



**CIRCULAR NO.SU/B.Sc./CBC&GS /67/2023**

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies, Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **following syllabi of Bachelor of Science with Practical Pattern of Question Paper under the scheme of Choice Based Credit & Grading System** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	<b>B.Sc. Biotechnology (Degree)</b>	<b>IIIrd &amp; IVth semester</b>
2.	<b>B.Sc. Automobile Technology (Degree)</b>	<b>IIIrd &amp; IVth semester</b>
3.	<b>B.Sc. Workshop Technology (Degree)</b>	<b>IIIrd &amp; IVth semester</b>
4.	<b>B.Sc. Refrigeration and Air Conditioning (Degree)</b>	<b>IIIrd &amp; IVth semester</b>
5.	<b>B.Sc.Physics (Optional)</b>	<b>IIIrd &amp; IVth semester</b>
6.	<b>B.Sc.Chemistry (Optional)</b>	<b>IIIrd &amp; IVth semester</b>
7.	<b>B.Sc.Analytical Chemistry (Optional)</b>	<b>IIIrd &amp; IVth semester</b>
8.	<b>B.Sc. Statistics (Optional)</b>	<b>IIIrd &amp; IVth semester</b>

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,  
Aurangabad-431 004.  
REF.NO.SU/2023/670-77  
Date:- 03.06.2023.

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**Deputy Registrar,**  
**Academic Section**

**Copy forwarded with compliments to :-**

- 1] **The Principal of all concerned Colleges,**  
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

**Copy to :-**

- 1] **The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.**
- 2] The Section Officer,[B.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
- 3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
- 4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
- 5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
- 6] The Public Relation Officer, Dr.BAMU,A'bad.
- 7] The Record Keeper, Dr.BAMU,A'bad.

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**Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad**

Syllabus  
**B.Sc. Chemistry**  
**Semester III & IV**

**With effect from 2023-24**



**Prof. Pathan Mohd Arif Ali Khan**  
Chairman  
Board of Studies in Chemistry,  
Dr. Babasaheb Ambedkar Marathwada  
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Dr. Uj

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Prof. Pathan Mohd Arif Ali Khan  
Chairman  
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# Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Choice Based Credit System (CBCS) Curriculum

For Faculty of Science and Technology

Course Structure and Scheme of Examination


BSc. Three year Undergraduate Degree Program

Subject : **Chemistry**

Semester I								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	CHE 111	Core Course (Theory Paper I) <b>Inorganic Chemistry</b>	2	2	50	10	40	20
	CHE 112	Core Course (Theory Paper II) <b>Organic Chemistry</b>	2	2	50	10	40	20
	CHE 121	Lab Course 1 (CHE-111 -CHE-112)	3	1.5	50	10	40	20
<b>Total Credits for Semester I: 5.5 (Theory:04 ; Laboratory: 1.5)</b>								

Semester II								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	CHE 211	Core Course (Theory Paper III) <b>Physical Chemistry</b>	2	2	50	10	40	20
	CHE 212	Core Course (Theory Paper IV) <b>Applied Chemistry</b>	2	2	50	10	40	20
	CHE 221	Lab Course 2 (CHE-211 CHE-212)	3	1.5	50	10	40	20
<b>Total Credits for Semester IV: 5.5 (Theory:04; Laboratory: 1.5)</b>								

Practicals exam of both I and II semester will be conducted at the end of second term

  
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## Chemistry

Semester III								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	CHE 311	Core Course (Theory Paper V) <b>Organic Chemistry</b>	2	2	50	10	40	20
	CHE 312	Core Course (Theory Paper VI) <b>Physical Chemistry</b>	2	2	50	10	40	20
	CHE 321	Lab Course 3 (CHE-311)	3	1.5	50	10	40	20
	CHE 322	Lab Course 4 (CHE-312)	3	1.5	50	10	40	20
SEC	CHE 313 Select any one from SEC-1A & SEC-1B	CHE 313 SEC-1A <b>Laboratory safety and Laboratory Practices</b>	2	2	50	10	40	20
		CHE 313 SEC-1B <b>Water Analysis</b>	2	2	50	10	40	20
<b>Total Credits for Semester III: 07+02 (Theory:04+02; Laboratory: 03)</b>								

