b>		
	27	26	25	25	24	21	148		

### Program Outcomes (PO) B.Sc. Chemistry Hons. 2021

**PO1Core competency:** The chemistry graduates are expected to know the fundamental concepts of chemistry and applied chemistry. These fundamental concepts would reflect the latest understanding of the subject and in allied subject areas. Students will learn to investigate, experiment, relate information and draw logical conclusions based on scientific reasoning.

**PO2Disciplinary knowledge and skill:** To learn and apply the knowledge of Chemistry in research and addressing practical problems and to apply various scientific methods to address different problems and critically analyze the data. The student will be inquisitive about processes and phenomena happening during experiments in laboratories and seeks answers through the research path.

**PO3Skilled communicator:** Communicate effectively on various scientific issues with the society at large, They are expected to read and understand documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea.

**PO4Critical thinker and problem solver:** Critical thinking and analytical reasoning and the scientific knowledge will help to develop scientific temper of a Chemistry graduate that will be more beneficial for the society. The student will be able to draw logical conclusions based on a group of observations, facts and rules. Student will be able to solve the problems related with society like water sanitation, effective remediation, pollution, development of effective drugs and other necessary chemicals without side effects.

**PO5Team player:** The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based work ,project and industry.

**PO6Moral and ethical awareness:** Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world.. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.

**PO7Skilled project manager:** Graduates are expected to be familiar with decision making process and basic managerial skills to become a better leader by acquiring knowledge about Chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

**PO8Digitally literate:** The student will acquire knowledge in understanding and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work. Students will acquire digital skills and integrate the fundamental concepts





with modern tools.

**PO9 Environment and sustainability** Apply the knowledge of basic science, Chemistry and allied fields to protect environment and to prevent environmental degradation as science graduate, to stay firm on the value systems, of their culture, including their own for a healthy socio cultural environment.

**PO10 Lifelong learner:** Graduates will acquire the ability to engage in independent and self-learning as well as to successfully pursue their career objectives in advanced education and in professional courses, through the use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability.

## SEMESTER I

### BC11001A: Inorganic Chemistry I

#### Chemical Bonding and Periodicity in Properties

##### Prerequisites

Basic knowledge of atomic structure, periodic table, quantum number and shapes of orbitals

##### Course outcome

CO1: The periodic properties like atomic and ionic radii, ionization energy, ionization potential and electron negativity and their determinations and applications

CO2: Different types of bonding like ionic bond and metallic bond, Covalent bonding in molecules and molecular geometry based on VBT, VSEPR and MOT to know structure of different molecules and ions

CO3: s- block elements of alkali and alkaline earth metals and their industrial and biological applications

CO4: p- block elements and their different compounds having industrial and biological applications.

##### Unit-I

**Periodic Properties :** Atomic and ionic radii, ionization energy, electrode potential (use of redox potential-reaction feasibility), electron affinity and electronegativity – definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behavior, electronic configuration.

**MIT : Principle of chemical science (fall 2008)**

##### Unit-II

##### Chemical Bonding I

- (i) **Ionic Bond** – Types of ionic solids, radius ratio effect and coordination number, limitations of radius ratio, lattice defects, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules.
- (ii) **Metallic Bond** : Free electron, valence bond and band theories. Weak Interactions: Hydrogen Bond – experimental evidence, van der Waal's forces.

##### Unit - III

##### Chemical Bonding II

**Covalent Bond :** Shape of s,p,d orbitals and their characteristics, valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridizations and shapes of simple inorganic molecules and ions such as  $\text{NH}_3$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$

*Handwritten signatures and initials:*  
Dhan, A. J., J. Chakraborty, A. S., N. S., S. S.



$\text{ICl}_2^-$  and  $\text{H}_2\text{O}$  by valence shell electron pair repulsion (VSEPR) theory and Molecular Orbital Theory, bonding, nonbonding and antibonding molecular orbitals, linear combination of atomic orbitals (LCAO). Applications of MO theory.

#### Unit-IV

**s-Block Elements:** Tendencies of alkali and alkaline-earth metals, hydration energies, solvation and complexation, Hydride (classification, general methods of preparation and salient features), principle of metallurgical extraction, Chemistry of Li and Be, their anomalous behaviour and diagonal relationships, alkyls and aryls and their role in biology.

#### Unit-V

**p-Block Elements :** Comparative study (group-wise) of group 13 & 14 elements with respect to periodic properties. Compounds such as hydrides, halides, oxides and oxyacids; diagonal relationship; preparation, properties, bonding and structure of diborane, borazine and alkali metal borohydrides. Preparation, properties and technical applications of carbides and fluorocarbons. Silicones and structural principles of Silicates, Borazines, Phosphonitrichalides

#### Books Recommended

1. "A New Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. "Modern Inorganic Chemistry", R. C. Aggarwal, 1st Edition (1987), Kitab Mahal, Allahabad.
3. "Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
4. "Inorganic chemistry" Shriver & Atkins (Fifth edition)
5. "Chemistry of the elements", N. N. Greenwood and A. Earnshaw

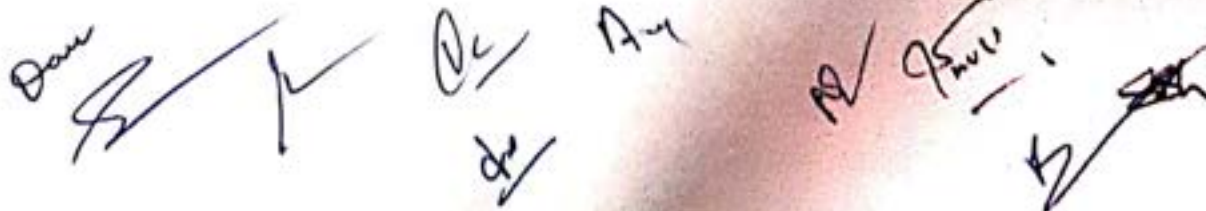
#### Mapping Course Outcomes Leading To the Achievement of Program Outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	-	1	2	1	2	3
CO2	3	3	3	1	1	1	3	1	2	2
CO3	2	3	3	1	1	1	2	-	3	3
CO4	3	2	1	-	3	-	2	1	3	2

0- Not related; 1- low; 2- medium; 3- high

#### BCH002A: Radical Analysis Lab

1. To identify carbonate, Sulphite, Sulphide of dilute  $\text{H}_2\text{SO}_4$  group.
2. To identify Nitrite and Acetate of dilute  $\text{H}_2\text{SO}_4$  group.
3. To identify Chloride, Bromide and Iodide of concentrated  $\text{H}_2\text{SO}_4$  group.
4. To identify Nitrate and Oxalate of concentrated  $\text{H}_2\text{SO}_4$  group.
5. To identify acidic radicals not identified with dilute or concentrated  $\text{H}_2\text{SO}_4$  group.
6. To analyze basic radicals of group I and II.
7. To analyze basic radicals of group III and IV.
8. To analyze basic radicals of group V, VI and VII.
9. To analyze a mixture of one acidic and one basic radical.

Don  




10. To analyze a mixture of one acidic and one basic radical with interfering radical

### **BCH003A: Organic Chemistry I: Reaction Mechanism and Hydrocarbons**

**Prerequisites:** Basic knowledge of bond length, bond angles, bond energy, types of bonds, Types of reagents, electrophiles, and nucleophiles, Hybridization, van der Waals interactions, resonance.

#### **Course outcomes (CO):**

At the end of this course student will be able to -

**CO1:** Analyze and formulate mechanisms of different organic reaction including addition, Substitution, elimination and rearrangement reactions.

**CO2:** Understand physical properties and apply chemical properties of various hydrocarbons viz. alkanes, alkenes, alkynes and dienes in different sectors.

**CO3:** Develop a sound understanding of the fundamental concepts of stereochemistry.

**CO4:** Apply the knowledge on nature and behavior of hydrocarbons in industries.

### **Unit I**

#### **Structure, Bonding & Mechanism of Organic Reactions**

Hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding. Types of organic reactions, Energy considerations.

Types, structure, relative stability, and reactivity of Carbocations, Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanism: product analysis, intermediates, isotope effects. Kinetic and stereochemical studies.

### **Unit II**

#### **Alkanes & Cycloalkanes**

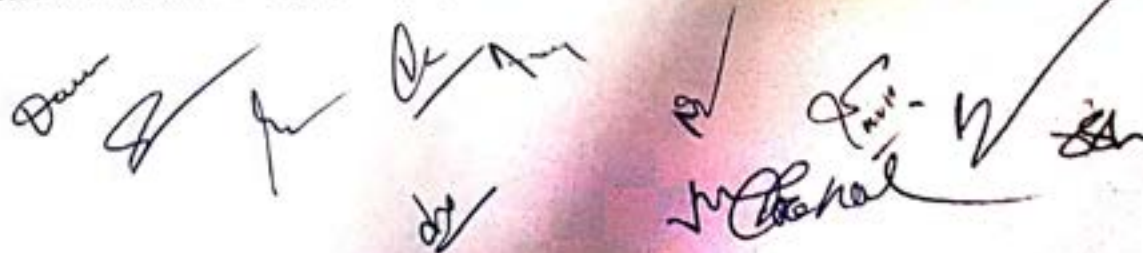
Isomerism in alkanes, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction, and decarboxylation of carboxylic acids). Physical properties and chemical reaction of alkanes. Mechanism of free radical halogenations of alkanes, orientation, reactivity and selectivity.

Introduction and nomenclature of cycloalkanes, Baeyer's strain theory and its limitations, Ringstrains in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds.

### **Unit III**

#### **Alkenes**

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halide, regioselectivity in alcohol dehydration The Saytzeff rule, Hofmann's elimination, physical properties and relative stabilities of alkenes. Chemical reactions



of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions, Markovnikov's rule, hydroboration- oxidation, oxymercuration -reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ . Polymerization of alkenes. Substitution at the allylic and vinylic-positions of alkenes. Industrial applications of ethylene and propene.

#### Unit IV

##### Alkynes and Dienes

Nomenclature, structure and bonding in alkynes. Methods of preparation. Chemical reactions of alkynes, acidity of alkynes. Mechanisms of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reduction, oxidation and polymerization.

**Nomenclature and classification of dienes:** isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2- and 1,4- additions, Diels-alder reaction

#### Unit V

##### Stereochemistry of Organic Compounds-I

Concept of isomerism, types of isomerism. Optical isomerism: elements of symmetry, molecular chirality enantiomers. stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers. meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration: sequence rules, D & L and R & S systems of nomenclature.

##### BOOKS:

1. A Text Book of Organic Chemistry : K. S. Tiwari, S. N. Mehrotra and N. K. Vishnoi
2. Modern Principles of Organic Chemistry : M. K. Jain and S. C. Sharma
3. A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal
4. A Text Book of Organic Chemistry : B. S. Bahl and Arun Bahl
5. A Text Book of Organic Chemistry : P. L. Soni
6. Organic Chemistry : (Vol. I, II & III) S. M. Mukherji, S. P. Singh and R. P. Kapoor, Wiley Eastern Ltd. (New Age International)
7. Organic Chemistry : Morrison & Boyd, Prentice Hall

##### Mapping of CO-PO

##### Mapping Course Outcomes Leading To the Achievement of Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	1	3	1	2	1	2	3
CO2	1	2	1	2	2		1	2	2	1

*[Handwritten signatures and initials are present below the table, including "Dum", "B", "K", "A", "An", "V", "S", "J", "S", "S"]*



CO3	2	3	2	2	2	2	1	3	2	
CO4	3	3	2	3	3	3	2	3	3	2

#### BCH004A: Functional Group Detection Lab

1. To purify the impure sample of organic compounds by sublimation .
2. To separate the mixture (1 solid+1 liquid) by distillation .
3. To detect the elements (N and S) from the given organic compound.
4. To detect the element (halogen) from the given organic compound.
5. To purify the impure sample of organic compound by crystallization and decolourization of the compound by charcoal.
6. To detect the functional group (alcoholic and phenolic) from the given organic compound.
7. To detect the functional group (Carboxylic) from the given organic compound.
8. To detect the functional group ( Ester) from the given organic compound.
9. To detect the functional group (Carbonyl) from the given organic compound.
10. To detect the functional group (Amine and Aniline) from the given organic compound.
11. To detect the functional group (Carbohydrate And Nitro) from the given organic compound.
12. To detect the functional group (Amide) from the given organic compound

#### BCH005A: Physical Chemistry-1

##### States of Matter

**Prerequisite:** Basic knowledge of Structure of atoms, Solutions, Basics of thermodynamics

The student will able to-

CO1: Understand fundamental concepts of states of matter.

CO2: Describe basic properties of solutions.

CO3: Analyze experimental methods for determination of properties of solutions.

CO4: Acquire knowledge about properties of dilute solutions.

##### Unit-I

**Solid State:** Types of crystals (molecular, covalent, metallic, ionic), Imperfections in crystals: point defect, Schottky defect, Frankel defect, metal excess defect (colour centre), line defect (dislocations), edge and screw dislocations, Crystal structure of NaCl, KCl, Graphite, and Diamond. Band theory of solids.

MIT- Band theory of solids

##### UNIT-II

**Liquid State:** Surface tension of liquids, capillary action, surface tension and temperature, interfacial tension, surface active agents, Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature, Intermolecular forces of liquids.

MIT- Band theory of solids, surface tension

##### Unit -III

**Gaseous State:** Kinetic theory of gases, transport coefficients. Collision in a gas- mean free path, collision diameter and its dynamics, collision number and effusion. Behaviour of real gases -Van der Waal's equation, Critical phenomena - critical constants of a gas and their determination, continuity of state, critical state, Principle of corresponding states, liquefaction of gases.

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MIT- Kinetic theory of gases, transport coefficients. collision diameter and its dynamics, collision number and effusion.

#### Unit -IV

**Solutions:** Liquid-liquid - ideal solutions, Raoult's law. Ideally dilute solutions, Henry's law. Non- ideal solutions. Vapour pressure - composition and vapour pressure- temperature curves; Azeotropes-HCl-H<sub>2</sub>O, ethanol-water systems and fractional distillation. Partially miscible liquids-phenol-water, trimethylamine-water, nicotine-water systems. Effect of impurity on consolute temperature. Immiscible liquids and steam distillation. Nernst distribution law. Calculation of the partition coefficient. Applications of distribution law.

#### Unit -V

**Dilute solutions:** Colligative properties. relative lowering of vapour pressure, its relation to molecular weight of non-volatile solute. Elevation of boiling point and depression of freezing point. Derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods of determination. Osmosis, osmotic pressure, experimental determination. Abnormal Colligative properties- Van't Hoff factor.

#### BOOKS:

1. "Physical Chemistry", P. C. Rakshit, 5th Edition (1985), 4th Reprint (1997), Sarat Book House, Calcutta.
2. "Principles of Physical Chemistry", B. R. Puri, L. R. Sharma, and M. S. Pathania, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar

MIT- Osmosis, osmotic pressure, Abnormal Colligative properties- Van't Hof factor.

#### Mapping Course Outcomes Leading To the Achievement of Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2					1			2
CO2	3	3						1		2
CO3	3	2		1			1	2		2
CO4	3	2		2			1	2		1

#### BCH006A Basic Physical Chemistry Lab

1. To calibrate pipettes.
2. To calibrate burettes.
3. To prepare standard solution and dilution -0.1 M to .001M solution.
4. To standardize a secondary standard solution
5. To prepare standard 0.1 N NaOH solution using 0.1 N Oxalic acid as primary standard solution.
6. To determine strength of unknown CH<sub>3</sub>COOH using 0.1 N NaOH as intermediate solution.
7. To determine the percentage composition of a given mixture (non interacting system) by viscosity method.
8. To determine the percentage composition of a given mixture (non interacting system) by surface tension method.
9. To determine the partition coefficient of Iodine between water and carbon tetrachloride (or chloroform, carbon disulphide etc) at room temperature.

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## SEMESTER II

### BCH007A: Inorganic Chemistry II

#### Non-aqueous Solvents and Transition and Inner Transition Elements

##### Prerequisites:

Basic knowledge of periodic table, General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals – metallic character, ionization enthalpy, oxidation states, ionic radii.

##### Course outcome

CO1: students will be able to explain the unique characteristics of different types of acids and bases.

CO2: students will be able to analyze the chemical reaction in different non aqueous solvents and advantages/ limitations of various solvents

CO3: students will be able to explain the trends in atomic and physical properties of group 15, 16, 17 & 18 elements

CO4: students will be able to learn about the vast world of transition elements and their unique properties and basic knowledge of lanthanides and actinides chemistry.

#### Unit-I

**Acids and Bases:** Acid and base, pH and hydrolysis of salts, Arrhenius, Brønsted-Lowry, Lux flood, Solvent System and Lewis concepts of acids and bases. Factors affecting strengths of Lewis acids and bases.

#### Unit-II

**Non-aqueous Solvents:** Physical properties of a solvent for functioning as an effective reaction medium. Types of solvents and their general characteristics. Reactions in liquid ammonia and liquid sulfur dioxide.

#### Unit-III

**Chemistry of P-block elements (Groups 15, 16, 17 and 18) :** Group trend in periodic properties, hydrides, oxides, oxyacids and halides. Structures of oxides and oxyacids of nitrogen, phosphorus, sulphur, selenium, tellurium and halogens. Chemistry of cyclophosphazenes and tetrasulphur tetranitride.

##### Interhalogens and Noble gases

Basic properties of iodine, structure and bonding of interhalogens and polyhalides, Preparation and structure of noble gas compounds

#### Unit-IV

**Transition Metals:** Characteristic properties of 3d elements – ionic radii, oxidation states, complexation tendency, magnetic behaviour and electronic spectral properties. Spectrophotometric estimation of metal ions.

#### Unit-V

**Lanthanides & Actinides :** Comparative study of lanthanide elements with respect to electronic configuration, atomic and ionic radii, oxidation state and complex formation. Lanthanide contraction. Occurrence and principles of separation of lanthanides. Actinides: electronic configuration, atomic and ionic radii, oxidation state, Magnetic and spectral properties.

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### Books Recommended

1. "Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. "Modern Inorganic Chemistry", R. C. Aggarwal, 1st Edition (1987), Kitab Mahal, Allahabad.
3. "Basic Inorganic Chemistry", F.A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
4. "Inorganic chemistry: Principles of structure and reactivity" James E. Huysen, Ellen A. Keiter and Richard L. Keiter
5. "Inorganic chemistry" Gary L. Miessler and Donald A. Tarr
6. "Selected topics in inorganic chemistry" Dr. Wahid U. Malik, Dr. G. D. Tuli, Dr. R. D. Madan

### Mapping of CO-PO

Mapping Course Outcomes Leading To The Achievement Of Program Outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	1	3	1	3	3
CO2	3	3	1	3	3	1	3	1	3	2
CO3	2	3	2	1	-	1	2	-	3	3
CO4	3	2	-	2	3	1	2	1	3	2
CO5	3	3	1	2	3	-	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

### BCH008A Quantitative analysis Lab-I

1. To determine the hardness of Water by complexometric method.
2. To determine the hardness of Water by HCl method.
3. Calibration of weights and calculation of errors in it.
4. Prepare a standard solution of  $\text{Na}_2\text{CO}_3$  and standardize the given solution of  $\text{HCl}/\text{H}_2\text{SO}_4$
5. Prepare a standard solution of sodium oxalate and standardize given solution of  $\text{KMnO}_4$
6. Determine percentage purity of commercial sample of  $\text{NaOH}$
7. Prepare a standard solution of  $\text{K}_2\text{Cr}_2\text{O}_7$  and standardize given solution of  $\text{Na}_2\text{S}_2\text{O}_3$
8. Estimation of Barium as  $\text{BaSO}_4$  gravimetrically

### BCH009A: Organic Chemistry II:

#### Stereochemistry II, Carbohydrates, Aromaticity & Halides

##### Course outcomes (CO):

At the end of this course student will be able to -

- CO1: apply the knowledge of isomerism, stability and reactivity on different conformations.  
CO2: understand the carbohydrates, their occurrence, structure, configuration, properties and also get the knowledge of the role of these bio-molecules in biological system and day to day life.  
CO3: interpret the concept of aromaticity, properties and the chemical reactions of aromatic compounds.  
CO4: evaluate the structure and classes of aryl and alkyl halides, physical properties, preparation of halo compounds, substitution, elimination, reduction reactions and their uses in everyday life w.r.t. environment concern.

