The Kelkar Education Trust's
Vinayak Ganesh Vaze College of Arts, Science & Commerce
AUTONOMOUS
Mithaghar Road, Mulund East, Mumbai-400081, India
College with Potential for Excellence
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Syllabus for Program S.Y. B. Sc.

Chemistry Major & Minor

Syllabus as per Choice Based Credit System (NEP-2020)

(June 2024 Onwards)

Submitted by

Department of chemistry
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Name of the Programme	❖ **S. Y. B. Sc. Chemistry : CBCS (NEP-2020)**
The F. Y. B. Sc. in Chemistry course is a one Year Full Time Course consisting of two semesters, to be known as Semester I and Semester II. Each semester consists of one major course and one minor course along with other courses- OE, VSC/SEC, AEC, VEC,FP,CEP and CC	
1. Course Code	
2. Course Title	General Chemistry : Paper - I General Chemistry : Paper - II Fundamentals of Analytical Chemistry : Paper - III
3. Semester wise Course Contents	Copy of the detailed syllabus Enclosed
4. References and additional references	Enclosed in the Syllabus
5. No. of Credits per Semester	22
6. No. of lectures per Unit	10 Hrs.
7. No. of lectures per week	12
8. No. of Tutorial per week	--
9. Scheme of Examination	Semester End Exam: **60 marks** (4 Questions of 15 marks each) Internal Assessment : **40 marks** Class Test : 15 marks Project/ Assignment : 15 marks Class Participation : 10 marks
10. Special notes, if any	No
11. Eligibility, if any	As laid down in the College Admission brochure / website
12. Fee Structure	As per College Fee Structure specifications
13. Special Ordinances / Resolutions, if any	No

The Kelkar Education Trust's

Vinayak Ganesh Vaze College of Arts, Science & Commerce, (AUTONOMOUS)

Programme Structure and Course Credit Scheme :

Semester	Major		Minor	OE	VSC/SEC	AEC,VEC,IKS	OJT, FP,CEP,CC, RP	Total
	Mandatory	Elective						
III	8 Credit (6L+2P) (Three Paper)	--	4 Credit (2L+2P) (One Paper)	2Credit (2L) (One Paper)	2Credit VSC (2P) Practical	AEC - 2 Credit (One Paper)	FP (2 Credits) - CC (2 Credits)	22
IV	8 Credit (6L+2P) (Three Paper)	-	2 Credit (2L) (One Paper)	2Credit (2L) (One Paper)	2Credit SEC (2P) Practical	AEC - 2 Credit (One Paper)	CC(2 Credit) + CC (2 Credit) CEP (2 Credit)	**22**
TOTAL	16	NA	6	4	4	4	2+6	**44**

Programme: S. Y. B. Sc.

Semester	Course	Course Title	Course Code	Credits
III	Major	Course 1 : General Chemistry -III	VGVUSMCH301	2
		Course 2 : General Chemistry -IV	VGVUSMCH302	2
	Major/Minor	Course 3 : Fundamentals of Analytical Chemistry-I (NOTE: Course 3 is common for Major and Minor)	VGVUSMNCH303	2
	Minor	Other than Chemistry(Physics /Botany /Zoology)	NA	2
	Major(practical)	Major (Practical)	VGVUSMNCHP304	2
	Minor (practical)	Minor (practical)	VGVUSMNCHP304	2

	Open Elective (OE)	1.Naval Battles and Strategies - I	VGVUOE301	2
		2. Understanding Mental Health and Illness	VGUOE302	2
	Vocational skill Courses (VSC)	Chemical and Instrumental Analysis	VGVUSVSCHP305	2
	Ability Enhancement Courses (AEC)	1. मराठी भाषेतील संवाद कौशल्ये (Dept. of Marathi)	VGVUAE301	2
		2. हिंदी भाषा कौशल (Dept. of Hindi) Student will select any one from AEC Courses	VGVUAE302	
	Field Project	Field Project related to major will be offered	VGVUSCHFP301	2
	Co-curricular Courses	Community Engagement Activities	VGVUCC301	2
		Cultural Activities	VGVUCC302	2
		National Service Scheme (NSS)	VGVUCC303	2
		Sports Activities	VGVUCC304	2
		Yoga	VGVUCC305	2
		Student will select any one from Co-curricular Courses		
	Total Credits			22
s **IV**	Major	Course 1 : General Chemistry –V	VGVUSMCH401	2
		Course 2 : General Chemistry –VI	VGVUSMCH402	2
	Major/Minor	Course 3 : Fundamentals of Analytical Chemistry-II (NOTE: Course 3 is common for Major and Minor	VGVUSMNCH403	2
	Minor	Other than Chemistry(Physics /Botany /Zoology)	NA	2
	Major(practical)	Major (Practical)	VGVUSMNCHP404	2
	Minor (practical)	Minor (practical)	VGVUSMNCHP304	2
	Open Elective (OE)	1.Naval Battles and Strategies - II	VGVUOE401	2