Semester IV								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	CHE 411	Core Course (Theory Paper VII) <b>Inorganic Chemistry</b>	2	2	50	10	40	20
	CHE 412	Core Course (Theory Paper VIII) <b>Applied Chemistry</b>	2	2	50	10	40	20
	CHE 421	Lab Course 5 (CHE-411)	3	1.5	50	10	40	20
	CHE 422	Lab Course 6 (CHE-412)	3	1.5	50	10	40	20
SEC	CHE 413 Select any one from SEC-2A & SEC-2B	CHE413 SEC-2A <b>Pharmaceuticals Chemistry</b>	2	2	50	10	40	20
		CHE413 SEC-2B <b>Industrial Fermentation &amp; Alcohol Technology</b>	2	2	50	10	40	20
<b>Total Credits for Semester IV: 07+02 (Theory:04+02; Laboratory: 03)</b>								

Practicals exam of both III and IV semester will be conducted at the end of second term


  
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## Chemistry

Semester V								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	CHE 511	Core Course (Theory Paper IX)	2	2	50	10	40	20
	CHE 512	Core Course (Theory Paper X)	2	2	50	10	40	20
	CHE 521	Lab Course 7 (CHE-511)	3	1.5	50	10	40	20
	CHE 522	Lab Course 8 (CHE-512)	3	1.5	50	10	40	20
SEC	CHE 513	Select any one from SEC-3A & SEC-3B	2	2	50	10	40	20
<b>Total Credits for Semester III: 07+02 (Theory:04+02; Laboratory: 03)</b>								

Semester VI								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	CHE 611	Core Course (Theory Paper XI)	2	2	50	10	40	20
	CHE 612	Core Course (Theory Paper XII)	2	2	50	10	40	20
	CHE 621	Lab Course 9 (CHE-411)	3	1.5	50	10	40	20
	CHE 622	Lab Course 10 (CHE-412)	3	1.5	50	10	40	20
SEC	CHE 613	Select any one from SEC-4A & SEC-4B	2	2	50	10	40	20
<b>Total Credits for Semester IV: 07+02 (Theory:04+02; Laboratory: 03)</b>								

Practicals exam of both V and VI semester will be conducted at the end of second term

  
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Important Notes:

- i) **Nomenclature:** DSC- Discipline Specific Core course, SEC – Skill Enhancement Course, AECC- Ability Enhancement compulsory course, DSE- Discipline Specific Elective, UA- University Assessment ( Semester End), CIA- Continuous Internal Assessment
- ii) **Assessment:** 80% for University Assessment ( Semester End Examination) and 20 % for Continuous Internal Assessment ( CIA)
- iii) Continuous Internal Assessment (CIA): **Theory** (10 Marks): Internal Test 05 Marks (Two Internal Tests of 05 marks each and average of the two test will be considered) and 05 Marks for Assignment/tutorials.
- iv) Continuous Internal Assessment ( CIA): **Practical** ( 10 Marks): 07 Marks for Internal Practical Examination and 03 Marks for record book/submission of collection and field survey report and excursion report
- v) Practical examination : Annual examination

**BSc III Semesters**  
Core course (Theory Paper V)  
CHE-311 Organic Chemistry

Credits 02

Lectures 45

**Aldehydes and Ketones**

[10 L]

Introduction, IUPAC nomenclature, Preparation: from acid chlorides and nitriles. Reactions of aldehydes and ketones with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub>-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemenson reduction, Wolff-Kishner reduction and Meerwein-Ponndorf Verley reduction.

**Carboxylic acids and their derivatives**

[7 L]

**Carboxylic acids (aliphatic and aromatic):** Introduction and IUPAC nomenclature, factors affecting acidity of carboxylic acids. *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell-Vohlard – Zelinsky Reaction.

**Carboxylic acid derivatives (aliphatic):** (up to 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reaction: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

**Amines and Diazonium Salts:**

[6L]

**Amines (Aliphatic and Aromatic):** Introduction and IUPAC nomenclature, *Preparation* from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. *Reactions:* Hofmann vs. Saytzeff elimination. Nitration, bromination and sulphonation of aniline. Preparation of p-bromo aniline from aniline, Diazotization reaction, Sandmeyer reaction.