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## Unit I

### Stereochemistry of Organic Compounds-II

Geometrical isomerism: determination of configuration of geometrical isomers, E & Z systems of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism: conformational analysis of ethane and n-butane. conformations of cyclohexane, axial and equatorial bond, conformation of mono substituted cyclohexane derivatives. Newmann projection and sawhorse formulae, Difference between configuration and conformation.

## Unit II

### Carbohydrates

Classification and nomenclature of monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D (+) glucose.

## Unit III

### Arenes & Aromaticity

Nomenclature of benzene derivatives. The aryl group, aromatic nucleus and side chain structure of benzene, molecular formula and Kekule structure, stability.

Huckle's rule, aromatic ions, Aromatic electrophilic substitution-general pattern of the mechanism, role of  $\sigma$  and  $\pi$  complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction, energy profile diagrams. Activating & deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

## Unit IV

### Alkyl Halides

Nomenclature of alkyl halides, methods of preparation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides,  $SN^2$  and  $SN^1$  reactions with energy profile diagrams. Polyhalogen compounds, chloroform, carbon tetrachloride.

## Unit V

### Aryl Halides

Methods of formation of aryl halides, nuclear and side chain reactions. The addition, elimination

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and the elimination-addition mechanism of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl, allyl, vinyl and aryl halides. Synthesis and use of D.D.T. and B.H.C.

**Books Suggested :**

1. A Text Book of Organic Chemistry : K. S. Tiwari, S. N. Mehrotra and N. K. Vishnoi
2. Modern Principles of Organic Chemistry : M. K. Jain & S. C. Sharma
3. A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal
4. A Text Book of Organic Chemistry : B. S. Bahl and Arun Bahl
5. Organic Chemistry by Morrison & Boyd, Prentice Hall
6. A Text Book of Organic Chemistry : P. L. Soni
7. Organic Chemistry: (Vol. I, II & III) S. M. Mukherji, S. P. Singh and R P. Kapoor

**Mapping of CO-PO**

**Mapping Course Outcomes Leading To The Achievement Of Program Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	1	2	3	1	2	2		2
CO2	2	3	3	1	2	1		1	2	2
CO3	3	3	2	2	2	2	2	2	2	1
CO4	2	2	2	2	2		2	1	3	

**BCH010A: Organic Compound Detection Lab**

1. To identify an organic compound number 1 through the functional group analysis, determine its M.P and prepare its suitable derivative.
2. To identify an organic compound number 2 through the functional group analysis, determine its M.P and prepare its suitable derivative.
3. To identify an organic compound number 3 through the functional group analysis, determine its M.P and prepare its suitable derivative.
4. To identify an organic compound number 4 through the functional group analysis, determine its M.P and prepare its suitable derivative.
5. To identify an organic compound number 5 through the functional group analysis, determine its M.P and prepare its suitable derivative.
6. To identify an organic compound number 6 through the functional group analysis, determine its M.P and prepare its suitable derivative
7. To identify an organic compound number 7 through the functional group analysis, determine its M.P and prepare its suitable derivative
8. To identify an organic compound number 8 through the functional group analysis, determine its M.P and prepare its suitable derivative
9. To identify an organic compound number 9 through the functional group analysis, determine its M.P and prepare its suitable derivative



BCH011A

## Electrochemistry and Surface Chemistry

At the end of this course student will be able to -

CO1: Understand aspects of electrochemistry and thermodynamics.

CO2: Describe principle theories of Chemical kinetics.

CO3: Learn about colloidal nature of matter

CO4: Analyse basic terms and theorems of surface phenomenon.

### Unit-I

**Electrochemistry-I :** Arrhenius theory of electrolytic dissociation, classification of electrolytes; Theory of strong electrolytes :- Qualitative idea of Debye-Huckel theory of ion-ion interactions, Debye-Huckel limiting law for activity coefficient of ions in electrolyte solution (derivation not required), its modification for concentrated solutions. Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance : qualitative idea of electrophoretic and relaxation effects, Migration of ions: transference number and its determination (Hittorf and Moving Boundary methods).

### Unit-II

**Thermodynamics-I:** Introduction of different terms and processes in thermodynamics : Systems (isolated, closed, open) and surroundings, macroscopic properties (extensive and intensive), kinds of processes, work, heat and First Law of thermodynamics, state and state functions (exact and inexact differential), path dependence of work and heat. Enthalpy, heat changes at constant volume and constant pressure, heat capacities (  $C_v$  ,  $C_p$  ) and relation between them for ideal gases.

MIT- First Law of thermodynamics, work and heat. Enthalpy,

### UNIT-III

**Chemical Kinetics-I:** Introduction, order and molecularity of a chemical reactions, integrated rate equations for zeroth, first, second and third order reactions, effect of temperature on reaction rates (Arrhenius equation), collision theory and transition state theory (derivation thermodynamically), deviations from collision theory.

MIT- collision theory and transition state theory (derivation thermodynamically), deviations from collision theory.

### Unit-IV

**Surface chemistry:** Definition of colloids. Solids in liquids (sols), preparation, purification, properties - kinetic, optical, electrical. Stability of colloids, Hardy-Schulze law, protective colloid. Liquids in liquids (emulsions) preparation, properties, uses. Liquids in solids (gels) preparation, uses.

### Unit-V

**Surface process:** Adsorption: Physical adsorption, chemisorption. Freundlich, Langmuir adsorption isotherms. Applications of adsorption, Multi layer adsorption-BET equation (no derivation) and its application to surface area measurement.

### BOOKS

1. "Physical Chemistry", P. C. Rakshit, 5th Edition (1985), 4th Reprint (1997), Sarat Book House, Calcutta.
2. "Principles of Physical Chemistry", B. R. Puri, L. R. Sharma, and M. S. Pathania, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar.

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3. "Physical Chemistry", K. J. Laidler and J. M. Meiser, 3rd Edition, Houghton Mifflin Comp., New York, International Edition (1999).
4. An Introduction of Electrochemistry by S. Glasstone

#### Mapping of CO-PO

#### **Mapping Course Outcomes Leading To The Achievement Of Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2			1	2	1	2
CO2	3	3	1	2	1		1	2	1	2
CO3	3	2	1	1						2
CO4	3	3	1	2	1		1	2	1	2

#### **BCH012A: Thermochemistry & Surface chemistry Lab**

1. To determine the solubility of benzoic acid at different temperatures and to determine
2.  $\Delta H$  of the dissolution process.
3. To determine the water equivalent of the thermos flask or calorimeter.
4. To determine the enthalpy of neutralization or heat of neutralization for a strong acid and strong base.
5. To determine heat of neutralization of a weak acid say acetic acid and to calculate its heat of ionization or enthalpy of ionization.
6. To determine heat of neutralization of a weak base say  $\text{NH}_4\text{OH}$  and to calculate its heat of ionization or enthalpy of ionization.
7. To determine the strength of given acid pH metrically. For this you are provided with standard NaOH solution.
8. To draw the solubility curve of phenol -water system and to determine critical solution temperature of the system and the composition of phenol-water system at C.S.T.
9. To determine the C.S.T of phenol-water system in presence of 1% NaCl solution and 1% succinic acid solution.
10. To determine the dissociation constant of a weak acid conductometrically and verify ostwalds dilution law.
11. To determine the transition temperature of the given substance by thermometric method ( $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ )

#### **BCH013A: Basic Analytical Chemistry**

On completion of the course, B.Sc. student will be able to understand:

**CO-1** about the various types of error with curves and methods of minimizing errors with significant figures and computation rules.

**CO-2** about the Properties and formation of precipitates, contamination and methods of removing impurities in precipitates and about the theoretical and practical aspects of various analytical reagents and their applications.

**CO-3** about the solvent extraction systems, distribution laws and Craig concept also with Radioanalytical Methods and their applications.

**CO-4** about classification of chromatographic methods and applications and Elementary idea of HPLC, GC, TGA,

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DTA.

#### Unit-I

**Statistical Evaluation:** Determinate and Indeterminate errors. Normal error curve. Accuracy and Precision, relative and standard deviation. Methods for minimizing errors. Criteria for rejection of an observation. Significant figures and computation rules.

#### Unit-II

**Precipitation:** Desirable properties of gravimetric precipitates. Formation of gravimetric precipitates. Conditions for quantitative precipitation. Contamination in precipitates. Methods for removing impurities in precipitates. Organic precipitants (oxime, dithiozone,  $\alpha$ -nitroso-(naphthol, cupferron, dimethyl glyoxime) in chemical analysis.

#### Unit-III

**Analytical Reagents:** Principles of qualitative and quantitative analysis; acid-base, oxidation-reduction and complexometric titrations using EDTA; Karl Fischer reagent and periodate in chemical analysis. precipitation reactions; use of indicators; use of organic reagents in inorganic analysis.

#### Unit-IV

**Solvent Extraction :** Distribution law, solvent extraction, equilibrium constant from distribution coefficient ( $KI + I_2 = KI_3$ ). Craig concept of counter-current distribution, Important solvent extraction systems.

**Radioanalytical Methods :** Elementary theory, isotope dilution and Neutron activation methods and applications, applications of isotopes.

#### Unit-V

**Chromatography :** Classification of chromatographic methods, general principle and application of adsorption, partition, ion-exchange, thin layer, column and paper chromatography. Elementary idea of HPLC, GC, GSC. TGA & DTA analysis.

#### Books Recommended

1. "Modern Methods of Chemical Analysis", R. L. Peacock, L. D. Shields, T. Cairns, and I. C. McWilliam, 2nd Edition (1976), John Wiley, New York.
2. "Basic Concepts of Analytical Chemistry", S. M. Khopkar, 2nd Edition (1998), New Age International Publications, New Delhi.
3. "Environmental Chemistry", A. K. De, 3rd Edition (1994), Wiley Eastern, New Delhi.
4. "Instrumental Methods of Analysis", H. H. Willard, L. L. Merritt, and J. A. Dean, 6th Edition (1986), CBS Publishers & Distributors, Shahdara, Delhi.
5. "Analytical Chemistry", G. D. Christian, 4th Edition (1986), John Wiley & Sons, New York.
6. "Principles and Methods of Chemical Analysis", H. F. Walton, 2nd Edition (1966), Prentice Hall, New Delhi

#### Mapping of CO-PO

Mapping Course Outcomes Leading To The Achievement Of Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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CO1	3	3	2	1	3	3	2	1	3	2
CO2	3	2	3	2	2	3	1	1	3	2
CO3	3	3	3	2	2	3	1	3	3	2
CO4	3	3	3	3	3	3	2	3	3	2

#### BCH014A: Estimations, Calibrations and Chromatographic analysis (Practical)

1. Calibration of weights and calculation of errors in it.
2. Prepare a standard solution of  $\text{Na}_2\text{CO}_3$  and standardize the given solution of  $\text{HCl}/\text{H}_2\text{SO}_4$
3. Prepare a standard solution of sodium oxalate and standardize given solution of  $\text{KMnO}_4$
4. Determine percentage purity of commercial sample of  $\text{NaOH}$
5. Prepare a standard solution of  $\text{K}_2\text{Cr}_2\text{O}_7$  and standardize given solution of  $\text{Na}_2\text{S}_2\text{O}_3$
6. Estimation of Barium as  $\text{BaSO}_4$  gravimetrically
7. Preparation of 0.1 N solution of  $\text{HCl}/\text{HNO}_3$  using density and percentage by weight and their standardization by using  $\text{Na}_2\text{SO}_3$
8. Prepare a calibration curve using  $\text{KMnO}_4$  and determine concentration in unknown given sample solution.
9. Prepare a calibration curve using  $\text{K}_2\text{Cr}_2\text{O}_7$  and determine concentration in unknown given sample solution.
10. Preparation of 0.05 N  $\text{H}_2\text{SO}_4$  using density and weight percentage and its standardization.
11. To separate the mixture of Methyl Orange and Methylene Blue by using cyclohexane and ethyl acetate(8.5:1.5) as solvent system by TLC.
12. To separate the mixture of Aldehyde and Ketones by TLC.
13. To separate the pigments from spinach leaves by column Chromatography.
14. Preparation and separation of 2,4-dinitro Phenylhydrazine of acetone , 2-butanone using toluene and petroleum ether(40:60).
15. To separate the mixture of D,L-alanine, glycine and L-leucine using n-butanol : acetic acid :water(4:1:5). Spray reagent- Ninhydrin.

### SEMESTER III

#### BCH015A

#### Coordination Chemistry and Organometallic Compounds

**Prerequisites:** Coordination compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds.

#### Course outcome

**CO1:** students will be able to identify common organic ligands used to construct coordination complexes and learn how certain ligands interact with transition metal, students will be able to explain the formation of metal ligand bonds, predict the geometry of molecules.

**CO2:** students will be able to relate electronic configuration to the basic magnetic properties of coordination complexes, calculate the spin only magnetic moment of simple coordination complexes.

**CO3:** students will be able to understand the classification, properties and applications of organometallic compounds, study the methods of preparations, properties, structure and bonding of metal carbonyls and metal clusters

**CO4:** students will be able to understand the role of metal in biological system.

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### Unit-I

**Coordination Compounds :** Werner's theory, nomenclature, chelates, stereo-chemistry of coordination numbers 4, 5 and 6. Various types of isomerism in coordination complexes. Important applications of coordination compounds. Theories of metal-ligand bonding in transition metal complexes- Sidgwick effective atomic number concept, valence bond theory of coordination compounds.

MIT : Principle of chemical science (fall 2014)

### Unit-II

**Theories of Metal-Ligand bonding :** Limitations of valence bond theory; Crystal-field theory and crystal-field splitting in octahedral and tetrahedral complexes; factors affecting the crystal-field parameters.

MIT : Principle of chemical science (fall 2014)

### Unit-III

**Magnetic Properties of Transition Metal Complexes :** Types of magnetic behaviour, methods of determining magnetic susceptibility, L-S and J-J coupling, orbital contribution to magnetic moments. Correlation of magnetic moment data and stereochemistry of Co(II) and Ni(II) complexes; anomalous magnetic moments.

### Unit-V

**Organometallic Chemistry :** Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyl and aryls of Li, Al, Hg, Sn, Ti. A brief account of metal-ethylenic complexes and homogeneous hydrogenation. Metal carbonyls : 7h EAN rule, classification of metal carbonyls, structures and shapes of metal carbonyls of V, Cr, Mn, Fe, Co and Ni.

### Unit-V

#### **Bioinorganic Chemistry:**

Essential and trace element in biological process, oxygen transport with reference to haemoglobin, biological role of alkali metals.

Metal ions present in biological systems, classification of elements according to their action in biological system. Sodium / K-pump,

carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals.

Iron and its application in bio-systems, Haemoglobin, Myoglobin.

#### **Books Recommended**

1. "Concise Inorganic Chemistry", J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. "Modern Inorganic Chemistry", R. C. Aggarwal, 1st Edition (1987), Kitab Mahal, Allahabad.
3. "Basic Inorganic Chemistry", F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
4. "Inorganic Chemistry", A. G. Sharpe, 3rd International Student Edition (1999), ELBS / Longman, U.K.
5. "Inorganic Chemistry", D. F. Shriver and P. W. Atkins, 3rd Edition (1999), ELBS, London.
6. "Organometallic Compounds" (Pragati Publications) **Indrajeet Kumar**



7. "Selected topics in inorganic chemistry" Dr. Wahid U. Malik, Dr. G. D. Tuli, Dr. R. D. Madan

### Mapping of CO-PO

#### Mapping Course Outcomes Leading To The Achievement Of Program Outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	-	1	2	1	2	3
CO2	3	3	3	1	1	1	3	1	2	2
CO3	2	3	3	1	1	1	2	1	3	3
CO4	3	2	-	1	3	-	2	1	3	2

0- Not related; 1- low; 2- medium; 3- high

#### **BCH016A: Quantitative analysis Lab-I**

1. To estimate Ni as Ni-DMG in given solution.
2. To estimate Cu as CuSCN in given solution.
3. Qualitative Analysis: Separation and determination of two metal ions Cu-Ni involving volumetric and gravimetric methods.
4. Qualitative Analysis: Separation and determination of two metal ions Ni-Zn involving volumetric and gravimetric methods.
5. Qualitative Analysis: Separation and determination of two metal ions Cu-Fe etc. involving volumetric and gravimetric methods.

#### **BCH017A Organic Chemistry III:**

##### **Organic compounds of Hydroxy, Carbonyl, Carboxylic acid functional groups & Biomolecules**

##### **Course outcomes (CO):**

At the end of this course student will be able to -

CO1: understand the synthesis and reactions of alcohols and phenols, their synthetic and industrial applications, their use as solvent and important synthetic reagents.

CO2: understand the preparations, reactions and properties of carbonyl compounds (aldehydes and ketones), carboxylic acid and its derivatives.

CO3: apply the knowledge of oxygen containing compounds in industrial applications of various synthetic, condensation and polymerization reactions.

CO4: demonstrate an understanding of fundamental of structure/function of biomolecules viz. amino acids, proteins, enzymes, nucleic acids and DNA.

##### **Unit I:**

##### **Alcohols**

*[Handwritten signatures and initials are present in this section, including "Am", "D", "A", "S", "dy", and "SS"]*



Classification and nomenclature. Monohydric alcohols - Nomenclature, Method of formation by Reduction of aldehydes, Ketones, Carboxylic acids and esters, Hydrogen bonding. Acidic nature. Reactions of alcohols.

Dihydric Alcohols - Nomenclature, methods of formation, Chemical reaction of vicinal glycols, Oxidative-Cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol-pinacolone rearrangement. Trihydric Alcohols - Nomenclature and methods of formation, chemical reactions of glycerol.

## Unit II:

### Phenols

Nomenclature, Structure and bonding. Preparation of Phenols, Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, Resonance stabilization of phenoxide ion. Reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis. Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann Reaction.

## Unit III:

### Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl, Aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketone, Cannizzaro's reaction, MPV, Clemmensen, Wolff-Kishner,  $\text{LiAlH}_4$  reductions.

## Unit IV:

### Carboxylic Acids & Derivatives

Nomenclature structure and bonding, Physical properties, Acidic nature of carboxylic acids, Effect of substituents on acid strength. preparation of carboxylic acids. Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction.

Structure and nomenclature of acid chlorides, esters, amides and acid-anhydrides. Relative stability and reactivity of acid derivatives. physical properties, Inter conversion of acid derivatives by nucleophilic acyl substitution. preparation of carboxylic acid derivatives, chemical reactions. mechanism of esterification and hydrolysis (Acidic and Basic)

## Unit V:

Amino Acids: Classification, structure and stereochemistry of amino acids. Acid-base behavior,



isoelectric point and electrophoresis. Preparation and reactions of  $\alpha$ -amino acids.

**Peptides and Proteins:** Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure, Protein denaturation/renaturation.

**Nucleic Acids:** Introduction. constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

**Books Suggested:**

1. A Text Book of Organic Chemistry: K. S. Tiwari, S. N. Mehrotra and N. K. Vishnoi
2. Modern Principles of Organic Chemistry: M. K. Jain & S. C. Sharma
3. A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal
4. A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl
5. Organic Chemistry by Morrison & Boyd, Prentice Hall
6. A Text Book of Organic Chemistry: P. L. Soni
7. Organic Chemistry: (Vol. I, II & III) S. M. Mukherji, S. P. Singh and R. P. Kapoor

**Mapping of CO-PO**

**Mapping Course Outcomes Leading To The Achievement Of Program Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	1	3	2
CO2	2	2	1	2	2		2	3	2	2
CO3	3	2	3	2	1	1	2		3	1
CO4	3	2	2	3	2	1	2	2	3	2

**BCH018A: Organic preparation & Binary Mixture Analysis lab**

1. To separate and identify the organic mixture containing two solid components using water and prepare their suitable derivatives.
2. To separate and identify the organic mixture containing two solid components using water and prepare their suitable derivatives.
3. To separate and identify the organic mixture containing two solid components using hot water and prepare their suitable derivatives.
4. To separate and identify the organic mixture containing two solid components using NaOH and prepare their suitable derivatives.
5. To separate and identify the organic mixture containing two solid components using NaOH and prepare their suitable derivatives.
6. To separate and identify the organic mixture containing two solid components using  $\text{NaHCO}_3$  and prepare their suitable derivatives.
7. To separate and identify the organic mixture containing two solid components using  $\text{NaHCO}_3$  and prepare their suitable derivatives.

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## BCH019A: Physical Chemistry-3-Quantum Mechanics and Phase Equilibria

The student will be able to-

CO1: Understand fundamental concepts of quantum Chemistry.