		2. Psychology of Well-being (Psychology Dept.)	VGUOE402	
	Skill Enhancement Courses (SEC)	Analytical Chemistry, Tools and Techniques	VGVUSVSCHP405	2
	Ability Enhancement Courses (AEC)	1. मराठी भाषेतील लेखन कौशल्ये(Dept. of Marathi)	VGVUAE401	2
		2. व्यावहारिक लेखन कौशल (DEPT.OF HINDI)	V GVUAE402	2
	Community Engagement Programme (CEP)	CEP Related to Major will be offered	VGVUSCHCEP401	2
	Co-curricular Courses	1.Community Engagement Activities	VGVUCC401	2
		2. Cultural Activities	VGVUCC402	2
		3.National Service Scheme (NSS)	VGVUCC403	2
		4.Sports Activities	VGVUCC404	2
		5.Yoga	VGVUCC405	2
		Student will select any TWO Co-curricular Courses		
	Total Credits			22

❖ Semester-wise Details of Chemistry Course

Semester - III									
Teaching Scheme (Hrs/Week)				**Continuous Internal Assessment (CIA) 40 marks**			**End Semester Examination Marks**		**Total**
Course	**L Hrs**	**P Hrs**	**Credit**	**CIA-1**	**CIA-2**	**CIA-3**	**Theory**	**Practical**	
Major P-I	02	---	2.0	15	15	10	60	100	100
Major P-II	02	---	2.0	15	15	10	60	100	100
Major P-III	02	---	2.0	15	15	10	60	100	100

Minor	02	---	2.0	15	15	10	60	100	
Major (Practical)	----	4	2.0	--	---	---	---	100	100
Minor (Practical)		4	2.0	---	-----	---	60	100	100
VSC	-----	4	2.0	---	--	---	----	100	100
OE	02	---	2.0	15	15	10	60	---	100
AEC	02	----	2.0	15	35	----	NA	NA	50
FP	----	4	2.0	report	presentations	----	----	------	50
CC	-----	4	2.0	15	15	20	----	----	50
Total	12	20	22	---	----	---	----	-----	850
CIA-II : Assignment/Project CIA-III : APICID &A Max. Time, End Semester Exam (Theory) : 2 .00 Hrs.									

Semester - IV

Teaching Scheme (Hrs/Week)				**Continuous Internal Assessment (CIA) 40 marks**			**End Semester Examination Marks**		**Total**
Course	**L Hrs**	**P Hrs**	**Credit**	**CIA-1**	**CIA-2**	**CIA-3**	**Theory**	**Practical**	
Major P-I	02	---	2.0	15	15	10	60	100	100
Major P-II	02	---	2.0	15	15	10	60	100	100
Major P-III	02	---	2.0	15	15	10	60	100	100
Minor	02	---	2.0	15	15	10	60	100	
Major (Practical)	----	4	2.0	--	---	---	---	100	100

Minor (Practical)	NA	NA	NA	---	-----	---	NA	NA	NA
SEC	-----	4	2.0	---	--	---	----	100	100
OE	02	---	2.0	15	15	10	60	---	100
AEC	02	----	2.0	15	35	----	NA	NA	50
CEP	----	4	2.0	report	presentations	----	----	------	50
CC-I	-----	4	2.0	15	15	20	----	----	50
CC-II	-----	4	2.0	15	15	20	----	----	50
Total	12	20	22	---	----	---	----	-----	900
CIA-II : Assignment/Project CIA-III : APICID &A Max. Time, End Semester Exam (Theory) : 2 .00 Hrs.									

- L - Lectures
- T - Tutorials
- P - Practical
- C - Credits

PROGRAM OUTCOMES

Bachelor of Science (B.Sc.) offers theoretical as well as practical knowledge about different subject areas which includes Physics, Chemistry, Mathematics and Biology. This programme course is most beneficial for students who have a strong interest and background in Science and Mathematics. The program outcomes expected from this course can be predicted as follows:

PO.1. This course forms the basis of science and comprises of the subjects like, chemistry, physics, botany, zoology and mathematics.

PO.2. It develops the skill of thinking methodically and helps to draw a logical conclusion.

PO.3. The hands-on, practical and flexible approach –a unique feature of Vaze college-along with industry collaboration and expert teaching staff – prepares a student for a career.

PO.4. It helps to develop scientific temper and thus will contribute to the scientific developments. This can add to the progress of the society as well as to the nation

PO.5. The B.Sc degree in various disciplines of science will provide an opportunity to student to choose their career in various fields such as research in well-known institutes like IIT,TIFR,IISC etc

PROGRAM SPECIFIC OUTCOMES FOR BACHELOR OF SCIENCE(B.Sc)

DEPARTMENT OF CHEMISTRY

The B.Sc in Chemistry course of Chemistry Department of V.G.Vaze College will benefit thestudents in the following way:

PSO.1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in branches of Physical, Inorganic, Organic and Analytical Chemistry

PSO.2. It will impart various skills of handling chemicals, reagents, apparatus, instrumentsand the care and safety aspects involved in such handling.