**Heteronuclear Aromatic Compounds**

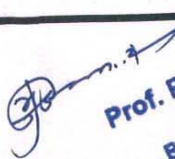
[10 L]

Introduction, Classification of heterocyclic compounds, Structures of pyrrole, thiophene, furan and pyridine and their aromaticity. Basicity of pyrrole, furan thiophene, pyridine and pyrrolidine. Preparation and electrophilic substitution of Furan, Pyrrole, Thiophene, and Pyridine. Chichibabin reaction

**Stereochemistry of Cyclohexane:**

[6 L]

Bayer's strain theory, structure of cyclohexane, axial and equatorial H atoms, heat of combustion of cycloalkanes, conformations and stabilities of methyl cyclohexane, t-butyl cyclohexane, 1,1 dimethyl cyclohexane, 1,2 dimethyl cyclohexane, 1,3 dimethyl cyclohexane, 1,4 dimethyl cyclohexane

  
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**Active Methylene Compounds**

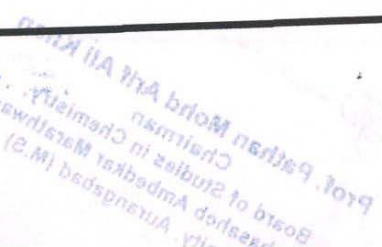
[06 L]

Definition, Preparation of Ethyl acetoacetate and Synthetic uses of ethylacetoacetate.  
Preparation of Diethyl malonate and Synthetic uses of diethyl malonate.

## REFERENCE BOOKS

1. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Prentice Hall of India, Sixth Edition,
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers *Organic Chemistry* - Oxford University Press, USA, 2<sup>nd</sup> Ed.
3. Bahl, A. and Bahl, B.S. *Advanced Organic Chemistry*, S. Chand,
4. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley and Sons
5. Mc Murry, J.E. *Fundamentals of Organic Chemistry*, 7<sup>th</sup> Ed. Cengage Learning India Edition,
6. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi
7. Finar, I. L. *Organic Chemistry* (Vol. I and II), E.L.B.S.

  
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**BSc III Semesters**

Core course (Theory Paper VI)

CHE-312 (Physical Chemistry)

Credits 02

Lectures 45

**Surface Chemistry**

[8L]

Introduction to surface chemistry - some basic terms related to surface chemistry adsorption, adsorption materials, factors affecting adsorption, characteristics of adsorption, types of adsorption, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich's adsorption isotherm, BET theory (only introduction), application of adsorption, Numericals.

**Phase equilibrium**

[8L]

Introduction; definitions of phase, components and degrees of freedom of a system; stability of phases, criteria of phase equilibrium. Gibbs phase rule and its thermodynamic derivation, phase diagrams of one- component systems- water, carbon dioxide and sulphur systems, Numericals.

**Quantum Chemistry**

[10 L]

Introduction, de Broglie hypothesis, The Heisenberg's uncertainty principle, quantization of energy, Operators, Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the  $\psi$  and  $\psi^2$ , sketching of wave function and probability densities for 1D box, degeneracy, applications to conjugated systems, zero-point energy and quantum tunnelling, Numerical

**Photochemistry**

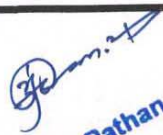
[8 L]

Introduction, Difference between thermal and photochemical processes, Laws of photochemistry: i) Grothus - Draper law ii) Stark-Einstein law, Quantum yield, Reasons for high and low quantum yield., Factors affecting Quantum yield, Experimental method for the determination of quantum yield, types of photochemical reactions - photosynthesis, photolysis, photocatalysis, photosensitization, Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence, Chemiluminescence, Numericals

**Conductometry**

[6 L]

Introduction, Electrolytic Conductance, Resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, variation of equivalent and specific

  
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conductance with concentrations, Kohlrausch's law and its applications, conductivity cell, conductivity meter, Whetstone Bridge, determination of cell constant conductometric titrations (strong acid-strong base, strong acid-weak base, weak acid strong base) and Numericals.


**Colorimetry:**

[5 L]

Introduction, interaction of electromagnetic radiation with matter, essential terms: radiant power, transmittance, absorbance, molar, Lambert's Law, Beer's Law, Lambert-Beer's Law, molar absorptivity, deviations from Beer's Law, Colorimeter: *Principle, Construction and components, Working*. Applications—unknown conc. By calibration curve method, Determination of unknown concentration of Fe(III) by thiocyanate method, Numericals

## REFERENCE BOOKS

- 1 Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition
2. Principles of Physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
3. Essentials of Physical chemistry by Bahl Tuli-Revised, S. Chand and Company Ltd.
4. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton
5. Physical-Chemistry-4<sup>th</sup> Edition - Gilbert W. Castellan (Narosa Publication)
6. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical,.
7. Basic Concept of Analytical Chemistry, S. M. Khopkar, New Age International (UK) Ltd, United Kingdom
8. Analytical Chemistry, G.R. Chatwal, Sham Anand.
9. Instrumental Methods of Chemical Analysis, Chatwal and Anand

  
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**BSc IV Semesters**  
Core course (Theory Paper VII)  
CHE-411 Inorganic Chemistry

Credits 02

Lectures 45

**Coordination Compounds**

[10 L]

Double salt, coordination compound, coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio; Werner's theory, Effective atomic number, equilibrium constant. chelate effect, IUPAC nomenclature. Cationic and anionic complexes, Isomerism in coordination compounds: polymerization isomerism, ionization isomerism, hydrates isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism, optical isomerism.