CO2: Describe application of phase equilibrium and phase diagram.

CO3 : Understand thermodynamics of mixing in solutions and applications of nuclear chemistry.

CO4 : Explain terms involved and thermodynamics in chemical equilibrium

### Unit-I

#### Elementary quantum mechanics:

Black-body, radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Compton effect. De-Broglie hypothesis. Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.

### Unit II

#### Phase Equilibria and Photochemistry:

Phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one component systems (water and sulfur), condensed phase rule, two component systems (phenol-water, lead-silver, tin-magnesium). Law of photochemical equivalence, quantum efficiency, reasons for low and high quantum efficiency. Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized Reactions.

MIT- Phase rule, phase diagrams of one component systems (water and sulfur), condensed phase rule.

### Unit-III

#### Thermodynamics of Solutions:

Partial molar quantities, chemical potential, the Gibbs-Duhem equation, fugacity, activity and activity coefficient (concept and physical significance), reference and standard states. Lewis-Randall rule, thermodynamic functions of mixing ( $DG_{mix}$ ,  $DS_{mix}$ ,  $DV_{mix}$ ,  $DH_{mix}$ ).

### Unit IV

#### Nuclear Chemistry:

Isotopes, their separation and applications. Nuclear forces, nuclear binding energy, stability of nucleus, energy changes in nuclear reactions, nuclear fission and fusion. Uses of nuclear radiations (radiation, sterilization, radiation energy for chemical synthesis). Radio isotopes as a source of electricity.

### Unit-V

#### Chemical Equilibrium:

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Temperature dependence





of equilibrium constant; Vant Hoff reaction isochor, Van't Hoff reaction isotherm. Le-Chatelier's principle and its applications, Clausius Clapeyron equation its applications. Nernst distribution law – Its thermodynamic derivation, Modification of distribution law when solute undergoes dissociation, association and chemical combination.

**MIT- Clausius Clapeyron equation its applications.**

#### BOOKS:

1. "Physical Chemistry", P. C. Rakshit, 5th Edition (1985), 4th Reprint (1997), Sarat Book House, Calcutta.
2. "Principles of Physical Chemistry", B. R. Puri, L. R. Sharma, and M. S. Pathania, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar.
3. D A McQuarrie, Introduction to Quantum Chemistry
4. Introduction to Quantum Mechanics by Pauling and Wilson
5. Quantum Mechanics by Griffiths.
6. Text Book of Physical Chemistry by Samuel Glasstone
7. Essentials of Nuclear Chemistry By H.J. Amikar, New Age International,

#### Mapping of CO-PO

**Mapping Course Outcomes Leading To The Achievement Of Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								2
CO2	3	3	2	2	1		2	2		2
CO3	3	3					1	1		2
CO4	3	3	1	2			1	2		2

#### **BCH 020A: Conductometric analysis & Kinetic study Lab**

1. To determine the specific reaction rate of the hydrolysis of methyl or ethyl acetate catalysed by HCl at room temperature.
2. To determine the specific reaction rate of the hydrolysis of methyl or ethyl acetate catalysed by  $H_2SO_4$  at room temperature and compare the relative strength of acids.
3. To determine the specific reaction rate of the hydrolysis of methyl or ethyl acetate catalysed by HCl at  $40^\circ C$ ,  $45^\circ C$  and  $50^\circ C$  and calculate energy of activation graphically as well as employing the rate constant relationship with energy of activation.
4. To prepare colloidal solution of arsenious sulphide.
5. To study the reaction rate of decomposition of iodide by  $H_2O_2$  Kinetically.
6. To study the hydrolysis of methyl acetate catalysed by HCl solution and equinormal solution of urea hydrochloride and determines the degree of hydrolysis of the salt.
7. To determine the relative strength of acids ( $HCl, H_2SO_4$ ) during hydrolysis of an ester.
8. To study neutralization reaction of strong acid and strong base by conductometric method
9. To study neutralization reaction of strong acid and weak base by conductometric method
10. To study neutralization reaction of weak acid and strong base by conductometric method

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## SEMESTER IV

### BCH021A: Organic Chemistry IV: Organic Compounds of Nitrogen, Heterocyclic & Photochemistry

#### Course outcomes (CO)

At the end of this course student will be able to -

CO1: know the different methods used in synthesis, reactions, classification, physical and chemical properties of amines and nitro compounds with their industrial applications.

CO2: understand the synthesis and reaction of 5, 6 member and condensed heterocyclic systems along with their industrial and medicinal applications.

CO3: identify and write type of mechanisms involved in photochemical reactions, synthesis, Jablonski diagram and applications of various photochemical reactions.

CO4: recognize the structure, physical, chemical properties, synthesis and various reactions of enolates.

#### Unit I

##### Organic Compounds of Nitrogen:

Preparation of nitro alkanes and nitro arenes. Chemical Reactions of Nitro alkanes. Mechanism of nucleophilic substitution in nitro arenes and their reduction in acidic, neutral and alkaline media. Reactivity, Structure and nomenclature of amines, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Amine salts as phase-transfer catalysts. Gabriel-Phthalimide reaction, Hofmann bromamide Reaction. Reactions of amines. Electrophilic Aromatic substitution in arylamines, Reactions of amines with nitrous acid. Synthetic transformations of aryl-diazonium salts, azo coupling.

#### Unit II

##### Heterocyclic Compounds I:

Introduction, Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions, with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

#### Unit III

##### Heterocyclic Compounds II:

Introduction to condensed five and six-membered heterocycles. Preparation and reactions of indole, quinuclidine and isoquinoline. Mechanism of electrophilic substitution reactions of indole, quinuclidine and isoquinoline.

#### Unit IV

##### Organic Photochemistry:

Photochemical energy plank Condon Principle, Jablonski diagram singlet and triplet states,

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dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield, experimental methods of photochemistry.

Photochemistry of carbonyl compounds-  $n-\pi$ ,  $\pi-\pi^*$  transitions Norrish type I and Norrish type II cleavages, Paterno-Buchi reaction.

#### Unit V

##### Organic Synthesis *via* Enolates:

Acidity of  $\alpha$ -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

##### Books Suggested :

1. Organic Chemistry, Morrison and Boyd, Prentice Hall.
2. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
3. Fundamentals of Organic Chemistry, Solomons, John Wiley.
4. Organic Chemistry Vol. I, II, III S.M. Mukerji, S.P. Singh and R.P. Kappor, Wiley Eastern Ltd. (New Age International)
5. Organic Chemistry, F.A. Carey, McGraw Hill, Inc.
6. Introduction to Organic Chemistry, Streitwieser, Heathcock and Kosover. Macmillan.
7. Organic Chemistry (Vol. I & II) : S. M. Mukherji, S. P. Singh and R. P. Kapoor, Wiley Eastern Ltd.
8. A Text Book of Organic Chemistry (Vol. I & II) : K. S. Tiwari, S. N. Mehrotra & N. K. Vishnoi

##### Mapping of CO-PO

##### Mapping Course Outcomes Leading To The Achievement Of Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	2	2	2	2	1	3	2
CO2	3	2	1	2	2		2	2	2	1
CO3	3	3	2	1	2	1	2		3	2
CO4	2	1	2	2	2	1	1	1	1	

##### BCH022A: Organic Synthesis and Chromatography Lab

1. To prepare acetanilide from aniline (Acetylation).
2. To prepare phenyl benzoate from phenol (Benzoylation).
3. To prepare Iodoform from ethanol and acetone. (Aliphatic Electrophilic Substitution).
4. To prepare m-dinitro benzene from nitro benzene.
5. To prepare p-nitro acetanilide from acetanilide
6. To prepare Benzoic acid from toluene.
7. To separate the mixture of Methyl Orange and Methylene Blue by using cyclohexane and ethyl acetate (8.5:1.5) as solvent system by TLC.





9. To separate the mixture of Aldehyde and Ketones by TLC.
10. To separate the pigments from spinach leaves by column Chromatography.
11. Preparation and separation of 2,4-dinitro Phenylhydrazones of acetone, 2-butanone using toluene and petroleum ether (40:60).
12. To separate the mixture of D,L-alanine, glycine and L-leucine using *n*-butanol : acetic acid : water (4:1:5). Spray reagent- Ninhydrin.
13. To separate monosaccharides – a mixture of D-galactose and D-fructose using *n*-butanol : acetone : water (4:1:5). Spray reagent – aniline hydrogen phthalate.
14. Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination

### SEMESTER V

#### BCH023A: Organic Chemistry V: Spectroscopy

##### Course outcomes (CO):

At the end of this course student will be able to -

CO1: knowledge about the interactions of electromagnetic radiation and matter and their applications in spectroscopy.

CO2: Principles and applications of Atomic Spectroscopy, AAS, FES, ICPES, UV-Visible, IR, Raman, NMR and analyze the data for the structure determination and chemical analysis.

CO3: Apply appropriate techniques for the qualitative and quantitative analysis by working in the interdisciplinary and multidisciplinary areas of chemical and biological sciences.

CO4: Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution).

##### Unit I:

##### Atomic Spectroscopy

Electromagnetic radiations, concept of electromagnetic spectrum. Introduction of Absorption and Emission spectroscopy. Principle of Flame Emission Spectroscopy (FES) and Atomic absorption Spectroscopy (AAS), comparison, instrumentation and applications, Burners (Total consumption burner and Premix burners), Inductively coupled plasma Emission Spectroscopy (ICPES)

##### Unit II:

##### Ultraviolet and Visible Spectrophotometry

Origin of UV Spectra, Principle, instrumentation, Electronic transition ( $\sigma \rightarrow \sigma^*$ ,  $n \rightarrow \sigma^*$ ,  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$ ), relative positions of  $\lambda_{\max}$  considering conjugative effect, steric effect, solvent effect (with reference to  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$  transitions), red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples). Aromatic and Polynuclear aromatic hydrocarbons. Woodward-Fiesher rules for Dienes and enones and calculation of  $\lambda_{\max}$ . Problems of aromatic ketones, aldehydes and esters using empirical rules.

##### Unit III:

##### Infrared Spectroscopy

Introduction, principle of IR spectroscopy, instrumentation, sampling techniques, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies.

Applications. Application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; factors affecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size).

### Raman Spectra

Basic principle, Instrumentation, Application of Raman spectra, Comparison of IR and Raman Spectra

### Unit IV:

### Nuclear Magnetic Resonance

Principle, Magnetic and nonmagnetic nuclei, absorption of radio frequency. Equivalent and nonequivalent protons, chemical shifts, shielding and De-shielding effects, anisotropic effect, relative strength of signals, spin-spin coupling, long range coupling, coupling constant, applications to simple structural problems, Phenomenon of Chemical Exchange.

### Unit V:

### Rotational Spectroscopy

Diatomic molecules, energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length; qualitative description of non-rigid rotor, isotope effect.

### BOOKS:

1. Spectrometric Identification of Organic Compounds: Robert M. Silverstein, Francis X. Webster, David Kiemle Wiley; 7<sup>th</sup> Edition.
2. Applications of spectroscopic techniques in Organic Chemistry: P.S. Kalsi, New Age International; 6th Edition.
3. Elementary Organic Spectroscopy; Principles And Chemical Applications: Y. R. Sharma, S. Chand & Co Pvt Ltd.
4. Fundamentals of Molecular Spectroscopy: C. M. Banwell and E. McCash, Tata McGraw Hill, 4<sup>th</sup> Edition.
5. Organic spectroscopy by William Kemp

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2		2	1	2	2	3	2
CO2	3	2	3	2	2		3	3	3	3
CO3	2	3	2	2	2	2	3	2	3	3
CO4	2	2	2	2	2		1	2		1

*Dem*  
*h*  
*Q*  
*Am*  
*dr*  
*AV*  
*95*  
*in*  
*Michael*  
*Sh*



1. To identify the following functional group in the given compounds by IR spectroscopy:  $\text{-OH}$ ,  $\text{-NH}_2$ ,  $\text{-NO}_2$ ,  $\text{-COOH}$ ; Hydrogen Bonding (Intermolecular and Intramolecular)
2. To Identify the compound by U.V Spectroscopy containing:  $\pi$  -Bonding;  $\pi$  -Conjugation; Aromaticity
3. Elucidate the structure of given unknown organic compound by NMR spectroscopy.
4. To calculate the molecular mass of unknown organic molecules.
5. To draw spectral absorption curve for given substance ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) using spectrophotometer and determine the wavelength for maximum absorption.
6. To draw spectral absorption curve for given substance ( $\text{KMnO}_4$ ) using spectrophotometer and determine the wavelength for maximum absorption.
7. To determine the concentration of unknown solution by verifying Lambert Beer's Law for  $\text{K}_2\text{Cr}_2\text{O}_7$ .
8. To determine the concentration of unknown solution by verifying Lambert Beer's Law for  $\text{KMnO}_4$ .

Done

A 2/11/11

Sh



✓

Q

Answer

Integral



## Discipline Specific Electives (DSE)

### DSE-1: BCH025A: GREEN CHEMISTRY

#### Course outcomes (CO)

At the end of this course student will be able to -

CO1: understand the basic concept of green chemistry and future trends

CO2: get idea about solvent selection

CO3: understand the reactions in MW and ultrasound

CO4: analyze the important catalysts in green synthesis

#### Unit-I

##### Introduction, Principle & Concepts of Green Chemistry:

What is green chemistry? Need for green chemistry; inception and evolution of green chemistry; Twelve principles of green chemistry with their explanations and examples; designing a green synthesis using these principles; green chemistry in day to day life.

#### UNIT-II

Selection of solvent : Aqueous phase reactions ii) Reactions in ionic liquids, Heck reaction, Suzuki reactions, epoxidation. iii) Solid supported synthesis

Super critical CO<sub>2</sub>: Preparation, properties and applications, (decaffeination, dry cleaning)

#### UNIT-III

Microwave and Ultrasound assisted green synthesis: Apparatus required, examples of MAOS (synthesis of fused anthro quinones, Leukart reductive amination of ketones) - Advantages and disadvantages of MAOS. Aldol condensation-Cannizzaro reaction-Diels-Alder reactions-Strecker's synthesis

#### UNIT-IV

Green catalysis: Heterogeneous catalysis, use of zeolites, silica, alumina, supported catalysis-biocatalysis: Enzymes, microbes Phase transfer catalysis (micellar/surfactant)

Examples of green synthesis / reactions and some real world cases: 1. Green synthesis of the following compounds: adipic acid, catechol, disodium imino di acetate (alternative Strecker's

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synthesis) 2. Microwave assisted reaction in water – Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols – microwave assisted reactions in organic solvents. Diels-Alder reactions and decarboxylation reaction. 3. Ultrasound assisted reactions – sonochemical Simmons-Smith reaction (ultrasonic alternative to iodine)

#### UNIT-V

**Future trends in Green Chemistry:** Oxidation-reduction reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Noncovalent derivatization. Biomass conversion, emission control. Biocatalysis

#### Reference books:

1. Green Chemistry Theory and Practice. P.T. Anatas and J.C. Warner
2. Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
3. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
4. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
5. Green Chemistry: Introductory Text, M.Lancaster
6. Principles and practice of heterogeneous catalysis, Thomas J.M., Thomas M.J., John Wiley
7. Green Chemistry: Environment friendly alternatives R S Sanghli and M.M Srivastava, Narosa Publications

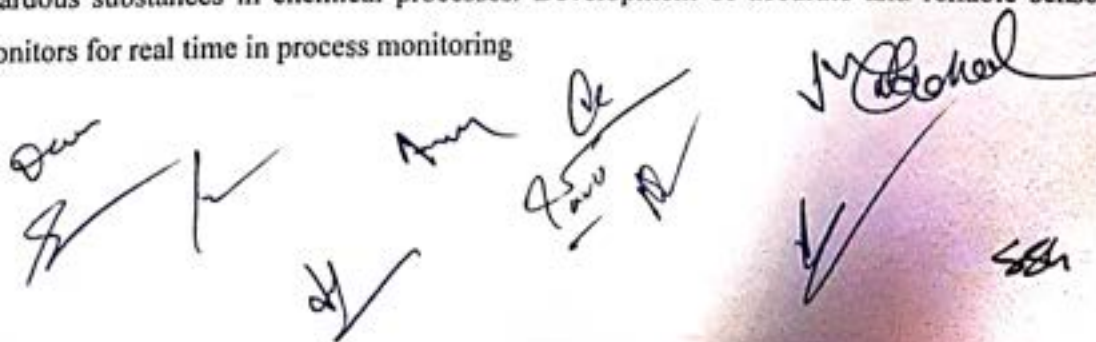
#### BCH026A: GREEN CHEMISTRY Lab

1. Green procedure for organic qualitative analysis: Detection of N, S and halogens
2. Acetylation of 10 amine by green method: Preparation of acetanilide
3. Rearrangement reaction in green conditions: Benzil-Benzilic acid rearrangement
4. Electrophilic aromatic substitution reaction: Nitration of phenol
5. Radical coupling reaction: Preparation of 1,1-bis-2-naphthol
6. Green oxidation reaction: Synthesis of adipic acid
7. Green procedure for Diels Alder reaction between furan and maleic anhydride

#### Seminar

**Basic principles of Green Chemistry and their illustrations with examples.**

- (i) Prevention of waste/byproducts.
- (ii) Maximum Incorporation of the materials used in the process into the final product (Atom Economy): Green metrics
- (iii) Prevention/Minimization of hazardous/toxic products.
- (iv) Designing safer chemicals - different basic approaches
- (v) Selection of appropriate auxiliary substances (solvents, separation agents etc)
- (vi) Energy requirements for reactions—use of microwave, ultrasonic energy
- (vii) Selection of starting materials—use of renewable starting materials.
- (viii) Avoidance of unnecessary derivatization—careful use of blocking/protection groups.
- (ix) Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents.
- (x) Designing biodegradable products.
- (xi) Prevention of chemical accidents.
- (xii) Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Development of accurate and reliable sensors and monitors for real time in process monitoring



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## Industrial Chemistry BCE027A – BCE036A

**Prerequisites:** All the Concepts of Inorganic, organic and Physical Chemistry, Basics of Environmental Science

**Paper-I** Industrial Aspects of Chemistry

**Paper-II** Fossil fuels, Cleansing agents, Oils and Fats

**Paper-III** Pharmaceuticals, Fermentation, Pesticides & Perfumes

**Paper IV** Processes in Organic Chemicals Manufacture.

**Paper-V** Chemical Process: Economics and Entrepreneurship.

**Paper-VI** Green Chemistry

### BCE027A: Paper I: Industrial Aspects of Chemistry

#### Course Outcome:

After completion of this course student will be able to -

**CO1:** Understand the problems generated by impure water in industries and treatment methods.

Student will also understand the relation between corrosion and its threats to Industry

**CO2:** Learn and understand about the earthen materials and their manufacturing process.

**CO3:** Understand about Fertilizers

**CO4:** Understand about dyes

#### Unit-I

##### Industrial Water and Its Analysis:

Hardness of Water, Disadvantages of Hard Water, Temporary and Permanent hardness. Units and inter conversions of Units. Estimation of hardness by EDTA Methods. Water for Industrial purpose, Water for Steam Making-Boiler Troubles, Carry Over, Priming and Foaming, Boiler Corrosion, Scales and Sludges, Caustic Embrittlement.

**Water Treatment:** Internal Treatment methods, External Treatment methods, Lime-Soda Process, Zeolite Process, Ion- Exchange Process, Numerical Problems on EDTA Methods and Lime-Soda process.

#### Unit-II

##### Corrosion

Definition, Examples, Types of Corrosion: Theories of Corrosion and Mechanism - Dry Corrosion, (Direct Chemical attack), Wet Corrosion, (Electro Chemical Theory), Principles of Corrosion, Galvanic Series, Galvanic Corrosion, Concentration Cell Corrosion, Mechanism of Wet Corrosion - Hydrogen evolution type, Oxygen absorption type. Factors Influencing Corrosion. Control of Corrosion - Proper Design, use of pure metal and metal alloys, Passivity, Cathodic Protection - Sacrificial anode and Impressed Current. Modifying the Environment, use of Inhibitors. Types of Protective Coatings: Metallic Coatings - Anodic Coatings, Galvanization, Cathodic Coatings - Tinning, Metal Cladding, Electroplating Ex: Chromium Plating, Metal Spraying, Cementation, Colorizing, Chromizing. Chemical Conversion Coatings: (1) Phosphate (2) Chromate (3) Anodized Coatings. Corrosion inhibitors, their types and mechanisms.

#### Unit-III

**Glass:** Glassy state and its properties, classification (silicate and non-silicate glasses).

Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

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**Ceramics:** Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

**Cements:** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

#### UNIT – IV

##### Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

##### Unit-V

**Synthetic Dyes:** Colour and constitution (electronic concept). Classification of dyes. Synthesis of Methyl orange. Congo red. Malachite green. Crystal violet, Phenolphthalein. Fluorescein. Alizarin and Indigo

##### BCE028A: Lab

1. To determine the hardness of Water by complexometric method.
2. To determine the amount of free chlorine in given water sample.
3. Determination of Total residual Chlorine in water sample.
4. To standardize pH by buffer solution and determine pH of different given water samples.
5. To determine the conductivity of different given water samples.
6. To measure dissolved oxygen in water.
7. To measure Total Solid in sewage.
8. Analysis of fertilizers: urea, NPK fertilizer, super phosphate,
9. Analysis of DDT, BHC, eldrin, endosulfone, malathion, parathion.,
10. Analysis of cement- loss on ignition, insoluble residu, total silica, sesqui oxides, lime, magnesia, ferric oxide, sulphuric anhydrid.
11. Analysis of glasses - Determination of silica, sulphuur, barium, arsinic, antimony, total R2O3, calcium, magnesium, total alkalies, aluminium, chloride, floride
12. Bleaching of Dyes by Photoxidation

##### Mapping of CO-PO

##### Mapping Course Outcomes Leading To The Achievement Of Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2	2	1	1	2	3	3
CO2	3	3	1	2	2	1	1	2	2	3
CO3	3	3	1	2	2	1	1	2	2	3
CO4	3	3	1	2	2	1	1	2	2	3

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### Suggested Readings

1. B.K. Sharma, "Industrial Chemistry", Krishna Prakasam Media (P) Ltd., Meerut, 2001.
2. A text book of Engineering Chemistry by Jain & Jain, Dhanpat Rai Publishing Company, New Delhi (15 Edition) (2006).
3. Chemistry of Engineering Materials by C.P. Murthy, C.V. Agarwal and A. Naidu BS Publication Hyd. 2007.
4. Engineering Chemistry by J C Kuriacose and J. Rajaram, Tata McGraw-Hill Co, New Delhi (2004)
5. Organic Chemistry by Morrison&Boyd, Prentice Hall.

### BCE029A: Paper-II Industrial Chemistry-II: Fossil fuels, cleansing agents, oils and fats

#### Course Outcome:

After completion of this course student will be able to -

CO1: Understand about the Industrial fuel coal

CO2: Learn and understand about the petrochemical products and Lubricants

CO3: Understand about Fats and oil

CO4: Understand about food additives

#### Unit-I

##### Fuel Chemistry

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

**Coal:** Uses of coal (fuel and non-fuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro Gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

#### Unit-II

**Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

#### UNIT-III

**Lubricants:** Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pour point) and their determination.

#### Unit-IV

##### Oils and Fats

Classification of oils, fat splitting, distillation of completely miscible and nonmiscible oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, Soap and Synthetic Detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS,

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LABS), detergent binders and builders.

#### Unit-V

##### Food additives

A general study of food flavours, colours and preservatives, artificial sweetners.

#### BCE030A: Lab

1. To determine moisture, volatile and ash content in a given coal sample by proximate analysis.
2. To determine the calorific value of Solid Fuel by Bomb's Calorimeter
3. Testing of turmeric powder, milk and mustard oil for adulterants.
4. Estimation of glucose in food samples.
5. Extraction of natural coloring and flavoring agent from flowers and fruits
6. Estimation of hardness of water by titration with soap solution.
7. Estimation of Available Oxygen in Hydrogen Peroxide.
8. Preparation of soap.
9. Determination of Viscosity of a given lubricant by Redwood Viscometer No.1.
10. Determination of Flash and Fire Points of a given lubricant by Pensky Martin Apparatus.
11. Determination of Cloud and Pour Points of a given lubricant.

#### Suggested Readings

1. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., New Delhi.
2. S. C. Bhatia: *Chemical Process Industries*, Vol. I & II, CBS Publishers, New Delhi.
3. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
5. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut.

#### Mapping of CO-PO

#### Mapping Course Outcomes Leading to the Achievement of Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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CO4	3	3	1	2	2	1	1	2	2	3

#### BCE031A: Paper -III PHARMACEUTICALS, FERMENTATION, PESTICIDES & PERFUMES

##### Course Outcome:

After completion of this course student will be able to -

CO1: Understand about drug designing, synthesis of drugs and their effects and will be able to think creatively about novel drug designing

CO2: Learn and understand the chemistry of cosmetics and perfumes.

CO3: Learn and understand the chemistry of pesticides

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**CO4:** Understand about the working of fermentation Industries and polymer Industries.

#### **Unit-I Drugs and Pharmaceuticals**

Drug discovery, design and development; Basic Retrosynthetic approach.

Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIVAIDS related drugs (AZT- Zidovudine).

#### **Unit-II Cosmetics and Perfumes**

A general study including preparation and uses of the following: Hair dye, hair spray, Shampoo, Sun-tan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil,  $\alpha$ -phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

#### **Unit-III Pesticides**

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

#### **Unit-IV Fermentation Industries**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Pencillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamine B2 Vitamine B12 and Vitamine C.

**Unit-V Inorganic Polymers:** Classification, preparation, properties and uses of boron containing polymers, phosphorus containing polymers, silicon containing polymers, Silicones (fluid, elastomers and resins) and sulphur containing polymers (SN)x.

#### **BCE032A: PRACTICAL INDUSTRIAL CHEMISTRY**

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of Aspirin and its analysis.
7. Preparation of nail polish and nail polish remover.
8. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
9. Preparation of simple organophosphates, phosphonates and thiophosphates
10. Preparation of Magnesium bisilicate (Antacid).

#### **Suggested Readings**

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.

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2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.
4. G.L. Patrick: *Introduction to Medicinal Chemistry*, Oxford University Press, UK.
5. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
6. R. Cremllyn: *Pesticides*, John Wiley.
7. William O. Foye, Thomas L., Lemke, David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt Ltd. New Delhi.

#### Mapping of CO-PO

Mapping Course Outcomes Leading to The Achievement of Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2	2	1	1	2	2	3
CO2	3	3	1	2	2	1	1	2	2	3
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CO4	3	3	1	2	2	1	1	2	2	3

#### **BCE033A: PAPER-IV Processes in Organic Chemicals Manufacture.**

##### **Course Outcome:**

After completion of this course student will be able to -

**CO1:** Understand about the importance of Nitration, amination and halogenations.

**CO2:** Learn and understand about the importance of oxidation.

**CO3:** Understand about the importance of Hydrogenation.

**CO4:** Understand about the importance of Esterification.

##### **Unit-I**

**Nitration:** Introduction, nitrating agents, mechanism and nitration of paraffin hydrocarbons - benzene to nitrobenzene, m-dinitrobenzene, chlorobenzene to o & p-nitrochlorobenzenes. Acetanilide to p-nitro acetanilide, toluene, continuous v/s batch nitration. Amination

By reduction: Introduction, methods of reduction, metal and acid, catalytic sulfide, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal, conc. Caustic oxidation-reduction. Commercial manufacture of aniline, m-nitroaniline, p-aminophenol. By aminolysis: Introduction, aminating agents, factors affecting.

##### **Unit-II**

**Halogenation:** Introduction, reagents for halogenations, halogenations of aromatics - side chain and nuclear halogenations, commercial manufacture of chlorobenzene, chloral, monochloroacetic acid and chloromethanes. Sulphonation: Introduction, sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, alkyl benzene, batch Vs continuous sulphonation.

##### **Unit-III**

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**Oxidation:** Introduction, types of oxidation reactions, oxidizing agents, mechanism of oxidation, liquid phase oxidation and vapour phase oxidation, commercial manufacture of benzoic acid, maleic anhydride, phthalic anhydride, acetaldehyde, acetic acid.

#### Unit-IV

**Hydrogenation:** Introduction, catalysts for hydrogenation reactions, hydrogenation of vegetable oil, manufacture of methanol from carbon monoxide and hydrogen, catalytic reforming. **Alkylation:** Introduction, types of alkylation, alkylating agents, mechanism of alkylation reactions, manufacture of phenyl ethyl alcohol and ethyl benzene.

#### Unit-V

**Esterification:** Introduction, esterification by organic acids, by addition of unsaturated compounds, esterification of carboxy acid derivatives, commercial manufacture of ethyl acetate, vinyl acetate and cellulose acetate.

### BCE034A: PRACTICAL INDUSTRIAL CHEMISTRY

1. Synthesis of common industrial compounds involving two step reactions, e.g. 4-bromo aniline, 3-nitroaniline, sulphanilamide, 4-amino benzoic acid, 4-nitro benzoic acid, dihalobenzenes, nitrohalobenzenes, paracetamol, oils of winter green.
2. Determination of acid value, Iodine value and saponification value.
3. Industrial analysis – analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.
4. Identification of drugs by TLC
5. Estimation of amino acid.
6. Estimation of amino group.

#### Suggested Readings:

##### Books Suggested:

1. A Text Book of Organic Chemistry: K. S. Tiwari, S. N. Mehrotra and N. K. Vishnoi
2. Modern Principles of Organic Chemistry: M. K. Jain & S. C. Sharma
3. A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal
4. A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl
5. Organic Chemistry by Morrison & Boyd, Prentice Hall
6. A Text Book of Organic Chemistry: P. L. Soni
7. Organic Chemistry: (Vol. I, II & III) S. M. Mukherji, S. P. Singh and R. P. Kapoor
8. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Prentice Hall
9. Advanced Organic Chemistry Reactions, Mechanisms, and Structure by Jerry March (4 Edition)

#### Mapping of CO-PO

#### Mapping Course Outcomes Leading To The Achievement of Program Outcomes

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CO4	3	3	1	2	2	1	1	2	1	3

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**BCE035A: Paper-V Chemical Process: Economics and Entrepreneurship.****Course Outcome:**

After completion of this course student will be able to -

CO-1: understand about the marketing, cost estimation method of project, choice of Technology, plant layout etc.

CO2: Understand about the entrepreneurship, export and import strategy

CO3: Understand about accounting, fund flow and resource management.

CO4: Understand about the quality control, assurance and also about factory rules.

**Unit-I** Factors involved in project cost estimation; methods employed for the estimation of capital investment. Capital formation, elements of cost accounting. Interest and investment costs, time value of money equivalence. Depreciation, methods of determining depreciation. Some aspects of marketing, pricing policy, profitability criteria, economics of selecting alternatives, variation of cost with capacity, break-even point, optimum batch sizes, production scheduling etc.

**Unit-II** Need, scope and characteristics of entrepreneurship, special schemes for technical entrepreneur's development (STED), exposure to demand based, resource based, service based. Import substitute and export promotion industries, criteria for principles of products selection and developments.

**Unit-III** Choice of technology: plant and equipments. Techno-economic feasibility of the projects. Plant layout and process planning for the project.

**Unit-IV** Financial Institutions, their procedure and incentives, financial ratio and their significance. Books of accounts, financial statements and Funds flow analysis.

Energy requirement and utilization. Resources management: men, machine and materials.

**Unit-V** Quality control, quality assurance and testing of the product. Packaging and advertising. After sales service. Licensing and registration. Important provisions of Factory Act, sales of goods Act, partnership Act.

**BCE036A: Lab: Case studies and Seminars on Industrial Chemistry****Suggested Readings****Mapping of CO-PO****Mapping Course Outcomes Leading to The Achievement Of Program Outcomes**

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CO2	1	3	2	2	3	1	3	3	1	3
CO3	1	3	2	2	3	1	3	3	1	3
CO4	1	3	2	2	3	1	3	3	3	3

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## DSE- 3 PHARMACEUTICAL CHEMISTRY BCH0037A – BCH046A

Paper-I Inorganic Pharmaceutical Chemistry

Paper-II Biochemistry

Paper-III Medicinal Chemistry – I: Basic of Pharmaceuticals

Paper IV Indian traditional food storage practices and their relevance

Paper-V Food Standards, Quality Assurance and Evaluation

Paper-VI Green Chemistry

### BCH037A: Paper-I Inorganic Pharmaceutical Chemistry

An outline of methods of preparation, uses, sources of impurities, tests for purity and identity, including limit tests for iron, arsenic, lead, heavy metals, chloride, sulphate and special tests if any, of the following classes of inorganic pharmaceuticals included in Indian Pharmacopoeia

Course outcomes (CO):

At the end of this course student will be able to -

CO-1: understand about acids, bases, buffers and gastrointestinal agents and know about cationic and anionic components of inorganic drugs useful for systemic effects.

CO-2: develop a sound understanding about optical agents, anesthetics and respiratory stimulants.

CO-3: apply the knowledge on dentifrice, anti-caries agents, complexing and chelating agents used in therapy miscellaneous agents.

CO-4: Understand nuclear radio pharmaceuticals, reactions and nomenclature.

#### UNIT-I

Acids and Bases: Buffers, Water. Gastrointestinal Agents: Acidifying agents, Antacids, Protectives and Adsorbents, Cathartics. Major Intra-and Extra-cellular Electrolytes: Physiological ions. Electrolytes used for replacement therapy, acid-base balance and combination therapy.

#### UNIT-II

Essential and Trace Elements: Transition elements and their compounds of Pharmaceutical importance: Iron and haematinics, mineral supplements.

Cationic and anionic components of inorganic drugs useful for systemic effects.

#### UNIT-III

Optical Agents: Protectives, Astringents and Anti-infectives. Gases and Vapours : Oxygen, Anesthetics and Respiratory. Stimulants.

#### UNIT-IV

Dental Products: Dentifrice, Anti-caries agents. Complexing and chelating agents used in therapy Miscellaneous Agents: Sclerosing agents, expectorants, emetics, poisons and antidotes, sedatives etc. Pharmaceutical Aids Used in Pharmaceutical Industry. Anti-oxidants, preservatives, filter aids, adsorbents, diluents, excipients, suspending agents, colorants etc.

#### UNIT-V

Inorganic Radio Pharmaceuticals: Nuclear radio pharmaceuticals, Reactions, Nomenclature, Methods of obtaining their standards and units of activity, measurement of activity, clinical applications and dosage, hazards and precautions.

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### Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO-8	PO-9	PO-10
CO1	2	2	2	1	1	1			1	2
CO2	1	2	2	1	2	2	1			1
CO3	2	1	2		2	2		1		2
CO4	1	2	1	1	2	2				2

1 - LOW 2- MEDIUM 3-HIGH

### BCH038A: PHARMACEUTICAL CHEMISTRY LAB

#### PRACTICAL:

1. Preparation (minimum number stated against each of the following categories illustrating different techniques involved.

1. Aromatic waters
2. Spirits
3. Tinctures
4. Creams
5. Cosmetic preparations
6. Capsules
7. Tablets
8. Ophthalmic preparations
9. Preparations involving aseptic

#### Suggested Readings

- 1.) Remington's Pharmaceutical Sciences.
- 2.) The Extra Pharmacopoeia-Martindale.

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### Course Outcome

**CO1:** Understand about biochemical organization of the cell and transport processes, concept of free energy and bioenergetics.

**CO2:** Understand about enzyme kinetics, its mechanism and significance of co-enzymes

**CO3: Understand about carbohydrate metabolism and role of sugar nucleotides in biosynthesis**

**CO4:** Understand about biological Oxidation, Energetics, Mechanism of oxidative phosphorylation and know about biosynthesis of amino acids.

Biochemical organization of the cell and transport processes across cell membrane.  
The concept of free energy, determination of change in free energy - from equilibrium constant and reduction potential, bioenergetics, production of ATP and its biological significance.

**Enzymes:** Nomenclature, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.  
**Co-enzymes:** Vitamins as co-enzymes and their significance. Metals as co-enzymes and their significance.

**Carbohydrate Metabolism:** Conversion of polysaccharide to glucose-1-phosphate, Glycolysis and fermentation and their regulation, Gluconeogenesis and glycogenolysis, Metabolism of galactose and galactosemia, Role of sugar nucleotides in biosynthesis, and Pentosephosphate pathway.

**Biological Oxidation :** Redox-potential, enzymes and co-enzymes involved in oxidation reduction & its control, The respiratory chain, its role in energy capture and its control, Energetics of oxidative phosphorylation, Inhibitors of respiratory chain and oxidative phosphoryla Mechanism of oxidative phosphorylation.

Biosynthesis of amino acids. Catabolism of amino acids. Conversion of amino acids to specialized products, Assimilation of ammonia. Urea. cycle, metabolic disorders of urea cycle. Metabolism of sulphur containing amino acids. Porphyrin biosynthesis. formation of bile pigments. hyperbilirubinemia. Purine biosynthesis. Purine nucleotide interconversion. Pyrimidine biosynthesis. and Formation of deoxyribonucleotides.

### Mapping of PO/CO

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CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO-8	PO-9	PO-10
CO1	1	3	2	2	1	1			1	1
CO2	2	2	3	2	2	3	2			1
CO3	2	2	2		3	2		1		2
CO4	1	3	1	1	2	2				2

1 - LOW 2- MEDIUM 3-HIGH

#### BCH040A: Pharmaceutical Chemistry - II LAB

1. Identification tests for inorganic compounds particularly drugs and pharmaceuticals.

2. Limit test for chloride, Sulfate, Arsenic, Iron and Heavy metals.

3. Assay of inorganic pharmaceuticals involving each of the following methods of compounds marked with (\*) under theory.

- Acid-Base titrations (at least 3)
- Redox titrations (one each of permanganometry and iodimetry).
- Precipitation titrations (at least 2)
- Complexometric titration (Calcium and Magnesium).

#### Suggested Readings:

- Indian pharmacopoeia

#### BCH041A: Pharmaceutical Chemistry-III: (Medicinal Chemistry - I)

##### Course Outcome

At the end of this course student will be able to -

CO-1: understand about Physico-chemical aspects of drug molecule, biological action, Drug designing, graph theory and applications of quantum mechanics

CO-2: understand about Synthetic procedures of drugs, mode of action, structure activity relationship

CO-3: understand about physicochemical properties of Drugs acting at Synaptic and neuro-effector junction sites and role of sugar nucleotides in biosynthesis

CO-4: Understand about Physicochemical properties of Autocoids, Drugs affecting uterine motility

#### UNIT-I

Basic Principles of Medicinal Chemistry: Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug- receptor interaction including transduction mechanisms.

#### UNIT-II

Principles of Drug Design (Theoretic~fl Aspects) : Traditional analog (QSAR) and mechanism based approaches (Introduction , graph theory, applications of quantum mechanics, Computer Aided Drug Designing (CADD) and molecular modeling.

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### UNIT-III

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship

### UNIT-IV

Physicochemical properties of the following classes of drugs:

#### A. Drugs acting at Synaptic and neuro-effector junction sites:

- Cholinergics and Anticholinesterases
- Adrenergic drugs
- Antispasmodic and anti ulcer drugs
- Neuromuscular blocking agents.

### UNIT-V

Physicochemical properties of the following classes of drugs:

#### B. Autocoids

- Antihistamines
- Eicosanoids
- Analgesic-antipyretics, anti-inflammatory (non-steroidal) agents.

#### C. Drugs affecting uterine motility

Oxytocics (including oxytocin, ergot alkaloids and prostaglandins' Biochemical approaches in drug designing wherever applicable should be discussed.

#### Mapping of PO/CO

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CO2	2	2	1	2	3	2	2			2
CO3	1	3	2		3	2		2		2
CO4	1	3	2	1	1	2				1

1 - LOW 2- MEDIUM 3-HIGH

#### BCH042A: Pharmaceutical Chemistry-III: (Medicinal Chemistry - I) Lab

- Identification of drugs by morphological characters. Physical and chemical tests for evaluation of drugs wherever applicable.
- Gross anatomical studies(t.s.)of the following drugs :Senna, Datura, cinnamon, cinchona, coriander, fennel , clove, Ginger, Nux-vomica, Ipecacuanha.
- Identification of fibers and surgical dressing.

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**Suggested Books:**

1. Indian pharmacopoeia.

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## BCH043A: Pharmaceutical Chemistry - IV (Medicinal Chemistry - II)

### Course Outcome

At the end of this course student will be able to -

**CO-1:** understand about Synthetic procedures, action, uses, structure activity relationship and Physico-Chemical properties of Steroids and related drugs

**CO-2:** understand about Synthetic procedures of selected drugs acting on the Central Nervous System and Physico-Chemical properties.