**Valence Bond Theory of Coordination Compounds**

[6 L]

Aspects and assumptions of VBT, applications of VBT. Hybridization, structure and bonding in Inner orbital complexes  $[\text{Ag}(\text{NH}_3)_2]^+$ ,  $[\text{Ni}(\text{Cl}_4)]^{2-}$ ,  $[\text{Ni}(\text{CN})_4]^{2-}$ ,  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$  and outer orbital complex  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ ,  $[\text{Cu}(\text{NH}_3)_6]^+$ ,  $[\text{FeF}_6]^{3-}$ . limitations of VBT

**Crystal Field Theory**

[12 L]

Shapes of d-orbitals, Assumption of Crystal field Theory (CFT), splitting of 'd' orbitals in Oh ligand field, effect of weak and strong ligand fields, spectrochemical series, crystal splitting energy, Crystal field stabilization energy and factors affecting it, tetragonal distortion in Cu(II) complexes. Crystel field splitting in octahedral, tetrahedral and square planner complexes, application of CFT.

**Oxidation and Reduction**

[06 L]

Introduction, oxidation number, Galvanic cells, Single electrode potential, Signs of Single electrode potential, Standard electrode potentials, Electrochemical series, Nernst equation, Application of Electrochemical series, Source of electric energy in a Galvanic cell, Hydrogen over voltage, Oxygen over voltage, Redox stability in water, Oxidation by atmospheric oxygen, Latimer diagram, Frost diagram, Pourbaix diagram.



**Volumetric analysis**

[07 L]

Introduction, Terminology, Basic requirement of titration reaction, Standard solution, Primary Standards, Expressing concentration of Standard solution, Volumetric titration co-relation, P-Function, Acid-base titration, Theory of acid-base indicators, Mathematical treatment, Redox titration, Complexometric titration, Polydentate titrants for complexometric titration, EDTA titration, Indicators for EDTA titration, Titration curves, EDTA titration methods, Cautions of volumetric titrimetry, Correction for unavoidable errors.

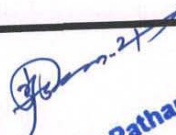
**The Chemistry Of Elements In Medicine**

[04 L]

1) Introduction, Chelation Therapy, Cancer Treatment, Anti-arthritis drugs, Imaging agents.

**Books:**

1. Principles of Inorganic Chemistry by Puri, Sharma and Kaliya.
2. Advanced inorganic chemistry by Gurudeep Raj and Chatwal Anand.
3. Advanced inorganic chemistry vol. II by Satyaprakash, Tuli, Basu and Madan.
4. Inorganic Chemistry by Huheey, Keiter and Keiter.
5. Nuclear Chemistry by Arnikar,
6. Concise Inorganic Chemistry by J. D. Lee.
7. Vogel's Qualitative Inorganic Analysis (Seventh Edition),
8. A text book of Practical Chemistry for B. Sc. By V. V. Nadkarny, A. N. Kothare and Y. V. Lawande.
9. Advanced practical inorganic Chemistry by O. P. Agarwal

  
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**BSc IV Semesters**

Core course (Theory Paper VIII)

CHE-412 Applied Chemistry

Credits 02

Lectures 45

**Infrared Spectroscopy:**

(10L)

Introduction, Simple Harmonic oscillator, Modes of vibration, force constant, Vibrational spectrum of a diatomic molecules: Vibrational Energy expression, Allowed vibrational energies, zero-point energy, Selection rule, Vibration- rotation Spectra: Born-Oppenheimer approximation, Energy expression for vibrational rotor, Interpreting IR Spectra: functional group and fingerprint region. Infra-red spectroscopy in organic molecules, IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on  $>C=O$  stretching absorptions. Numericals.

**Raman Spectroscopy:**

(4L)

Introduction, Classical and Quantum theory of Raman Effect, Rayleigh, Stokes and anti-stokes lines, pure rotational Raman spectra of linear diatomic molecules

**Dyes and Pigments**

(9 L)

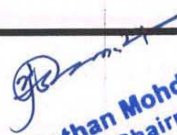
**Dyes:** Introduction, qualities of good dye, Colour constituents (Chromophore, auxochrome), classification of dyes according to their application, Synthesis and uses of following dyes: Nitroso dye-martius yellow, Azo dyes-Methyl orange and aniline yellow, Triphenylmethane dye-Crystal violet, Phthalein dye- Phenolphthalein, Xanthane Fluorescein, Anthraquinone Alizarin and Indigo dyes - Indigo.