**CO-3:** understand about Synthetic procedures of selected drugs, mode of action and Physico-Chemical properties of Diuretics, Cardiovascular drugs

**CO-4:** understand about Synthetic procedures of selected drugs, mode of action and Physico-Chemical properties of Anticoagulant and Antiplatelet drugs.

### UNIT-I

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs.

**Steroids and related drugs :** Steroidal nomenclature and stereochemistry, androgens and anabolic agents, estrogens, and progestational agents, adrenocorticoids.

### UNIT-II

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs.

**Drugs acting on the Central Nervous System:** General Anesthetics, Local Anesthetics, Hypnotics and Sedatives, Opioid analgesics, antitussives, anti convulsants,

### UNIT-III

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs.

**Drugs acting on the Central Nervous System:** Antiparkinsonism drugs, CNS stimulants, Psychopharmacological agents (neuroleptics, antidepressants, anxiolytics).

### UNIT-IV

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs.

Diuretics, Cardiovascular drugs

### UNIT-V

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs.

Anticoagulant and Antiplatelet drugs.

### Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO-8	PO-9	PO-10
CO1	3	2	3	3	1	2			2	2
CO2	2	2	2	2	1	2	2			2
CO3	1	2	2		2	2		2		2
CO4	2	3	3	2	1	2				1

1 - LOW 2 - MEDIUM 3 - HIGH

*[Handwritten signatures and initials are present below the table, including "Dum", "Am", "Dr", "P. De", "Saw", and others.]*



**BCII044A: Pharmaceutical Chemistry - IV (Medicinal Chemistry - II) LAB**

1. Detection and identification of proteins. Amino acids, carbohydrates and lipids.
2. Examination of sputum and faeces (microscopic & staining).
3. Practice in injecting drugs by intramuscular, subcutaneous and intravenous routes, withdrawal of blood samples.
4. Analysis of normal and abnormal constituents of Blood and Urine (Glucose, urea, creatine, creatinine, cholesterol, alkaline phosphatase, acid phosphatase, Bilirubin, SGPT, SGOT, calcium, Diastase, Lipase).

**Suggested Reading:**

- 1) Remington's Pharmaceutical Sciences.
- 2.) The Extra Pharmacopoeia-Martindale.

*Don*

*R. S. S.*

*Y*

*dv*

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*M. P. S.*

*Amel*

*De*

## BCH045A: Pharmaceutical Chemistry – V: (Medicinal Chemistry III)

### Course Outcome

At the end of this course student will be able to -

- CO-1: understand about Synthetic procedures and Physico-Chemical properties of Antimetabolites (including sulfonamides) and Chemotherapeutic agents.
- CO-2: understand about Synthetic procedures and Physico-Chemical properties of Antineoplastic agents, Anti-viral including anti - HIV agents and Immunosuppressives and immunostimulants.
- CO-3: understand about Synthetic procedures of and Physico-Chemical properties of Amino acids, peptide, nucleotides and related drugs and Thyroid and Anti thyroid drugs
- CO-4: understand about Synthetic procedures and Physico-Chemical properties of Insulin and oral hypoglycaemic agents, Peptidomimetics, nucleotidomimetics Diagnostic agents and Pharmaceutical Aids.

### UNIT-I

Drug metabolism and Concepts of Pro drugs.

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship (including physicochemical aspects) of the following classes of drugs. (Biochemical approaches in drug designing wherever applicable should be discussed).

- i) Antimetabolites (including sulfonamides).
- ii) Chemotherapeutic agents used in Protozoal, Parasitic and other infection

### UNIT-II

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship (including physicochemical aspects) of the following classes of drugs. (Biochemical approaches in drug designing wherever applicable should be discussed).

- (iii) Antineoplastic agents
- (iv) Anti-viral including anti - HIV agents.
- (v) Immunosuppressives and immunostimulants.

### UNIT-III

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship (including physicochemical aspects) of the following classes of drugs. (Biochemical approaches in drug designing wherever applicable should be discussed).

- (i) Amino acids, peptide, nucleotides and related drugs
- (ii) Thyroid and Anti thyroid drugs

### UNIT-IV

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship (including physicochemical aspects) of the following classes of drugs. (Biochemical approaches in drug designing wherever applicable should be discussed).

- (i) Insulin and oral hypoglycaemic agents.

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- (ii) Peptidomimetics and nucleotidomimetics.

## UNIT-V

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship (including physicochemical aspects) of the following classes of drugs. (Biochemical approaches in drug designing wherever applicable should be discussed).

- (i) Diagnostic agents.  
(ii) Pharmaceutical Aids.

### Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO-8	PO-9	PO-10
CO1	2	2	2	3	2	2			1	2
CO2	3	2	2	1	1	2	1			1
CO3	1	3	3		2	3		2		2
CO4	3	3	3	2	1	2				1

1 - LOW 2- MEDIUM 3-HIGH

### BCH046A: Pharmaceutical Chemistry – V: (Medicinal Chemistry III) LAB

1. Study of the human Skelton.
2. Microscopic examination of epithelial tissue, cardiac muscle, smooth muscle, skeletal muscle. Connective tissue and nervous tissues.
3. Examination of blood films for TLC.DLC and malarial parasite.
4. Determination of RBCs, clotting time of blood, erythrocyte sedimentation rate and Hemoglobin value.
5. Recording of body temperature, pulse, heart-rate, blood pressure and ECG.

### Suggested Reading

- 1) Remington's Pharmaceutical Sciences.
- 2) The Extra Pharmacopoeia-Martindale.

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**DSE:4 Nanochemistry and Technology BCH047A-BCH056A**

**Paper-I Introduction to Nanoscience and Technology**

**Paper-II Synthesis of Nano materials: Conventional and Green Approaches**

**Paper-III Analysis and Characterization of Nano materials**

**Paper IV Applications of Nano materials**

**Paper-V Nano Toxicology and Environmental concern**

**Paper-VI Green Chemistry**

**Paper I: BCH047A Introduction to Nanoscience and Technology**

**Course outcome**

**CO1:** Students will be able to understand the history of nanotechnology, evolution and growth of nanosystems

**CO2:** Students will be able to understand the classification of nanomaterials.

**CO3:** Students will be able to understand the basics of carbon nanotubes, fullerene, nanograined material.

**CO4:** Students will be able to understand the structure and properties of nanomaterials.

**Unit I: Introduction and History**

Background to nanotechnology - scientific revolutions -atomic structure-atomic size - bottom up/topdown nanotechnology-chemical reactivity-Incremental Nanotechnology-Evolutionary nanotechnology-Radical Nanotechnology-Emergence of nanotechnology-Challenging in nanotechnology-Misnomers and misconception of Nanotechnology.

**Unit II: Evolution and growth of Nanosystem**

Basic problems and limitations - opportunities of nano scale -evolution of band structures and Fermi surface. Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents-solid state phase segregation- grain growth and sintering precipitation in solid solutionhumerothery rule.

**Unit III: Nanomaterials and classifications**

Carbon Nanotubes (CNT) - Metals (Au, Ag, Pd, Cu) - Metal oxides (TiO<sub>2</sub>, CeO<sub>2</sub>, ZnO, MgO) - Semiconductors (Si, Ge, CdS, ZnSe). Classifications of nanomaterials-zero dimensional-onedimensional-two dimensional-three dimensional nanostructures- Quantum dots-Quantum wireQuantum well-semiconductors and ceramics.

**Unit IV: Special nanomaterials**

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Carbon fullerenes-fullerene derived crystals- carbon nanotubes. Micro and

Mesoporous material Ordered mesoporous materials-Random mesoporous materials-crystalline microporous materials. Core/Shell structures-Metal oxide structures-Metal polymer structures- Intercalation compounds-nanograined materials.

### Unit V: Materials Structure and Properties

Space lattice and unit cells, crystal system, Symmetry operation, Structures of common metallic, Semiconductor ceramic and superconductor materials, Miller Indices, Packing fractions, Formation of dangling bonds-atom like behavior of nanomaterials-physicochemical properties. Optical properties of nanomaterials-semiconductor-metal nanoparticles-Electrical and electronic properties Thermal properties-Ferro electric properties-mechanical and magnetic properties.

### Books for study:

1. Introduction to Nanoscience and Nanotechnology, By Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore
2. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, By Guozhong Cao, Ying Wang
3. Organic Nanomaterials: Synthesis, Characterization, and Device Applications, By Tomas Torres, Giovanni Bottari
4. Nanochemistry: A Chemical Approach to Nanomaterials, By Geoffrey A. Ozin, André C. Arsenault, Ludovico Cademartiri
5. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, By Guozhong Cao, Ying Wang
6. Material science and Engineering, by V. Raghawan

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	-	1	2	1	2	3
CO2	3	3	3	2	1	1	3	1	2	2
CO3	2	3	3	3	1	1	2	-	3	3
CO4	3	2	1	3	3	-	2	1	3	2

1- Not related; 1- low; 2- medium; 3- high

**BCE048A : Lab Seminar**

**Paper II: BCH049A: Synthesis of Nano materials: Conventional and Green Approaches**

### Course outcome

CO1: Students will be able to understand the basics and chemical approaches for synthesis of nanomaterials

CO2: Students will be able to understand the physical approaches for nanomaterial synthesis

CO3: Students will be able to understand hydrothermal method for the formation of carbon nanotubes, nano wires, nano rings and flowers etc.

CO4: Students will be able to understand the herbal synthetic methods for nano materials

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## Unit I: Bulk synthesis

Top down and bottom up approaches–Mechanical alloying and mechanical ball milling  
Mechanochemical process, Inert gas condensation technique – Arc plasma and laser ablation.

## Unit II: Chemical approaches

Sol- gel processing- Solvothermal, hydrothermal, co-precipitation, colloidal precipitation, Spray pyrolysis, sonochemical method, Electro spraying and spin coating routes, Self-assembly, selfassembled monolayers, gas phase synthesis. Langmuir-Blodgett (LB) films, micro emulsion polymerization- templated synthesis.

## Unit III: Physical approaches

Vapor deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD)-pulsed laser deposition, Magnetron sputtering - Etching process: Dry and Wet etching, microcontact printing.

## Unit IV:Hydrothermal methods:

Principle, 3D nanostructures – carbon nanotube – Inorganic nanotubes and nanorods – Nanoflowers- nanosprings – Nano-rings – chemical routes for 1D nanotubes and nanorods – Schlenky synthesis of Quantum dots- making bulk nanomaterials

## Unit V: Biological Methods

Use of bacteria, fungi, Actinomycetes for synthesis of nanoparticles - use of viruses for the synthesis of nanostructured materials- use of magnetotactic bacteria for synthesis of magnetic nanoparticles- use of natural plants for synthesis of nanoparticles.Biomineralization, biological production of nanoparticles – Phytosynthesis, phycosynthesis, mycosynthesis and Herbal synthesis - bioproduct mediated synthesis of nanoparticles.

## Books for Study:

1. S. Horikoshi, N. Serpone, Microwaves in Nanoparticle Synthesis: Fundamentals and Application, Wiley-VCH, Germany, 2013.
2. Om V. Singh, Bio-Nanoparticles: Biosynthesis and Sustainable Biotechnological implication, Wiley Blackwell, 2015.
3. A. Sengupta, C.K. Sarkar, Introduction to Nano: Basics to nanoscience and nanotechnology, Springer, London, 2015.
4. S.K. Kulkarni, Nanotechnology: Principles and Practices, Third edition, Springer International Publishing, 2014.
5. V.A. Basiuk, E.V. Basiuk, Green Processes for Nanotechnology: From inorganic to bioinspirednanomaterials, Springer, 2015.
6. A.C.Venetti, Progress in Materials Science Research, Nova Science Publishers, 2007.

## Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

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Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	-	1	2	1	2	3
CO2	3	3	3	2	1	1	3	1	2	2
CO3	2	3	3	3	1	1	2	-	3	3
CO4	3	2	1	3	3	-	2	1	3	2

0- Not related; 1- low; 2- medium; 3- high

### BCE050A : Synthesis of nanomaterials(Practical)

1. Synthesis of Iron oxide nanoparticles by Co-precipitation method.
2. Synthesis of ZnO nanoparticles by chemical method.
3. Synthesis of SnO<sub>2</sub> nanoparticles by Chemical sol-gel method.
4. Synthesis of TiO<sub>2</sub> nanoparticles by Chemical sol-gel method.
5. Electrodeposition of nano film of TiO<sub>2</sub>
6. Synthesis of Nanocomposite materials by solution method using capping agent
7. Synthesis of colloidal nano materials of Au and Ag nanoparticles
8. Preparation of polymer nanocomposites.
9. Synthesis of Silver Nanoparticles by Chemical reduction method and their UV-VIS absorption studies.
10. Synthesis of Gold Nanoparticles by Chemical reduction method and their UV-VIS absorption studies.

### Paper III : BCH051A: Analysis and Characterization Of Nanomaterials

#### Course outcome

- CO1: Students will be able to understand the basics of mechanical characterization of nano materials.  
CO2: Students will be able to understand the electrical properties of nanomaterials.  
CO3: Students will be able to understand to characterize the nanomaterial through spectroscopic techniques and also through microscopic techniques.  
CO4: Students will be able to understand the magnetic properties of nanomaterials.

#### Unit I: Mechanical Characterization

Micro hardness – nanoindentation – fatigue – failure stress and strain toughness – abrasion and

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wear resistance – fracture toughness – elasticity of nanomaterials – superplasticity – plastic nature of nanoceramics – nanomembranes – inter connected pores – plastic deformation of nanomaterials.

## Unit II: Electrical Characterization

DC electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density – impedance spectroscopy – dc electrical resistivity – activation energy – bulk and grain boundary capacitances – relaxation times of dipoles.

## Unit III: Spectroscopic Characterization

UV-VIS – calorimetric and spectrophotometric analysis – laws of absorption – instrumentation-chromophores – effect of conjugation on chromophores – qualitative and quantitative analysis -IR – Origin of Infrared transition and experimental techniques-Theory of Infrared Absorption – FT-IR – principle – instrumentation – interpretation of spectra aliphatic and aromatic hydrocarbons, carboxylic acids – Raman spectroscopy – Stokes and anti – Stokes scattering – surface enhanced raman scattering – PL studies – shape dependent optical properties – optical absorption - optical emission – surface plasma resonance (SPR).

## Unit IV: Magnetic Characterization

Concepts of dia-para-ferro and ferri magnetism – exchange correlation - exchange interaction – Hysteresis loop – coercivity – change of coercivity – grain size – soft magnets – hard magnets – spring exchange magnets – magnetic measurements using VSM – function of temperature - ferromagnetic resonance – magnetic force microscopy – Mossbauer spectroscopy for Fe and Sn containing nanomaterials – NMR – Introduction – Experimental Techniques – Chemical shift, dipolar interaction, spin - spin interaction – Applications – ESR – Principles and Applications of ESR Spectroscopy.

## Unit V: Microscopic Characterization

Electron Microscopes – AFM, STM, SEM- and TEM – working principle – instrumentation and applications – microstructures – optical microscope – grain size determination – grain size induced phase transition-surface mapping.

### Books for study

1. Gerd Kaupp, Atomic Force Microscopy, Scanning Nearfield Optical Microscopy and nanoscratching, Springer-Verlag, 2006.
  2. Rashid, Bashir and Steve Wereley, Biomolecular Sensing, Processing and Analysis, Springer, 2006.
  3. Tejal and Desai, Therapeutic Micro / Nano Technology, Springer, 2006.
- William F. Hosford, Physical Metallurgy, CRC Press, 2005.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course	Program Outcome
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outcome										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	3	2	1	1	2	1	3	3
CO2	3	3	2	3	-	1	3	1	2	2
CO3	2	3	3	2	1	1	2	-	3	3
CO4	3	2	1	3	3	-	2	1	2	2

0- Not related; 1- low; 2- medium; 3- high

#### BCE052A: Characterization of nanomaterials (Practical)

1. Studies on bulk and nanoparticles through UV-Vis spectroscopy.
2. Conductivity studies of polymer-nanocomposite material by four probe method.
3. Thin film characterization through AFM.
4. XRD studies for calculating the size of the nanoparticles and nanocomposites by Scherrer's formula and mass approximation method
5. SEM characterization of nanomaterials. for size and surface morphology
6. Raman spectroscopy studies on nanomaterials.
7. Conductivity studies of polymer-nanocomposite material by Four probe method
8. SERS studies of Gold nanoparticles
9. SERS studies of Silver nanoparticles
10. SPR studies of metal nanoparticles.

#### Paper IV: BCH053A: Applications of Nanomaterials

##### Course outcome

- CO1: Students will be able to understand the applications of nanomaterials in lithography and sensors.  
CO2: Students will be able to understand the applications of nanomaterials in medical science.  
CO3: Students will be able to understand the applications of nanomaterials in pharmaceutical industry.  
CO4: Students will be able to understand antibacterial, antimalarial, antiviral and anticancerous activities using nanomaterials.  
CO5: Students will be able to understand the applications of nanomaterials in electronics.

##### Unit I: Lithography and Sensors

Silicon MEMS fabrication technology, Advanced lithography: Deep UV/E beam/Ion Beam techniques, Dip pen nanolithography-Polymers in Microsystems, Packaging of MEMS devices by anodic/fusion bonding, Pressure sensors and packaging, MEMS performance and evaluation Surface confined chemical sensors- Nanoparticles sensors- thermal, radiation magnetic, chemical and mechanical nanosensors.

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## Unit II: Nanomedicine

Principles of nanomedicine – impact of nanotechnology in medicine- nanomedical perspective and the medical applications- nanoparticles delivery for cancer therapy – Bioactive nanomaterials in medicine- Nanodiagnostics - Nanoarrays for diagnostics-nanoparticles for molecular diagnostics-self-assembled protein nanoarrays- protein nanobiochip - Nanobiosensor-CNT biosensor-DNA biosensor.

## Unit III: Nanopharmaceutical

Nanoparticles for drug discovery – Nanotechnology for Drug Targeting, Targeted, non-targeted delivery, controlled drug release-protein and peptide based compounds for cancer and diabetes - lipid nanoparticles - vaccination - cell therapy -Gene therapy-nanoparticles drug delivery in cardiology and vascular disease- Nanoparticles and protein interactions-inter relationship between nanotech development and nanopharmaceutical development.

## Unit IV: Environmental and Bio-compatibility

Degradation of hazardous organic-pollution abatement- removal of bacteria and microbes-photocatalytic decontamination-heavy metal removal-detection and extraction of pesticides from water-Fuel cell application-thermoelectric and piezoelectric application-chemical and electrochemical sensor using nanomaterials. Antibacterial, antimalarial, antiviral and anticancer activities using nanomaterials.

## Unit V: Nanoelectronic

Nanoelectronics-Microelectronics- molecular electronics- photonics-photolithography-carbon nanotubes (CNT) in electronic applications- memories-dye sensitized solar cells-Physical concepts-Quantization of action, charge and flux-electrons in potential well-photons interacting with electrons in solids-diffusion processes-Effects on structure and Morphology of free or Supported Nanoparticles- Size and confinement Effects.

### Books for study:

1. Nanotechnology-Enabled Sensors, By Kourosh Kalantar-zadeh, Benjamin Fry
2. A.R.Jha, MEMS and Nanotechnology based sensors and devices for communication, medical and aerospace applications, CRC press, Taylor & Francis group, 2008.
3. Nanomedicine and Drug Delivery, edited by Mathew Sebastian, Neethu Ninan, A. K. Haghi
4. Nanopharmaceutics: The Potential Application of Nanomaterials, By Xing-Jie Liang
5. Biological and Pharmaceutical Applications of Nanomaterials, edited by Polina Prokopovich
6. K. Gosser, *et al*, "Nanoelectronics and Nanosystems", Springer, 2004.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

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Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	3	2	1	1	3	1	3	2
CO2	3	2	2	3	1	1	3	1	2	2
CO3	2	3	3	2	1	1	2	-	2	3
CO4	3	2	1	3	3	-	2	1	2	2
CO5	3	3	3	3	3	1	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

#### BCE054A: Synthesis of industrially important nanomaterials (Practical)

1. Synthesis of semiconductor nanoparticles.
2. XRD pattern of nanomaterials and estimation of particle size.
3. To study the effect of size on color of nanomaterials.
4. To prepare composite of CNTs with other materials.
5. Growth of quantum dots by thermal evaporation.
6. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

#### Paper V BCH055A: Nano Toxicology and Environmental concern

##### Course Outcome

- CO1: Students will be able to understand the basics of nano toxicology.  
 CO2: Students will be able to understand the mechanism of nanosize toxicity and health effects.  
 CO3: Students will be able to understand the effects of nanomaterials on environment.  
 CO4: Students will be able to understand the effect of exposure of nano materials on human health  
 CO5: Students will be able to understand the risk assessment and ethical, legal and social implications

##### Unit I: Introduction

**Concept of Nanotoxicology:** Laboratory rodent studies - Ecotoxicological studies - Methodology for Nanotoxicology - in vitro and in vivo toxicity testing

##### UNIT II: Mechanism

**Mechanism of nanosize particle toxicity:** Reactive oxygen species mediated NSP toxicity - Interactions between Nanoparticles and Living Organisms: Mechanisms and Health Effects - Interactions of Nanoparticles with Cells and their Cellular Nanotoxicology - Cytotoxicity of Ultrafine Particles - Cytotoxicity and Potential Mechanism of Nanomaterials- Immunotoxicity.

##### UNIT III: Pollution

**Nanopollution:** Nanomaterials in Environment - Toxicology of Airborne - Manufactured nanomaterials in the environment- Physicochemical characteristics of nanomaterials.

##### UNIT IV: Human exposure to Nanosized Materials

**Biological Activities of Nanomaterials and Nanoparticles :** nanoparticles interaction with biological membrane-Entry routes into the human body- Disposition of NSPs in the respiratory -

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Disposition of NSPs in the respiratory -Epithelial translocation - Translocation to the circulatory system - Neuronal uptake and translocation -Translocation of NSPs in the blood circulation to bonemarrow in mice - Studies of neuronal translocation of UFPs from respiratory tract - Exposure via GI Tract and Skin- toxicity of nanoparticles in the eye.

#### Unit V: Risk Assessment and Execution

Portals of entry and target tissue – Risk assessment: Ethical – Legal and Social Implications - Nanoparticle Toxicology and Ecotoxicology, The Role of Oxidative Stress – Development of Test Protocols for Nanomaterials – Regulation of Engineered Nanomaterials in Europe and USA

#### Books for Study

1. N. Duran, S.S. Guterres, O.L. Alves, Nanotoxicology: Materials, Methodologies, and Assessments, Springer, Newyork, 2014.
2. T. Otsuki, Y. Yoshioka, A. Holian, Biological Effects of Fibrous and Particulate Substances, Springer, Japan, 2016.
3. A.M. Gatti, S. Montanari, Case Studies in Nanotoxicology and Particle Toxicology, Academic Press, UK, 2015.
4. Nancy A. Monteiro-Riviere, C. Lang Tran, Nanotoxicology: Progress towards Nanomedicine, Second edition, CRC Press, Taylor and Francis, Boca Raton, 2014.
5. G. Ramachandran, Assessing Nanoparticle Risks to Human Health, William Andrew, Elsevier, USA, 2011.
6. J. Njuguna, K. Pielichowski, H. Zhu, Health and Environmental Safety of Nanomaterials:

#### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	2	1	1	3	1	2	3
CO2	3	3	2	3	1	1	2	1	2	2
CO3	2	3	3	2	1	1	2	-	2	3
CO4	3	2	1	3	3	-	2	1	2	2
CO5	2	3	3	3	3	1	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

#### BCE056A: Nanotoxicity (Practicals)

1. To study the cytotoxicity of nanomaterial using suitable material (Cell line/Insect culture/Ycant).

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## DE-5 Biochemistry BCH057A-BCH066A

Paper-I Biochemistry Paper I: Introduction of Bio molecules

Paper-II Enzymology

Paper-III Metals and their role in Biology and Mineral Metabolism

Paper IV Metabolism of carbohydrates and lipids

Paper-V Biochemical Techniques

Paper-VI Green Chemistry

### Paper I BCH057A: Introduction of Bio molecules

CO1: Students will be able understand the structure and function of biomolecules.

CO2: Students will be able to understand the types of biomolecules.

CO3: Students will be able to explain distinguish between protein carbohydrates, lipids and vitamins.

CO4: Students will be able to understand the organization bio molecules in cell.

#### Unit 1

Definition of Bio molecules, Monomers and Polymers, Primary and Secondary Metabolite, energy currency of Cell

#### Unit 2

Carbohydrates, Protein, Lipids, and Nucleic Acid occurrence in cell, their Classification and Functions molecules

#### Unit 3

Role of Bio molecules, Physico chemical properties of Bio molecules, Bioenergetics of Bio molecules, High energy compounds

#### Unit 4

Vitamins, Water and Fats soluble, Macro and Micro nutrients, structure of ATP

#### Unit 5

Role of Bio molecules in cell, Occurrence of bio molecules in cell, Prokaryotic and Eukaryotic cell

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### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	3	1	2	1	2	3
CO2	1	2	1	2	2	1	1	2	2	1
CO3	2	1	2	2	2	3	1	3	2	
CO4	2	2	2	1	1	1	2	3	3	2

#### **BCH058A : Practicals of qualitative analysis of biomolecules**

1. To prepare the solutions of given normality and its standardization.
2. To Calibrate the pH meter by using different buffer solutions
3. To Prepare the buffer solutions
4. To determine the pKa value and hence the Dissociation constant of a given acid by using pH meter.
5. To prepare buffer solutions in the pH range of 2.2 to 8.0
6. To perform Qualitative estimation of proteins
7. To Prepare dilute solutions of known concentration of sulphuric acid, hydrochloric acid and nitric acid.
8. To Study pH change by common-ion effect in case of weak acids and weak bases by above method (specific examples of  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$  and  $\text{NH}_4\text{OH}$  and  $\text{NH}_4\text{Cl}$  may be taken

#### **Suggested Readings**

1. Outlines of Biochemistry: Conn and Stumpf
2. Principles of Biochemistry: Jeffery Zubey
3. Biochemistry: Stryer
4. Voet D., Voet J.G, Biochemistry 4 th Edition, John Wiley and Sons, 2011.
5. Nelson, D. C. and Cox, M.M., Lehninger Principles of Biochemistry, 5th Edition, W. H. Freeman, 2010.
6. Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. 7th edition, W.H. Freeman and Co. New York, 2011.

#### **Paper II: BCH059A Enzymology**

- CO1: Students will be able to describe how enzymes are useful in biology and how they are different from catalyst.  
CO2: Students will be able to explain different types of enzymes and their role in different reactions.  
CO3: Students will be able to describe various factors involved in enzyme activity and how they affect enzyme activity.

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CO4: Students will be able to understand between Holo enzyme, co enzyme and prosthetic group and also able to understand enzyme inhibition.

#### Unit 1

History, Nomenclature of Enzyme, Function of Enzymes, Difference between Catalyst and Enzymes

#### Unit 2

Classification of Enzymes, Oxidoreductase, Transferase, Ligase, Hydrolase. Chemical nature and Properties of Enzymes

#### Unit 3

Factors affecting enzyme activity, Role of Metals in enzyme activity, Lock and Key model, induced fit model or Koshland's model.

#### Unit 4

Isozyme, Ribozymes, Co enzymes, Holo enzyme and Prosthetic group, Mono Meric and Oligomeric Enzymes, active sites and its features

#### Unit 5

Inhibition of Enzyme, feedback inhibition, Allosteric inhibition, K class and V class

#### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	1	2	1	2	3
CO2	1	3	1		2	1	2		2	2
CO3	2	1	2	3	2	3	1	3	3	
CO4	3	2	2	1	1	1	2	3	3	2

#### BCH060A : Practicals of Enzymology

1. Study of solubility of solid substances in water at different temperatures and plotting of a solubility curve.
2. Acquaintance with chemistry laboratory and basic laboratory techniques (cutting, bending and boring of glass tubes, sealing of apparatus, filtration, distillation, crystallization, preparation calibration, cleaning of glass apparatus and use of burner etc.)
3. To study activity of any enzyme under optimum conditions.
4. To study the effect of pH, temperature on the activity of salivary amylase enzyme
5. To determine concentration of an unknown protein by UV-Vis Spectrophotometer.
6. Enzymatic Assays
7. Effect of substrate concentration on enzyme kinetics
8. Determination of optimum pH and temperature for enzymatic activity

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## Suggested Readings

1. Peter Sykes A Guidebook to Mechanism in Organic Chemistry
2. M.S Chauhan version of Solomon Fryhle
3. Problems in chemistry by M.S Chauhan (Buy Solution book too :P ) {Balaji}
4. Modern Approach To Chemical Calculations (By R.C Mukherjee) {Bharti Bhavan}
5. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Publisher; Horwood Publishing Limited (2004)
6. Enzymes: A Practical Introduction To Structure, Mechanism And Data Analysis by Robert A. Copeland, publisher: Wiley (2012)
7. Introduction to Enzyme and Coenzyme Chemistry, 3rd Edition by T.D.H. Bugg, publisher Wiley-Blackwell
8. Lehninger Principles of Biochemistry, Fourth Edition, David L. Nelson and Michael M. Cox. W. H. Freeman; 4th edition (2004)

## Paper III: BCH061A Metals and their role in Biology and Mineral Metabolism

CO1: Students will be able to understand the different types of elements are needed to biological systems their sources and their functions.

CO2: Students will be able to explain role of trace elements and why they are needed in living organisms.

CO3: Students will be able to describe various trace elements and their metabolism

CO4: Students will be able to analyze the role of various metals in controlling the growth of living organisms.

### Unit 1

General functions of Mineral, Classification of Minerals, Trace elements, Essential and Non Essential elements, Major functions, Deficiencies diseases

### Unit 2

Calcium its functions, Factor affecting calcium absorption, Phosphorous sources and its function

### Unit 3

Magnesium and its Biochemical functions, sources, Manganese and Sodium and its biochemical functions

### Unit 4

Potassium and its functions, chlorine and Sulphur and their role in biochemical activity,

### Unit 5

Iron, Iodine, Copper and their functions

### Mapping of CO-PO

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### Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	3	1	2	1	2	3
CO2	1	1	1	2	2	2	2	2	3	1
CO3	2	1	2	3	1	3	1	2	2	
CO4	2	3	1	1	1	1	2	3	3	2

### BCH062A: Practicals of metal Detection (virtual)

1. To determine the pH, chlorides, nitrates, carbonates and bi carbonate in different soil sample and Water Samples.
2. To determine the concentration of Fe/ water in soil samples
3. To determine the concentration of Mn in Soil/ water sample Using AAS
4. To determine the concentration of Zn in soil/ water sample using AAS
5. To determine the concentration of Co in soil/ water sample using AAS
6. To determine the concentration of Cd, Pb, Ni in soil/ water sample using AAS

### Suggested Readings

1. Introduction to Physiology by Davidson H and Segal M. B. Academic Press.
2. Review of Medical Physiology-William F.Ganong
3. Physiological basis of Medical Practice, John.B.West.
4. Vander's Human Physiology-The mechanism of Body function, Widmaier, Raff, strang.

### Paper IV: BCH063A Metabolism of Carbohydrates and Lipids

**CO1:** Students will be able to define, classify and summarize the roles that carbohydrates play in biological systems. Predict the products of chemical reactions of carbohydrates (acetal/hemiacetal formation or oxidation).

**CO2:** Students will be able to illustrate different types of lipids and relate their structure to their role in biological systems.

**CO3:** Students will be able to describe what happens during carbohydrate glycolysis. Illustrate the basic components and steps of fermentation. Describe what happens in the citric acid cycle, oxidative Phosphorylation & ETS.

**CO4:** Students will be able to describe what happens in fatty acid oxidation and synthesis as well as in ketogenesis.

### Unit 1

Carbohydrates, their functions, Classification of carbohydrates, Monosaccharides and Polysaccharides, Aldoses and Ketoses sugar, D and L isomers Epimers, Structure of Glucose  
Mutarotation, Chemical properties of Carbohydrates, Tautomerization, Reducing Properties, Oxidation, Formation of Ester, Glycosides bond

### Unit 2

Sucrose, Maltose and Lactose Polysaccharides, Homo poly saccharides and Hetero poly saccharides,

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Starch, Glycogen and Cellulose,

### Unit 3

Catabolism and Anabolism, Major pathway of Carbohydrate, Glycolysis and TCA Cycle, Pyruvate dehydrogenase system

### Unit 4

Definition of Lipids, Functions of Lipids, Classification of Lipids, Simple, compound and Derived Lipids, Fatty acid, Even and Odd fatty acid, Essential and Non Essential Fatty acids, Saturated and Unsaturated Fatty acids

### Unit 5

Triacylglycerols, Properties of Triacylglycerols, Saponification Value, Acid Number, Iodine Number, Rancidity, Phospholipids, Glycolipids, Beta oxidation of Fatty acids, Lipoproteins

#### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	1	2	1	2	3
CO2	1	2	2	2	2	1	1	3	2	1
CO3	2	1	3	3	2	2	1	3	2	
CO4	3	2	2	1	1	1	2	3	3	2

#### **BCH064A: Practicals of Quantitative estimation of biomolecules**

1. To perform Qualitative estimation of carbohydrates
2. To perform Qualitative estimation of lipids
3. To Determine the acid value of oil
4. To perform Quantitative estimation of carbohydrates by anthrone method
5. To perform Quantitative estimation of reducing sugar
6. To perform Quantitative estimation of glycogen
7. To perform the Chlorophyll estimation Arnon' method

#### **Suggested Readings**

1. Outlines of Biochemistry: Conn & Stumpf
2. Principles of Biochemistry: Voet & Voet
3. Principles of Biochemistry: Jeffery Zubey
4. Clinical Biochemistry: D.C Deb
5. Biochemistry: Stryer
6. Lehninger's Principles of Biochemistry: Nelson & Cox



## Paper V: BCH065A Biochemical Techniques

CO1: Students will be able to explain basic principles for chromatographic separation techniques and typical applications of chromatographic techniques.

CO2: Students will be able to explain principles of electrophoresis techniques and discuss how these techniques can be used for various purposes.

CO3: Explain the basic principles of analyses and detection systems involved in radio isotopic techniques including ELISA. Describe hazards related with radiations and related safety measures.

CO4: Students will be able to describe Beer Lambert's Law. Explain the theoretical principles of selected instrumental methods within spectrometric/spectrophotometric methods, and main components in such analytical instruments

### Unit 1

Chromatography, Principal and Classification, Paper, Column and Thin Layer Chromatography, Rf Value

### Unit 2

Electrophoresis Principal of electrophoresis, Paper and Gel electrophoresis, Radio active isotopes

### Unit 3

Colorimeter and spectrophotometer

Principal of Spectrophotometer, Lambert and Beer law, Lambda Max,

### Unit 4

Ultra centrifugation and its principal, Enzyme linked Immuno assay (ELISA)

### Unit 5

Different blotting techniques, Radio Immuno assay, UV and Visible spectroscopy

### Mapping of CO-PO

#### Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	3	1	2	1	2	3
CO2	1	2	1	2	2	1	1	2	2	1
CO3	2	1	2	2	2	3	1	3	2	
CO4	2	2	2	1	1	1	2	3	3	2

### BCH066A: Practical of Analytical Techniques

1. To perform paper chromatography for dyes
2. To perform chromosomal banding using dyes
3. Demonstration of dialysis
4. To verify Lambert and beer law's
5. To calibrate spectrophotometer using  $K_2Cr_2O_7$  solution
6. To perform the Titrimetric estimation of molar and mass concentration of sulfuric acid
7. To determine the  $\lambda_{max}$  for DNA

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8. To separate various molecule on the basis of their sedimentation coefficient
9. To separate Amino acid using paper chromatography
10. To separate Amino acid using thin layer chromatography
11. To separate the aliphatic and aromatic fraction of oil by column chromatography
12. To separate the DNA using agarose gel electrophoresis

### Suggested Readings

1. Textbook of optics and atomic physics – P.P. Khandelwal (Himalaya Publishing House)
2. Nuclear physics an introduction – S.B. Patel (New Age International) Biophysics – Patabhi and Gautham (Narosa Publishing House)
3. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)
4. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)
5. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)
6. Introduction to atomic spectra – H.E. White (Mc Graw Hill)
7. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)

### DE- 5 Environmental Chemistry BCH067A – BCH076A

Paper-I Chemistry of Environmental pollutants

Paper-II Atmospheric Chemistry and Climate concerns

Paper-III Water and Air Pollution monitoring and Control Technology

Paper IV Solid and Hazardous Waste Management

Paper-V Environmental Policies, Conventions and Protocols

Paper-VI Green Chemistry

### BCH062: Chemistry of Environmental Pollutants

#### Course outcome

CO-1 students will be able to understand the fundamentals of environmental chemistry

CO-2 students will be able to understand the structure and composition of air, water and soil.

CO-3 students will be able to understand the basic chemistry of environmental pollutants.

CO-4 students will be able to understand the cause of air pollution

CO-5 students will be able to understand the cause and chemistry of surface and groundwater pollution

#### Unit-I

#### Fundamentals of environmental chemistry

Atomic structure, electronic configuration, periodic properties of elements; types of chemical bonds; mole concept, molarity and normality; quantitative volumetric analysis. Thermodynamic systems; acid-base theories and salts, solubility products; redox reactions; concepts of pH and pE, concept of buffer, Henderson-Hasselbalch equation; electrochemistry, Nernst equation, electrochemical cells. Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, polarity of the functional groups, synthesis of xenobiotic compounds like pesticides

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and dyes, synthetic polymers.

## Unit-II

### Air, Water and Soil chemistry

Structure and composition of atmosphere; photochemical reactions in atmosphere; smog: classical smog and photochemical smog, aerosols: PM 10, PM 2.5; chemistry of acid rain, case studies; ozone chemistry and ozone layer depletion, role of CFCs in ozone depletion. Physicochemical properties of water; alkalinity and acidity of water, hardness of water, solubility of gases in water, metal complex formation and chelation; heavy metals in water. Soil composition; 7 relations between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation exchange reactions in soil; NPK in soil.

## Unit III:

### Chemistry of environmental pollutants

Solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage.

## Unit IV

### Air pollution

Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO<sub>x</sub>, SO<sub>x</sub>, PM, CO, CO<sub>2</sub>, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

## Unit V

### Water pollution

Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

### Suggested books:

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsidas Bhanot Publishers.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
5. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.

### Mapping of CO-PO

### Chemistry of Environmental pollutants

S. No.	
UNIT 1	Fundamentals of environmental chemistry
UNIT 2	Air, Water and Soil chemistry
UNIT 3	Chemistry of environmental pollutants
UNIT 4	Air pollution
UNIT 5	Water pollution

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**Course outcome**

CO-1 students will be able to understand the fundamentals of environmental chemistry

CO-2 students will be able to understand the structure and composition of air, water and soil.

CO-3 students will be able to understand the basic chemistry of environmental pollutants.

CO-4 students will be able to understand the cause of air pollution

CO-5 students will be able to understand the cause and chemistry of surface and groundwater pollution

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	2	2	1	2	3
CO2	3	3	3	2	3	3	3	1	2	2
CO3	2	3	3	3	2	2	2	-	3	3
CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	3	3	3	3	3	2	1	3	3

2- Not related; 1- low; 2- medium; 3- high

### LAB

1. Study of functioning and operations of important instruments and equipments: Thermometer, pH meter, Conductivity meter, Sampling bottle, Plankton net, Sedgewick rafter, Luxmeter.
2. Analysis of common aquatic parameter: dissolved oxygen, free carbon dioxide, pH, Alkalinity.
3. Analysis of common Soil parameter: oxygen, carbon dioxide, pH Alkalinity
4. Determination of Soluble Salts from Soil.
5. Estimation of total hardness; chloride; acidity and alkalinity of water sample by titrimetric method

### BCH063: Atmospheric Chemistry and Climate concerns

#### Course outcomes

CO-1 students will be able to understand structure and composition of atmosphere

CO-2 students will be able to understand earth's energy balance, greenhouse effect.

CO-3 students will be able to understand the chemistry of atmospheric particles and gases.

CO-4 students will be able to understand the potential of different greenhouse gases causing the climate change

CO-5 students will be able to understand the importance of ozone layer and the factors responsible for its depletion.

#### Unit I:

##### Introduction

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles.

#### Unit II:

##### Global energy balance

Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.

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### Unit III:

#### Atmospheric chemistry

Chemistry of atmospheric particles and gases; smog – types and processes; photochemical processes; ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere.

### Unit IV

#### Global warming and climate change

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO<sub>2</sub> fertilization and agriculture; impact on economy and spread of human diseases.