**Pigments:** Introduction, classification and general properties of pigments. Inorganic pigments: i) Zinc oxide pigments (Fundamentals and properties, Raw materials, Direct process (American process), Precipitation process) ii) Iron oxide pigments (Fundamentals and properties, Production of iron oxide pigment by precipitation process .

**Polymerization**

(6 L)

Classification of polymerization processes, mechanism of- step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations. Polymerization techniques: bulk, solution, suspension, emulsion and interfacial condensation.

  
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**Molecular weight of Polymers**

(6 L)

Average molecular weight of polymer, Number average molecular weight ( $M_n$ ), Weight average molecular weight ( $M_w$ ), Number average molecular weight by end group analysis, Viscosity average molecular weight by viscometric method, Molecular weight distribution and its significance, polydispersity index

**Cosmetics**

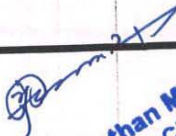
[10 L]

A general study including chemical composition, preparation and uses of the following:

Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), Eye make-up (Mascara, Eyeshadow, Eyeliner, Eyebrow pencil), Antiperspirants, perfume

**Reference Books**

1. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash
2. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18<sup>th</sup> Ed. (2014)
3. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 458-463.
4. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 830-849
5. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1<sup>st</sup> Ed.
6. Shreeve's chemical process industries 5th Edition, G.T. Austin, TATA McGraw-Hill
7. Edition, chemical engineering series
8. Industrial Chemistry, Part-II, R. K. Das, Kalyani Publisher, Second Ed.
9. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1<sup>st</sup> Ed.
10. Polymer Science by V.R. Gowarikar, N.V. Vishvanathan, Jaydev Shreedhar New Age International Ltd. Publisher 1996. (Reprint 2012)
11. Textbook of Polymer Science by Fred Billmeyer, 3<sup>rd</sup> Edn. A Wiley-Interscience Publication
12. John Wiley & Sons New York 1984. (Reprint 2008)
13. Introductory Polymer Chemistry by G.S. Misra New Age International (P) Ltd. Publisher 1996

  
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**BSc III Semesters**

Core course (Practical Paper V)

CHE-321 Physical Chemistry

Credits 1.5

4 Lectures per week

**Chemical Kinetics:**

1. To Study the Acid catalysed hydrolysis of an ester (methyl Acetate) and determine the rate constant (k). (first order reaction)
2. To study the kinetics of saponification reaction between sodium hydroxide and ethyl acetate.
3. To compare the relative strength of HCl and H<sub>2</sub>SO<sub>4</sub> or HNO<sub>3</sub> by studying the kinetics of hydrolysis of methyl acetate.
4. To determine Energy of activation of the reaction between K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> and KI with unequal initial concentration.
5. To determine the order of the reaction with respect to K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> by fractional life method following the kinetics of per sulphate-iodide reaction

**pH Metry:**

6. To determine equivalence point of neutralisation of acetic acid by pH-metric titration with NaOH

**Conductometry:**

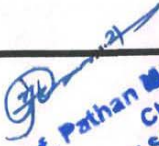
7. To determine the cell constant of the given cell using 0.01 M KCl solution and determine dissociation constant of a given monobasic weak acid.
8. To investigate the conductometric titration of Strong acid against strong base
9. To investigate the conductometric titration of weak acid against strong base

**Colorimetry:**

10. Prepare standard solutions of KMnO<sub>4</sub> / CuSO<sub>4</sub>, record their absorbance and Verify Beer's Law and determine unknown concentration.
11. Prepare solution of Fe(III) and SCN<sup>-</sup> of in different molar proportion, record their absorbance and calculate equilibrium constant of [Fe(SCN)]<sup>2+</sup> complex
12. Prepare solution of Fe(III)/Cu(II) and salicylic acid in different molar proportion and determine metal ligand ratio in Fe(III) or Cu(II)-Salicylic acid complex

**Potentiometry:**

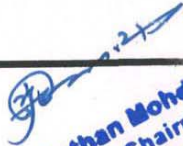
13. Potentiometric titrations of Strong acid vs. strong base

  
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14. Potentiometric titrations of Weak acid vs. strong base
15. Potentiometric titrations of Potassium dichromate vs. Mohr's salt

## Reference books

1. Vogel's Textbook Quantitative Chemical Analysis, 3rd, 6th Ed. A. I. Vogel J. Mendham, et al, Addison Wesley Publishing Co.
2. Experiments in Chemistry by D. V. Jahagirdar Himalaya publication 2014
3. Systematic experimental physical chemistry S. W. Rajbhoj, T. K. Chondekar Anjali publication
4. Practical Physical Chemistry, Vishwanathan and Raghwan Viva book
5. Practical Chemistry O.P. Pandey, D.N. Bajpai & S. Giri, S. Chand & Company Ltd.
6. Senior Practical Physical Chemistry B. D. Khosla, V. C. Garg & A. Gulati, S. Chand & Co. New Delhi (2011).
7. Experiments in Physical Chemistry C. W. Garland, J.W. Nibler, & D.P. Shoemaker, 8th Ed.; McGraw-Hill: New York (2003).
8. Experimental Physical Chemistry A.M. Halpern & G.C. McBane, 3rd Ed.; W.H. Freeman & Co.: New York (2003)
9. Advanced Physical Chemistry Experiment. Gurtu and Gurtu, Pragati Publication

  
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BSc IV Semesters  
Core course (Practical Paper VI)  
CHE-322 Organic Chemistry

Credits 1.5

4 Lectures per week

**Organic Qualitative Analysis (Five mixtures: water insoluble solid-solid type)**

Separation of Two Components from given binary mixture of organic compounds containing mono and di-functional group (carboxylic acid, phenols, amines, nitro, anilide etc.) and systematic identification of one component qualitatively.

**Organic Preparations**

(Confirmatory Test of functional group: M.P and purity by TLC)

(Preference should be given to green approach for following synthesis)

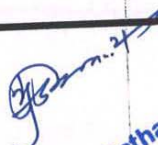
1. Preparation of benzoic acid from ethyl benzoate
2. Acetylation of primary amine
3. Base catalysed Aldol condensation
4. Preparation of Quinone from hydroquinone
5. Preparation of phthalimide from phthalic acid.

**Organic estimations**

6. Determine alcoholic OH groups by pthalation with pthalic anhydride in pyridine.
7. Determination of equivalent weight of a carboxylic acid by titration with standard aqueous alkali solution.
8. Estimation of amino acids by formol titration
9. Estimation of carbonyl compound with 2,4 dinitrophenyl hydrazine
10. Estimation of aldehyde/ketone by hydroxylamine -pyridine procedure

**Reference books**

1. Comprehensive Practical Organic Chemistry by V. K. Ahluwalia and Renu Aggarwal
2. A hand Book of Practical Chemistry, Dr. S. J. Naik, Phadake Prakashan.
3. Practical Organic Chemistry by Mann, F.G. & Saunders, B.C. Orient-Longman, 1960.
4. Vogel's Textbook of Practical Organic Chemistry, Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,
5. Elementary practical organic chemistry Part III quantitative analysis by A I Vogel
6. Elementary practical organic chemistry Part I qualitative analysis by A I Vogel
7. Elementary practical organic chemistry Part II preparations by A I Vogel

  
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BSc IV Semesters  
Core course (Practical Paper VII)  
CHE-421 Inorganic Chemistry

Credits 1.5

4 Lectures per week

**Chromatography**


1. Separation of binary mixture of cations by Column Chromatography by ion exchange resins / cellulose of (Co + Al) mixture, Separation of cations must be confirmed by qualitative test
2. Separation of binary mixture of cations by Column Chromatography by ion exchange resins / cellulose of (Cu + Mg) mixture Separation of cations must be confirmed by qualitative test
3. Separation of binary mixture of cations by Column Chromatography by ion exchange resins / cellulose of (Zn + Mg) mixture. Separation of cations must be confirmed by qualitative test
4. Separation and Identification of metal ions Ni and Cr by Paper Chromatography

**Synthesis of Coordination compounds**

5. Synthesis of sodium cobaltinitrite from Co(II) salt and NaNO<sub>2</sub> salts.
6. Synthesis of potassium Tris(oxalate)aluminium(III) using Al metal powder(Scrap aluminium).
7. Synthesis of Tris(acetylaceton)iron(III) by green chemistry method by reaction between Fe(OH)<sub>3</sub> and acac.
8. Synthesis of Tris(ethylenediamine)nickel (II) from Ni(II) salt, ethylenediamine and sodium thiosulfate.
9. Synthesis of K[Cr(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>.(H<sub>2</sub>O)<sub>2</sub>] Potassium dioxalato diaquachromate(III)
10. Synthesis of Tetra ammine copper(II) sulphate, [Cu(NH<sub>3</sub>)<sub>4</sub>]SO<sub>4</sub>.H<sub>2</sub>O

**Gravimetric estimation**

11. Estimation of nickel (II) using Dimethylglyoxime (DMG).
12. Estimation of copper as CuSCN
13. Estimation of iron as Fe<sub>2</sub>O<sub>3</sub> by precipitating iron as Fe(OH)<sub>3</sub>.
14. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)<sub>3</sub> (aluminiumoxinate).