### Unit V

#### Ozone layer depletion

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols.

#### Suggested books

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications

#### Mapping of CO-PO

#### **BCH063: Atmospheric Chemistry and Climate concerns**

S. No.	
UNIT 1	Introduction
UNIT 2	Global energy balance
UNIT 3	Atmospheric chemistry
UNIT 4	Global warming and climate change
UNIT 5	Ozone layer depletion

#### Course outcomes

CO-1 students will be able to understand structure and composition of atmosphere

CO-2 students will be able to understand earth's energy balance, greenhouse effect.

CO-3 students will be able to understand the chemistry of atmospheric particles and gases.

CO-4 students will be able to understand the potential of different greenhouse gases causing the climate change

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CO-5 students will be able to understand the importance of ozone layer and the factors responsible for its depletion.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	2	3	1	2	3
CO2	3	3	3	2	3	3	3	1	2	2
CO3	2	3	3	3	2	2	2	-	2	3
CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	3	3	3	3	3	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

### LAB

1. Estimation of atmospheric pressure, relative humidity, rainfall, insolation, wind speed, light intensity (Lux meter)

### BCH064: Water and Air Pollution monitoring and Control Technology

#### Course outcomes

- CO-1 Students will be able to understand the generation of waste water and their characteristics
- CO-2 Students will be able to understand various methods of analysis waste water
- CO-3 Students will be able to understand the basic processes of primary and secondary treatment of waste water
- CO-4 Students will be able to understand the collection of gaseous pollutants and their monitoring and analysis
- CO-5 Students will be able to understand the techniques involved in control of air pollution

#### Unit I

##### Waste water

Generation of waste water, categories of waste water and their characteristics, water resource management

#### Unit II

##### Waste water sampling and monitoring

Methods of analysis, determination of organic matter, inorganic substances, physical characteristics, concept of oxygen demand- DO, BOD, COD and bacterial measurements.

#### Unit III

##### Waste water treatment

Basic processes of primary treatments, pretreatment, sedimentation and floatation.

Secondary treatments: activated sludge process, trickling filter, rotating biological contractors, sludge treatment and disposal advanced waste water treatment, N- removal, P- removal, advanced biological systems, chemical oxidation, removal of suspended solids, dissolved solids.

#### Unit IV

##### Meteorological aspects of air pollutants dispersion

Temperature lapse rate and stability, wind roses, plume behaviour, dispersion of air pollutants,

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solution to the atmospheric dispersion equation, air pollution management.

#### **Air sampling and monitoring**

Collection of gaseous pollutants, collection of particulate pollutants, stack sampling monitoring and analysis of air pollutants.

#### **Unit V**

#### **Air pollution control**

Air pollution control techniques and equipments, particulate emission control by gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubbers  
Control of specific gaseous pollutants, control of  $SO_x$ , control of  $NO_x$ , control of hydrocarbons and control of carbon mono oxide.

#### **Suggested books**

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts, CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsidas Bhanot Publishers.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
5. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA

#### **Mapping of CO-PO**

#### **BCH064: Water and Air Pollution monitoring and Control Technology**

S. No.	
UNIT 1	Waste water
UNIT 2	Waste water sampling and monitoring
UNIT 3	Waste water treatment
UNIT 4	Meteorological aspects of air pollutants dispersion, Air sampling and monitoring
UNIT 5	Air pollution control

#### **Course outcomes**

CO-1 Students will be able to understand the generation of waste water and their characteristics

CO-2 Students will be able to understand various methods of analysis waste water

CO-3 Students will be able to understand the basic processes of primary and secondary treatment of waste water

CO-4 Students will be able to understand the collection of gaseous pollutants and their monitoring and analysis

CO-5 Students will be able to understand the techniques involved in control of air pollution

#### **MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES**

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	2	2	2	1	1	2	2
CO2	3	3	3	2	3	3	3	1	2	2
CO3	2	3	3	3	2	2	2	-	3	3

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CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	2	3	2	3	3	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

## Lab : ANALYTICAL METHODS, INSTRUMENTATION AND MEASUREMENT

1. Identification of rocks & minerals (Hand Specimen) a) Rocks- Granite, Basalt, Dolerite, Shale, Sandstone, Limestone, Slate, Marble, Quartzite, Gneiss b) Minerals- Talc, Bauxite, Mica, Quartz, Hematite, Galena
2. Topological sheet interpretation for geomorphology.
3. Determination of Optimum Dose of Alum (Coagulant) required for water.
4. Determination of Turbidity of water. (Turbidimeter / Nephelometer)
5. Determination of Residual Chlorine from treated water.
6. Determination of Dissolved Oxygen in water by Winkler's method
7. Determination of Nitrate from water ( Calorimeter)
8. Determination of Phosphate from water. (Colorimeter)

## BCH065: Solid and Hazardous Waste Management

### Course outcomes

CO-1 students will be able to understand the source and generation of solid waste.

CO-2 students will be able to understand the effect of solid waste disposal on environment

CO-3 students will be able to understand different techniques used in collection, storage, transportation and disposal of solid waste

CO-4 students will be able to understand effect of hazardous and non-hazardous industrial waste on air, water and soil

CO-5 students will be able to understand the concept of energy recovery from waste

### Unit I

#### Introduction

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

### Unit II

#### Effect of solid waste disposal on environment

Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

### Unit III

#### Solid waste Management

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste

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management techniques.

### **Integrated waste management**

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.

### **Unit IV**

#### **Industrial waste management**

Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

### **Unit V**

#### **Resource Recovery**

4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

#### **Waste- to- energy (WTE)**

Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

#### **Suggested books**

1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.
5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. & Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.

### **Mapping of CO-PO**

#### **BCH065: Solid and Hazardous Waste Management**

S. No.	
UNIT 1	Introduction
UNIT 2	Effect of solid waste disposal on environment
UNIT 3	Solid waste Management, Integrated waste management
UNIT 4	Industrial waste management
UNIT 5	Resource Recovery, Waste- to- energy (WTE)

#### **Course outcomes**

CO-1 students will be able to understand the source and generation of solid waste.

CO-2 students will be able to understand the effect of solid waste disposal on environment

CO-3 students will be able to understand different techniques used in collection, storage, transportation and disposal of solid waste

CO-4 students will be able to understand effect of hazardous and non-hazardous industrial waste on air, water and soil

CO-5 students will be able to understand the concept of energy recovery from waste

#### **MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES**

*[Handwritten signatures and initials]*

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	2	1	2	2	1	2	3
CO2	3	3	3	2	3	3	2	1	2	2
CO3	2	3	2	3	2	2	2	-	3	3
CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	3	3	3	3	3	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

### LAB

1. Visit to a Solid Waste Management site and Report submission

## BCH066: Environmental Policies, Conventions and Protocols

### Course outcomes

CO-1 Students will be able to understand causes and impacts, principles, objectives of National environment policy (NEP)

CO-2 Students will be able to understand National environment policy (NEP)

CO-3 Students will be able to understand International environmental policies I

CO-4 Students will be able to understand International environmental policies II

### Unit I

#### National environment policy (NEP) I

Key environmental challenges. Causes and impacts, principles, objectives of NEP, strategies and actions, regulatory reforms, enhancing and conserving environmental resources, environmental standards- EMS, ecolabelling and certification, environmental awareness and education, partnership and stakeholder involvement, international cooperation, environment and development policies: industrial policies, land use policies, land and agricultural policies, resettlement and rehabilitation policies.

### Unit II

#### National environmental policies (NEP) II

National forest policy, National water policy, National action plan on climate change: Overview, Principles and approach, mission for solar, water enhanced efficiency, sustainable habit and green India

### Unit III

#### International environmental policies I

Stockholm conference 1972, UNCED and earth summits, World summit on sustainable development (WSSD) 2002, International conventions: CITES. Ramsar convention on Wetlands, world heritage convention 1972, London convention 1972, Vienna convention 1985.

### Unit IV

#### International environmental policies II

Basel convention 1989, convention on biological diversity 1992, United Nations Framework convention on climate change 1992, Stockholm convention on POP 2001, Protocols: Kyoto protocol, Montreal protocol, Cartagena protocol on Biosafety.

### Suggested books

*[Handwritten signatures and initials]*



1. McKibben, B. 2012. Global Warming's Terrifying New Math, Rolling Stone Magazine.
2. Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. Resources of the Earth: Origin, use, and environmental impact (2nd edition). Prentice Hall, New Jersey.
3. Rowlands, I.H. 2009. Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies in Debora L. Van Nijnatten and Robert Boardman (eds), Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. 167-82.
4. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July.
5. Mallon, K. 2006. Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making. Earth Scan.
6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.

### Mapping of CO-PO

### **BCH066: Environmental Policies, Conventions and Protocols**

S. No.	
UNIT 1	National environment policy (NEP) I
UNIT 2	National environmental policies (NEP) II
UNIT 3	International environmental policies I
UNIT 4	International environmental policies II

### **MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES**

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	3	2	1	2	2	2	3
CO2	3	3	3	2	3	3	3	1	2	2
CO3	2	3	3	3	2	2	2	-	3	3
CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	3	3	3	3	3	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

### **LAB**

Review of different Case studies on Environmental Issues and power point presentation.

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## DE-6 Food Chemistry & Technology BCH067A-BCH076A

Paper-I Basic Food Constituents

Paper-II Chemistry of Food additives & Beverages

Paper-III Food Contamination & Preservation Techniques

Paper-IV Indian traditional food storage practices and their relevance

Paper-V Food Standards, Quality Assurance and Evaluation

Paper-VI Green Chemistry

### Paper-1: BCE067A Basic Food Constituents

CO1: Understand about classification of foods into different groups.

CO2: Gain knowledge about the composition and nutritive value of different foods.

CO3: Understand the different methods of cooking food.

CO4: Demonstrate skills to use appropriate cooking method for various food groups.

#### Unit-1 Food groups

Definition of food, food as source of nutrients, food composition and its relation to food groups and functions of foods

#### Unit-2 Food preparation

Methods of cooking (moist, dry and combination), their advantages and disadvantages and effects on nutritive value.

#### Unit-3 Cereals

Structure of wheat and rice, Composition and nutritive value of specific cereals (wheat, rice, maize, oats, rye and barley) and millets (pearl millet, finger millet, sorghum); methods of cereal cookery.

#### Unit-4 Pulses

Composition and nutritive value of certain beans, lentils and peas, toxic constituents of pulses, methods of pulse cookery.

#### Unit-5 Nuts and oilseeds

Composition and nutritive value of certain nuts and oilseeds (almonds, cashews, coconut, groundnut, walnut, flaxseed, soya bean, sesame and sunflower); role of nuts and oilseeds in cookery.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

*[Handwritten signatures and marks indicating mapping of course outcomes to program outcomes]*



	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	1	1	2	2	3
CO2	2	2	2	2	2	1	2	2	1	3
CO3	3	2	1	3	3	1	2	2	1	3
CO4	3	2	1	3	1	1	2	2	1	3

#### BCE068A: Practical:

1. Standard measurement of raw and cooked foods
2. Determination of edible portion of foods
3. Methods of cooking – for different food groups:
4. Moist heat – boiling, simmering, steaming, pressure cooking.
5. Dry heat methods – braising, roasting, panning and baking. Fat as a medium of cooking – sautéing, shallow fat frying and deep fat frying.
6. Stages of sugar cookery.

#### Suggested Readings

1. Bennion M. Introductory foods, McMillan Publishing Co. 1985.
2. Manay SN and Shadaksharaswamy M. Foods: Facts and Principles, New Age International (P) Ltd. New Delhi. 2010.
3. Srilakshmi B. Food Science, New Age International Pvt. Ltd. India. 2018.
4. Mathew S. Practical Manual of Introductory Foods, Agrobios (India), Jodhpur. 2001.
5. Mudambi SR and Rajagopal, MV. Fundamentals of Foods and Nutrition, New Age International (P) Ltd., Publishers, 4th edn, New Delhi. 2008.

#### Paper II: BCE069A Chemistry of Food additives & Beverages

**CO1:** Develop a sound understanding about various biochemical components of foods and their properties and application in food processing.

**CO2:** Understand about classification, structure and functions of carbohydrates and fatty acids.

**CO3:** Understand about the importance of Biochemistry of proteins, amino acids and Enzymes.

**CO4:** Develop a sound knowledge about the importance and application of enzymes in Food processing.

#### Unit-I

##### Introduction to food chemistry

Approach to the study of Food Chemistry-biochemical changes in foods, moisture in foods, water activity and sorption isotherms, shelf life of foods, Hysteresis. Scope and importance of biochemistry, Biomolecules.

#### Unit-II

##### Colloidal solutions

Definition, classification of colloidal solutions, protective colloids and gold number. Introduction

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to the proximate composition of foods, official methods for the analysis of foods – AOAC, AACC, AOCS,

### Unit-III

#### Carbohydrates

Introduction, classification of Carbohydrates, structure and food sources, chemical properties, functional properties of carbohydrates. Crude fiber, browning reactions in foods, application of stabilizers and thickeners in foods.

### Unit-IV Lipids

Classification, Sources and Chemistry of lipids-physical properties and chemical properties in foods. Role of fat and applications in food preparation. Shortenings – shortening value and factors affecting it.

### Unit-V

#### Proteins & Enzymes

Definition, classification, structure of amino acids, Essential and nonessential amino acids, Biologically important proteins, Enzymes, Nomenclature and Classification and functions of enzymes of Enzymes, Holo enzymes, apoenzymes, Co-enzymes & cofactors, mechanism of action, Enzyme Inhibition. Impact of Temperature, PH, and substrate concentration on enzyme activity, Application of Enzymes in food industry.

#### Books for Reference:

1. Dr. Ling, H D Belitz, Dr. Ing, W. Grosch, *Food Chemistry*, Springer, New York, 1987.
2. Braverman, *Introduction to the Bio-Chemistry of Foods*, Elsevier Scientific Publishing Company.
3. AOAC methods for food analysis.
4. Meyer, *Food Chemistry*, AVI Publishing Company, USA 1983.
5. Sadasivam and Manickam, *Biochemical Methods*, New Age International Publications, New Delhi, 1996.

#### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	1	3	2	2	1	2	3
CO2	3	2	3	2	2	2	1	2	2	1
CO3	2	3	2	2	2	2	1	3	2	2
CO4	3	3	2	3	3	3	2	3	3	2

#### BCE070A: Chemistry of Food additives & Beverages (PRACTICAL)

1. Laboratory safety Rules and Precautions.
2. To study the development of gluten in various flours.
3. Qualitative tests for mono, di and polysaccharides and their identification in unknown mixtures.
4. Quantitative estimation of glucose by Anthrone method
5. Determination of Acid Number in Lipids.



6. Qualitative tests for proteins.
7. Quantitative estimation of protein by Lowry's Method.

### Suggested Readings

1. Sadasivam and Manickam, *Biochemical Methods*, New Age International Publications, New Delhi, 1996.
2. Hawk PB, Oser BL and Summerson WH (1954). *Practical Physiological Chemistry*, McGraw Hill, New York.
3. Sundararaj P and Siddhu A (2006). *Qualitative Tests and Quantitative Procedures in Biochemistry*. Elite Publishing House Pvt. Ltd., New Delhi.

### Paper III: BCE071A: Food Contamination & Preservation Techniques

- CO1:** Develop a sound understanding about various biochemical components of foods and their properties and application in food processing
- CO2:** Understand about classification, structure and functions of carbohydrates and fatty acids.
- CO3:** Understand about the importance of Biochemistry of proteins, amino acids and Enzymes.
- CO4:** Develop a sound knowledge about the importance and application of enzymes in Food processing

#### Unit- I Classification of different foods of plant origin:

Cereals, Millets, Composition & constituents- Post harvest handling, Storage, methods of infestation.

#### Unit-II Processing of cereals, pulses, fats, oil seeds:

Processing and product development with maize, sorghum and ragi. Processing of Pulses along with different pre-treatments. Oil expelling methods with emphasis on Sesame, Sunflower, Mustard, Palm, Coconut, groundnut and Rice bran oils. Refining, Hydrogenation and Shortenings.

#### Unit-III Fruits and Vegetables:

Different processing operations – Fruit Juices, Squashes, Cordial, Jam, Jelly, Marmalade, Chutneys, Sauces, Pickle Processing along with Principles and methods of preparation and their usage in different communities.

#### Unit-IV Classification and composition of Spices and Plantation crops:

Study of special attributes of main spices like Pepper, Cardamom, Ginger, Garlic, Turmeric, Nutmeg, Coriander and Cinnamon. Chillies, Cocoa, Coffee, Tea and Gum and their processing and preservation methods.

#### Unit – V Classification of animal foods:

Meat and Meat products selection, Meat and Meat Products, Egg & Avian Products, Milk & milk products, Fish & Fishery products, and their composition. Characters of animal foods and selection of different animal foods for processing.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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CO1	2	3	2	2	2	2	2	3	2	3
CO2	3	3	3	2	2	2	2	2	2	1
CO3	3	3	2	2	2	2	1	3	2	2
CO4	3	3	2	3	3	3	2	3	3	2

### Suggested Readings

1. J.L. Multon, A.M. Riembert, D. Marsb& A.J. Eydt 1st edition, *Preservation & Storage of Grain, Seeds and their Products*, CBS Publications and Distributors, Delhi.
2. Kent, *Cereal Technology*, Oxford Perman Press, London.
3. Giridharlal, Sidappa and G.L. Tandon, *Preservation of Fruits and Vegetables*, ICAR, New Delhi.
4. Dey.S, *Outlines of Dairy Technology*, Oxford University Press, New Delhi, 1994.
5. Lawrie R.A, *Meat Science*, Paragon Press Oxford, New York.
6. Borgstorm G. *Fish as Food*, Vol-4, New York Academic Press.

### BCE072A Practicals:

1. Determination of quality parameters of rice and wheat.
2. Processing of flaked, parboiled and puffed rice.
3. Experiments on flour quality.
4. Flow properties of different raw materials (flours and grains)
5. Processing of different wheat products.
6. Planning and preparation of malted products.
7. Processing and preservation of different fruit and vegetable based products (jams, jelly, marmalade, pickles, squashes, juices and cordials).
8. Visit to rice and wheat/millet processing industry and study of different equipment.
9. Visit to fruits, vegetables & spice processing industry and study of processing.

### Suggested Readings

1. Giridharlal, Sidappa and G.L. Tandon, *Preservation of Fruits and Vegetables*, ICAR, New Delhi.
2. Dey.S, *Outlines of Dairy Technology*, Oxford University Press, New Delhi, 1994.
3. Lawrie R.A, *Meat Science*, Paragon Press Oxford, New York.
4. Borgstorm G. *Fish as Food*, Vol-4, New York Academic Press.

### Paper-IV: BCE073A: Indian Food Industry: Past and present scenario

After the completion of this course student will be able to understand about the

CO1: Food practices in India, pros and cons

CO2: Global demand of Indian food, bakery, confectionary etc Industry, food processing and role of Ministry of food

CO3: demand and supply, food laws

CO4: Future priorities in Food Production and processing agencies. Status of food processing industry in India & Abroad, employment generation



### Unit-I

Classification of food crops, food Losses, production and estimation of Post Harvest losses, traditional Indian food storage practices and their relevance in current Scenerio. Development Programmes and strategies to eliminate food loses.

### Unit-II

Dairy, Bakery, Confectionary. Beverage and Snack foods and their growth, popularity of Indian foods, National and International Projects and their food products. Global Demand for food, World Food Day, its importance and Action plan.

### Unit-III

Ministry of food processing industries (MOFPI), objectives and functions, APEDA-its objectives and functions, food characteristics, classification of foods, types of foods, convenience foods - Recent Trends for processing of foods, genetically modified foods.

### Unit-IV

Functional Foods and their advantages and disadvantages, Food Demand and Supply, Factors affecting Food Demand, Food Laws, Factors affecting food laws.