  
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BSc IV Semesters  
Core course (Practical Paper VIII)  
CHE-422 Applied Chemistry


Credits 1.5

4 Lectures per week

1. Estimation of Aspirin from a given tablet and find errors in quantitative analysis.
2. Determination of acetic acid in commercial vinegar by titrating with standard NaOH. Express results as average  $\pm$  standard deviation
3. Determination of Hardness of water from given sample by complexometric titration (Using E.D.T.A.) method
4. Removal of dyes / by Fenton's process or by adsorption on activated charcoal.
5. Removal of nitrophenols / by Fenton's process or by adsorption on activated charcoal.
6. Deionization water using cation and anion exchange resins / zeolites.
7. Estimation of paracetamol content in tablet
8. Estimation of the vitamin-c content in tablet
9. Estimation of Casein from milk sample
10. Estimation of Rhodamine B from chilli powder spectrophotometrically
11. Estimation of lead chromate in turmeric powder.
12. Estimation of Tannic acid from tea sample spectrophotometer/Colorimeter.
13. Estimation nutritive value of ghee sample (Desi Ghee)
14. To determine the molecular weight of a high polymer by using solutions of different concentrations
15. Quantitative estimation of reducing sugar from jam and jelly

**Reference books**

- 1) Food analysis by Pearson
- 2) Food analysis by A. G Woodman. Mc Graw Hill
- 3) Food analysis by S. S. Neilson.
- 4) Standard methods of biochemical analysis by S. R Thimmaiah
- 5) Biophysical chemistry (Principles and techniques), Upadhyay, Upadhyay and Nath

  
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**BSc III Semester**  
**Chemistry/ Analytical chemistry/Polymer chemistry**

Skill Enhancement Course ((SEC-1 Theory Paper )

Any one skill to be chosen out of two SEC-1-A and SEC-1-B

**CHE-313 (SEC-1-A) Laboratory safety and Laboratory Practices**

Credits 02

Lectures 45

**1. Laboratory Safety and Behavior (15L)**

Lab dress code, Types of clothing, Importance of proper attire, Types of clothing and foot ware, Safe clothing, hair, dangling jewellery responsible attitude, No food in Labs. Good Housekeeping, Proper use of PPE. Types of emergency, Firefighting preparedness plan, Fire extinguisher and their handling, Handling of acids and bases, Corrective measures, Material Safety Data Sheets.

**2. Personnel Protective Equipment, Emergency and Waste Management (30 L)**

Various safety goggles, Types of gloves, apron, masks, Different filters for masks, Face shield, Full body suit, Safety shoes, Helmet, Breathing apparatus suit, Safety belt, Earmuffs along with inspection methods, Emergency exit, acid room, fuming hood, alcohol room its location and approach path, Fire extinguishers and their periodic inspection, First aid kit, its contents and need for monitoring, Eye wash fountains and safety showers, Fire drill and chemical accident drills, Accident free days and incentives to follow safety rules, Accident recording and investigation for future controls, Inventory Management and Storage, Waste Classification as Hazardous Waste, Non-Hazardous Waste, mixed waste, Waste Disposal

**Reference books**

1. Safety in Laboratory and good laboratory practices Dr. N. D. Phatangare and P.H. Naikwadi
2. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version. National Research Council (US) Committee on Prudent Practices in the Laboratory. Washington (DC): National Academies Press (US);
3. Laboratory Safety for Chemical Student; Hill Robert H, Finster David. C John Willey and Sons
4. Laboratory Safety Handbook Fevzi Cakmak Cebeci ;Fens Laboratory Safety Team
5. Laboratory Safety Theory and Practice; Anthony Fuscaldo Academic Press



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**BSc III Semester**  
**Chemistry/ Analytical chemistry/Polymer chemistry**

Skill Enhancement Course ((SEC-1 Theory Paper )

Any one skill to be chosen out of two SEC-1-A and SEC-1-B

**CHE-313 (SEC-1-B) Water Analysis**

Credits 02

Lectures 45

**Unit –I Water : Universal Solvent**

[17 L]

- a. Hydrosphere, Water resources.
- b. Properties of water- color, odor, turbidity, total salt content, total suspended water.
- c. Water pollution- Definition of water pollution, types of water pollutants , sources of water pollutants, trace element in water, water quality parameters and standards
- d. Purification of water- Treatment of domestic and industrial water.

**Unit –II Chemistry of Water**

[18 L]

- a. Water Quality Parameters and Standards- Quality of drinking water, Quality of irrigation water, importance and determination of different parameter, hardness, dissolve oxygen, pH, COD, BOD, hazardous metal ions/salts etc.
- b. Water Microbiology - TOC E-coli and total bacteria.
- c. Sewage analysis

**References**

1. Laboratory Manual of Water and Wastewater Analysis, D.R. Khanna, R. Bhutiani, Daya Publishing House, Delhi. 2008
2. Chemical and Biological Methods for Water Pollution Studies, R.K. Trivedy, P.K.Goel, Oriental Printing Press, Aligarh, 1986
3. Laboratory Mannual of Water and Wastewater Analysis, D.R. Khanna, R. Bhutiani, Daya Publishing House, Delhi, 2008
4. Chemical and Biological Methods for Water Pollution Studies, R.K. Trivedy, P.K.Goel, Oriental Printing Press, Aligarh, 1986



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**BSc IV Semester**  
**Chemistry/ Analytical chemistry/Polymer chemistry**

Skill Enhancement Course (SEC-2- Theory Paper )

Any one skill to be chosen out of two SEC-2-A and SEC-2-B

CHE-413 (SEC-2-A) Pharmaceuticals Chemistry

Credits 02

Lectures 45

**Unit 1 Drugs & Pharmaceuticals**

[25 L]

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), HIV-AIDS related drugs (AZT- Zidovudine).

**Unit 2 Fermentation technique in drug preparation**

[20 L]

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

**Reference Books**

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.,I. Waverly Pvt. Ltd. New Delhi.

  
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**BSc IV Semester**  
**Chemistry/ Analytical chemistry/Polymer chemistry**  
**Skill Enhancement Course (SEC-2- Theory Paper )**

Any one skill to be chosen out of two SEC-2-A and SEC-2-B

CHE-413 (SEC-2-B) Industrial Fermentation & Alcohol Technology  
Credits 02 Lectures 45

**Unit 1. Industrial Fermentation**

[15 L]

Introduction: Fermentation, types of fermentations and role of microorganism and other condition on fermentation., Raw Materials for fermentative production of alcohol, Molasses: Composition, storage, spontaneous combustion, grades and classification of molasses, clarification of molasses, Other Saccharine Materials: cane juice, beet juice, sweet sorghum, mahua flowers. Starchy and Cellulosic Materials. Isolation and purification of cultures., Outline of alcohol production by batch fermentation process , Alcohol production by continuous fermentation process, Modern Techniques of Fermentation: Batch, Semi-continuous, Continuous (Biostil, Multicont, Melle- Bionet process of yeast Cell Recycling.

**Unit 2. Alcohol Technology**

[15 L]

Production statistics of ethyl alcohol. Various forms of ethyl alcohol as an industrial, commercial commodity and its grades etc. Primary Rectified spirit, Potable Grade Alcohol, Pharmaceutical Grade Alcohol, Fuel Grade ethanol. Fermented and Pre-Conditioned Alcoholic beverages like Beer, Wine, Fruit Wine etc, Indian made foreign liquors (Blended and matured), Detail Study of quality and quantity optimization of the water used in alcohol manufacturing unit: Process water, Raw material dilution water, Pump cooling and sealing water, Water used in Cooling tower, Boiler Feed water, Water used in Distillation techniques, Domestic used water, etc.

**Unit 3. Distillation and Alcoholometry**

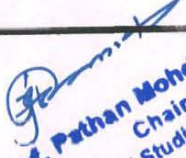
[15 L]

Distillation: Detail study and identification of various Distillation system configuration used in the manufacture of different grades and types of ethyl alcohol.

Alcoholometry: Estimation of strength of alcohol. Concept of proof spirit, Specific gravity method, to study with example and solutions.

**Reference Books:**

- 1) Industrial fermentation By. L.A. Under Koeffler. Chemica Pu.Co., New york
- 2) Comprehensive Biotechnology Vol.3 By M.M.Young Pergamon Press LTD., Oxford

  
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