### Unit-V

Employment Generation, through post harvest operations. Future priorities in Food Production need magnitude and Inter Dependence of food production and processing agencies. Status of food processing industry in India & Abroad, Indian food industry, Reasons for slow growth, Scope for Expansion

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	3	2	3
CO2	3	3	1	2	1	1	2	1	2	1
CO3	2	1	2	2	2	2	1	3	2	2
CO4	3	3	2	3	3	3	2	3	3	2

### Suggested Readings

1. NN Potter, Food Science III edition., AVI Publishing co. Inc., west port, USA, 1978.
2. K. VijayaRaghavan, *Agricultural Administration in India*.
3. Chiddasingh, *Modern Techniques of Raising Field crops*, Oxford & IBH Publishing co, New Delhi.
4. Graf and Saguy, *Food product Development*, CBS Publishers, New Delhi.
5. M. Swaminathan, *Food and Nutrition*, Voll &II, The Bangalore Printing &Publishing co.ltd,

Bangalore,

6. Mahata, B., Banji, N. Prashad and Vinodini Reddy Text Book of Human Nutrition, Oxford Publishing Co., Ltd. New Delhi,

### **BCE074A : Practicals**

1. Preparation of Beverages and comparison with regular beverages commonly found in the market.
2. Identification of food crops according to various categories.
3. List the processed and RTE food products available in the market
4. Processing and production of the products from major food groups.
5. Evaluation of the quality parameters of prepared food product.
6. Preparation of a recipe using functional foods.
7. Estimation of post-harvest loss during low temperature storage.

### **BCE075A: Food Standards, Quality Assurance and Evaluation**

- CO1:** Understand about basic food groups, food components and their nutritive value.  
**CO2:** Understand various methods and principles of cookery for different food groups.  
**CO3:** Gain knowledge about food laws and standards for food quality.  
**CO4:** To know about food additives and quality control of foods.

#### **UNIT-I**

##### **Principles of Quality control of foods**

Raw material control, processed food control and finished product inspection. Leavening agents- classification, uses and optimum levels. Food additives - Preservatives, colouring, flavouring, sequestering agents, emulsifiers, antioxidants.

#### **UNIT-II**

##### **Standardisation systems for quality control of foods**

National and International standardization system, GMP, GHP. Different types of food grade materials. Food adulteration - Common adulterants in foods and tests to detect common adulterants.

#### **UNIT-III**

##### **Standards for foods**

Cereals and pulses, milk and milk products, Coffee, tea, sugar and sugar products.

#### **UNIT-IV**

##### **Methods for determining quality**

Subjective and objective methods. Sensory assessment of food quality-appearance, color, flavour, texture and taste, different methods of sensory analysis, preparation of score card, panel criteria, sensory evaluation room.

#### **UNIT-V**

##### **Food safety, Risks and hazards**

Food related hazards, Microbial consideration in food safety, HACCP-principles and structured approach. FSSAI

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## Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	3	2	2	2	3	2	3
CO2	2	2	1	3	1	3	3	3	2	1
CO3	2	1	2	3	2	2	1	3	3	2
CO4	3	3	2	3	3	3	2	3	3	2

### Suggested Readings

1. Food science-Norman potter
2. Food Technology-Prencott,S.C.and Procter
3. Food chemistry-Meyer
4. Food science,Chemistry and experimental foods-M.Swaminathan
5. Food chemistry-Lee
6. Food science-Srilakshmi(2001)2nd edition, New age international publishers-(2001)
7. Rerfus,K.Guthrie-Food sanitation -3rd edition -Van Nostrand Reinhold Newyork 1988.
8. Mahirdra-S.N.-Food safety -A techno-legal analysis-Tata McGrawhill publishers 2000.
9. ManoranjanKalia-Food processing and preservation.
10. Roday-Food hygiene and sanitation.
11. Indian Food industry,2000,Vol19:2

### BCE076A: Practical's: Food Safety And Quality Control

1. Market survey of preserved fruits and vegetable products.
2. Visit to food testing lab or any agency of food standards.
3. Nutrition labeling requirements and developments.
4. Simple tests for food adulteration.
5. Case study on food safety issues - ICDS/MDM, Diarrheal outbreak / any other.

### DE 7 Forensic chemistry and toxicology BCH077A- BCH078A

#### Prerequisites:

- Paper-I Bio Inorganic Chemistry; Presence and role of metals in human body and biological system  
Paper-II Biochemistry and Forensic Medicines; Drug Analysis  
Paper-III Chemistry of Forensic Toxicology and Forensic Ballistics & Explosives  
Paper IV Chemical Analysis of Physical Evidence

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## Paper-V Instrumental Methods in Forensic Chemistry

## Paper-VI Green Chemistry

### Paper-I: BCH077A: Bio Inorganic Chemistry; Presence and role of metals in human body and biological system

#### Course outcome

CO1: Students will be able to analyze the structure and functions of metal ions containing biomolecules

CO2: Students will be able to understand the principle and mechanism of various cycles involved in energy production

CO3: Students will be able to understand structure and functions of DNA and RNA

CO4: students will be able to understand structure and functions of hemoglobin, myoglobin, hemocyanin and hemerythrin

CO5: students will be able to understand about disease caused due to metal deficiency and toxic effects of metals

#### Unit-I

##### Metal Ions in Biological Systems

Bulk and trace metals with special reference to Na, K, Mg, Ca, Fe, Cu, Zn, Co, and  $K^+/Na^+$  pump.

##### Metal Storage and Transport

Ferritin transferrin, and siderophores.

#### Unit-II

##### Bioenergetics and ATP Cycle.

DNA polymerisation, glucose storage, metal complexes in transmission of energy; chlorophyll's, photosystem I and photosystem II in cleavage of water.

#### Unit-III

##### DNA and RNA

Metal complexes of polynucleotide, nucleosides and nucleic acids (DNA and RNA)

Template temperature stability of DNA.

#### Unit-IV

##### Transport and Storage of Dioxygen

Haem proteins and oxygen uptake structure and function of haemoglobin's, myoglobin, haemocyanin and hemerythrin, model synthetic complexes of iron, cobalt and copper.

#### Unit-V

##### Metals in Medicine

Metal deficiency and disease, (Iron, Zinc, Copper) toxic effects of metals. metals used for diagnosis and chemotherapy with particular reference the anticancer drugs.

#### Suggested Books References:

1. Principles of Bioinorganic Chemistry. S.J. Lippard and J.M. Berg University Science Books.
2. Bioinorganic Chemistry, I Bertini, H.B. Gray. S.J. Lippard and Jon Valentine, University Science Books.
3. Inorganic Biochemistry Vols I and II Ed.
4. Progress in Inorganic Chemistry Vols. 11 18 Ed J.J. Lippard Wiley.
5. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
6. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
7. Inorganic biochemistry vol. I and II ed. G.L. Eichhorn, Elsever.

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8. Progress in Inorganic Chemistry, Vol 18 and 38 ed J.J. Lippard, Wiley.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	-	1	2	1	2	3
CO2	3	3	3	2	1	1	3	1	2	2
CO3	2	3	3	3	1	1	2	-	3	3
CO4	3	2	1	3	3	-	2	1	3	2
CO5	3	3	3	3	3	1	2	1	3	3

3- Not related; 1- low; 2- medium; 3- high

BCH078A: Lab  
Seminar

Paper II: BCH079A Biochemistry and Forensic Medicines; Drug Analysis

#### Course outcome

- CO1: Students will be able to understand the basics of drug chemistry  
CO2: Students will be able to understand the classification of drugs and effects of drugs of abuse on human health.  
CO3: Students will be able to understand about basic laboratory analysis of drugs of abuse  
CO4: Students will be able to understand the spectroscopic analysis of drugs of abuse  
CO5: Students will be able to understand the illegal use of drugs in sports

#### Unit I

##### Drug

Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry.

#### Unit II

##### Drugs of Abuse

Definition, Classification based on Form and Origin, Use, Effects and Schedules, Structure of NDPS Act and the definitions of each drug classification, Drugs as Evidence, Profiling Examples of Illegal Drugs, United Nations International Drug Control Programme.

#### Unit III

##### Analysis of Drugs of Abuse

Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Presumptive/Screening and Confirmatory Methods: Color/spot test, microscopic examination, Microcrystalline tests, Thin-Layer Chromatography, Sample Preparation before TLC Specimen, Extraction Evaluation of TLC for Drug Screening, Immunoassay Methods.

#### Unit IV

##### Spectroscopic analysis of Drugs of Abuse

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UV Spectrophotometry, IR/FTIR Spectrophotometry, NMR, GC-MS & HPLC/LC-MS, Legal Implications and Data Interpretation of Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine & other amphetamine derivatives), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances, Drugs in sexual assault

## Unit V

### Drug Abuse in Sports

Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.

### Suggested Books References:

1. Clarke's Analysis of Drugs and Poisons, (Formerly Isolation & Identification of Drugs) 3rd Ed. 2 Vol. Set.
2. Clark, E.G.C.: Isolation and identification of Drugs, VI and Vol. II, 1966, 1975-1986.
3. Modi, Text Book of Medical Jurisprudence Forensic Medicines and Toxicology (1999) CBS Pub. New Delhi
4. Saferstien (1982) Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.
5. DFS -Working Procedure Manual- Narcotics 6. E. Stahl (1969) Thin Layer Chromatography: A Laboratory Handbook. 7. Saferstein (1976) Criminalistics

### Mapping of CO-PO

#### BCH079A: Biochemistry and Forensic Medicines; Drug Analysis

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	-	2	2	1	2	3
CO2	3	3	3	2	1	3	3	1	2	2
CO3	2	3	3	3	1	2	2	-	3	3
CO4	3	2	1	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	3

0- Not related; 1- low; 2- medium; 3- high

#### BCH080A: Drug analysis (practical)

1. Analysis of Phenolphthalein in trap cases
2. Analysis of forensically important cosmetics
3. Analysis of Dyes, Pigments & Polymers
4. Presumptive Drug Testing by Color/spot test, Microcrystalline testing
5. Analysis of Drugs by Thin Layer Chromatography, High Pressure Liquid •
6. Chromatography and Gas Chromatography-Mass Spectrometry
7. Quantitative drug analysis by UV-vis spectrophotometer

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## Paper III: BCH081A Chemistry of Forensic Toxicology and Forensic Ballistics & Explosives

### Course outcomes

- CO1: Students will be able to understand the basics of forensic toxicology
- CO2: Students will be able to understand the core concept of internal and external ballistics
- CO3: Students will be able to understand the core concept of terminal and wound Ballistics
- CO4: Students will be able to understand the determination of range of Fire
- CO5: Students will be able to understand the types of explosive and mechanism of explosions

### Unit I

**Forensic Toxicology:** Introduction, History and Pioneers (Paracelsus, Mary Blandy James Marsh and M. J. B. Orfila), International organization related to Forensic Toxicology, Different mode of Classification of Poisons, Areas of Forensic Toxicology, Elements of Forensic Toxicology, Applications, Scientific Principles, Instrumentation and equipments, Nature of cases, Role of the Forensic Toxicologist, Laws related to Forensic Toxicology.

### Unit II

**Core concepts of Internal Ballistics:** Definition, Ignition of the propellant, Shapes of Propellants, Manner of the propellant burning, Piobert's law, Pressure space curve, Shot Start Pressure, All Burnt Point, Velocity, Le Du's formula, Muzzle velocity, various factors affecting the internal ballistics: lock time, barrel time, erosion, corrosion and gas cutting, equation of motion of projectile, Density of loading, Heat problems, Vibration & jump, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.

**Core concepts of External Ballistics:** Bullet Drop in the flight, Use of sight to compensate for bullet drop, Influence of Earth on Trajectory, Angle of Fall, Ballistic Coefficient and Air resistance-base drag, Sectional Density, Brief introduction to Terminal velocity, Maximum effective range, Drift, Yaw, Precession, Nutation, Terminal velocity, Ballistics tables, measurements of trajectory parameters, Escape velocity & Ricochet

### Unit III

**Core concepts of Terminal Ballistics:** Definition, Effect of projectile on hitting the target: function of Bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, Brief introduction to Cavitations (Temporary and Permanent), Ricochet and its effects, stopping power

**Wound Ballistics (Firearm injuries):** Ballistic aspect of firearm injuries, Mechanism of firearm injuries (Lacerations and Shockwaves etc.), Threshold velocity for penetration of skin/flesh/bones, preparation of gel block, penetrative in gel block and other targets, Bullet Entry/Exit Hole Identification, Evaluation of Accident, Suicide, murder and self defense firearm injuries, explosive wounds, evaluation of injuries caused due to shot-gun, rifle, handguns and country made firearms, methods of measurements of wound ballistics parameters, post-mortem and anti-mortem firearm injuries.

### Unit IV

**Determination of Range of Fire-** burning, scorching, blackening, tattooing and metal fouling shots dispersion and GSR distribution, time offering different method employed, and their limitations, Bullet recovery, time of firing.

**Gunshot Residues/ Powder Residues:** Composition of GSR depending upon propellants &

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CO2: Students will be able to understand the characterization of materials like glass, paints, soils, inks, metal etc obtained at crime scene

CO3: Students will be able to understand evidential value of fibers, collection & preservation of hair evidence and fiber evidence.

CO4: Students will be able to understand importance of DNA, technique of analysis and comparison of DNA

CO5: Students will be able to understand chemical nature of blood, visualization of blood stains

## Unit I

### Finger print identification

History, fundamental principles of finger prints, use of visualization reagents in the examination of fingerprints; use of precipitation reactions to detect fingerprints, presentation of developed finger prints.

## Unit II

### Material Characterization

Characterization of glass, paints, soils, inks, metals, fuels, arson

## Unit- III

### Forensic analysis of textile fibers

Principles of fiber transfer and fiber retention, comparison and analysis of fibers and hair, significance and evidential value of fibers, collection & preservation of hair evidence and fiber evidence.

## Unit-IV

### DNA Fingerprinting

Nucleic acids, DNA, structure and composition of DNA, importance of DNA, technique of analysis and comparison of DNA

## Unit-V

### Chemical testing of body fluids

Chemical nature of blood, visualization of blood stains, types of blood, semen, urine.

### Suggested Books References:

1. Forensic Science by H.J.Walls, Universal Law Publishing Co. Pvt. Ltd.
2. Lawyers guide to forensic medicine by B. Knight, Lawman (India) Pvt. Ltd.
3. Frontiers of Forensic edited by P.Chandrashekharan, forensic science society of India.
4. Modi's textbook of medical jurisprudence and toxicology edited by B.V.Subramanyam, Butterworths India.

### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	1	-	3	2	2	2	1

*[Handwritten signatures and initials are present below the table, including "Denu", "S", "P.S.", "Aman", "R", "De", "SSh", and "VSD"]*

CO2	3	2	3	2	1	2	3	1	2	3
CO3	2	3	3	3	1	2	2	-	3	2
CO4	2	2	1	2	3	2	2	1	3	2
CO5	3	2	3	3	3	2	2	-	3	3

0- Not related; 1- low; 2- medium; 3- high

### BCH084A: Chemical Analysis of Physical Evidence(Practical)

- 1.General comparison of Paints, Soils and Glass.
- 2.Miscellaneous evidences (Cloth, Bangles, fibres)
- 3.Evaluation of Crime scene.
- 4.Lifting of prints and impressions by caste and replicas
- 5.Sole prints comparison and their lifting from the scene of crime.
- 6.Study of Lip prints and ear prints.
- 7.Tool Marks examination

### Paper V: BCH085A: Instrumental Methods in Forensic Chemistry

#### Course outcomes

- CO1: Students will be able to understand the basic principle and use of UV-vis spectroscopy in forensic chemistry.  
CO2: Students will be able to understand the basic principle and use of IR and NMR spectroscopy in forensic chemistry.  
CO3: Students will be able to understand the use of electrophoresis and immunoassay in forensic chemistry.  
CO4: Students will be able to understand the use of chromatographic techniques in analysis of forensic materials  
CO5: Students will be able to understand the basic principle of mass spectrometry and absorption spectrometry

#### Unit I

**Spectroscopic analysis:** Definition and Fundamentals of Spectroscopy, Light and Energy, Electromagnetic Radiations, Wavelength and Frequency, Spectroscopy Techniques, Absorption of radiations, Basics of Fluorescence, Phosphorescence and Chemiluminescence spectrometry, Spectrophotometers.

**Ultraviolet and Visible-visible (UV-Vis) Molecular Spectroscopy:** Introduction, Review of UV-Visible spectroscopy-Fundamental laws of spectrophotometry, Deviation from Beer's Law, Instrumentation and techniques, Analytical Protocols, Forensic applications.

#### Unit II

**Infrared Spectroscopy:** Introduction, Review of IR spectroscopy, Dispersive and Non-dispersive IR spectrophotometers, Fourier Transform Infrared Spectroscopy, Instrumentation and Techniques, Analytical Protocols, Interpretation of IR spectra and Forensic applications.  
**Nuclear Magnetic Resonance (NMR):** Basic Principle, Properties of Nuclei, Width of Absorption Lines, Chemical shifts, Spin-spin coupling, Instrumentation, Analytical Protocols and Forensic applications

#### Unit III

**Electrophoresis:** Theory and General Principles, Various factors affecting electrophoresis, Low

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and High Voltage electrophoresis, Horizontal and Vertical Electrophoresis, Electrophoresis for DNA, RNA and Proteins, Electrophoresis techniques Immuno-electrophoresis, Sodium dodecyl sulphate (SDS) polyacrylamide gel electrophoresis, Iso-electric focusing (IEF), Capillary Electrophoresis (CE) -Theory and basic principles, Instrumentation, Forensic applications, DNA Profiling Techniques: PCR, RFLP etc. **Immunossays:** Antigens and antibodies, Basic principles of immunossay, Enzyme immunossays, Radioimmunoassay and Fluorescence immunossay, Application of immunossay in Forensic biological science.

#### Unit IV

**Chromatography:** Introduction, Review of basic principles and Classification of chromatographic techniques, Normal and Reverse Phase chromatography, HPTLC: Principle, Theory and Instrumentation, visualization, Qualitative and Quantitative concepts and Forensic applications.

**Gas Chromatography (GC):** Principles, Theory, Instrumentations, Injection, Columns, Detectors, Sample preparation, Interpretation of spectra, Forensic applications, Pyrolysis GC and Forensic applications.

**High Performance Liquid Chromatography (HPLC):** Principle, Theory, Instrumentation, Column, Detectors, Sample preparation, Interpretation of spectra, Forensic applications, Liquid Chromatography Mass Spectrometry (LC-MS), Forensic applications.

**Ion Chromatography:** Basic Principle, Instrumentation and Forensic applications.

#### Unit V

**Mass Spectrometry:** Basic Principle and Theory, Instrumentations, Techniques: Resolution, Resolving power and Mass Accuracy, Vacuum systems, Ionization types (CI-MS, EI-MS, ECI, FI, APCI), Mass analyzers (Transmission Quadrupole, Quadrupole Ion trap, Time of Flight & Double Focusing), Scanning modes (SIM and SCAN), Tandem Mass Spectrometry and MALDI-TOF

**Atomic Absorption Spectrometry:** Introduction, Basic principles, Theory, Instrumentation and Techniques, FAAS and GFAAS, Interference in AAS-Background correction methods, Forensic applications. **Atomic Emission Spectroscopy:** Introduction, Basic principles, Theory, Instrumentation and Techniques and forensic applications.

#### Suggested Readings

1. James R et al. (2005) Undergraduate Instrumental Analysis
2. Borrow (1980) Molecular Spectroscopy.
3. Wildard, H. H., et al (1974) Instrumental Methods of Analysis.
4. Moonesens A.A. et al (1973) Scientific Evidence in Criminal Cases.
5. Lee & Gaensslen : Advances in Forensic Science, (Vol. 2) Instrumental Analysis.
6. Settle, F.A. (1997) Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall.
7. Sue Jickells and Adam Negrusz (2008) Clarke's Analytical Forensic Toxicology

#### Mapping of CO-PO

Mapping course outcomes leading to the achievement of program outcomes

Course outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	1	1	2	2	2	1	1
CO2	2	2	3	2	-	3	3	1	2	3
CO3	2	3	3	3	1	2	2	-	3	2

*Handwritten signatures and initials are present below the table, including "Dane", "Am", "N", "De", "SBB", and "VOP".*

CO4	2	2	1	2	3	2	2	1	3	2
CO5	3	2	3	3	3	2	2	-	3	3

0- Not related; 1- low; 2- medium; 3- high

#### BCH086A: Analysis of forensic evidences (Practical)

Extracting poisons from viscera/blood and urine samples

TLC separation of pesticides/insecticides & Identification using chromomeric reagents

Identification of Gaseous Poisoning (Carbon Monoxide and HCN)

Detection of metallic poisons using Reinsch Test.

Extraction and analysis of different categories of poisons from viscera

Estimation alcohol in Blood

Microscopic Identification of plant poisons

Analysis of viscera and food material for in case of food poisoning by chemical microscopic and instrumental techniques.

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