PSO.3. It will help the learner capable of analyzing and interpreting results of the experiments which he/she conducts or performs.

PSO.4. The course is designed in such a way that it will correlate the theoretical aspects learnt in classroom with its practical program.

PSO.5. It will assess the importance of environmental protection by applying the principles of green chemistry.

PSO.6. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

PSO.7. The learner will be capable of acquiring or pursuing a source of livelihood like jobs inchemical industry.

PSO.8. The course will make the learner capable of solving problems in the various units of the syllabus

PSO.9. The learner will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PSO.10. The use of softwares in chemistry like chemdraw, modern chemical tools,Models, Charts,equipment’s etc will enhance the knowledge of the learner.

S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- III			
PAPER-I			
Course Name: General Chemistry - III(30 Lectures)			**Course Code** VGVUSMCH301
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory In ternal		**40**
Unit			**No. of Periods**
Unit - I	**1. Chemical Thermodynamics-II** 1.1 Free Energy Function: Helmholtz free energy, variation of Helmholtz free energy with volume and temperature, Gibb's free energy, Variation of Gibb's free energy with pressure and temperature, Gibb's free energy change for chemical reaction. 1.2 Gibb's Helmholtz equation, Van't Hoff reaction isotherm and Van't Hoff reaction, isochore. (Numericals expected). 1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation. **2. Electrochemistry** 2.1 Electronic and electrolytic conductors, conductance, specific conductance, equivalent conductance, molar conductance, determination of molar conductance, variation of molar conductance with concentration for strong and weak electrolytes, concept of limiting molar conductance. **2.2 Kohlrausch law of independent migration of ions** Applications of Kohlrausch's law: Determination of limiting molar conductance of a weak electrolyte, Determination of dissociation constant of a weak acid, Determination of solubility product of a sparingly soluble salt (Numericals expected) 2.3 Transference number and factors affecting transport number.		**05** **05**

Unit – II	**Chemical Bonding**	**3 L**
	2.1 Non directional Bonding Ionic Bond, Conditions for the Formation of Ionic bond 2.1.2 Types of Ionic Crystals 2.1.3 Radius Ratio Rules 2.1.4 Lattice Energy, Born-Lande Equation and Kapustinski Equation 2.1.5 Born-Haber Cycle and its Application	
	2.2 Directional Bonding - Orbital Approach 2.2.1. Covalent Bonding: Valence Bond Theory- basic tenets 2.2.2. Interaction between two hydrogen atoms and Potential energy diagram of the resultant system 2.2.3. Corrections applied to the system of formation of Hydrogen molecule 2.2.4. Resonance and concept of Formal charge, Rules for writing resonance structures 2.2.5. Bonding in polyatomic species, need for hybridization and types of hybrid orbitals - sp, sp^2, sp^3, sp^2d, sp^3d, sp^2d^2, sp^3d^3	**4 L**
	2.3 Molecular Orbital Theory 2.3.1. Comparing atomic orbitals and Molecular orbitals 2.3.2. Linear combination of atomic orbitals to give molecular orbitals LCAO-MO approach 2.3.3. Molecular orbital diagram H_2, He_2, diatomic molecules of second period elements and their ions, calculate bond order and predict magnetic property. (Problems and Numericals expected wherever possible)	**3 L**
Unit - III	**Organic Chemistry**	**2 L**
	3.1 Reactions and reactivity in alkyl and aryl halides 3.1.1 Alkyl halides: Nucleophilic substitution reactions: SN_1, SN_2, Neighboring Group participation (NGP), SN_i and SN_i mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group.	**2 L**
	3.1.2Aryl halides:Reactivity of aryl halides towards nucleophilic substitution reactions.Nucleophilic aromatic substitution (SNAr) addition-elimination mechanism and benzyne mechanism.	**6 L**
	3.2 Alcohols and Phenols 3.2.1 Alcohols: Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. 3.2.1 Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols. 3.2.2 Phenols: Preparation, physical properties and acidic character, factors affecting acidity of phenols Reactions of phenols.	

❖ Learning Outcomes:

On studying the syllabi, the learner will be able to:

- Recognize the importance of certain thermodynamic functions like Gibbs free energy, partial molal properties, fugacity, activity and will be able to apply these concepts to various physicochemical processes.
- Predict the behaviour of the electrolytes by conductance phenomenon and to apply
- Discuss the energetics of ionic and covalent bond formation.
- Predict the coordination number of ion in crystal
- Explain bonding and shape of polyatomic species based on Valence Bond Theory
- Identify a given nucleophilic substitution reaction mechanism as SN_1, SN_2 (with or without NGP) SN_i or SN_i.
- Design the synthesis of simple alcohols and phenol
- Predict acidity of substituted phenols based on substituents

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❖ Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. J.D.Lee, Concise Inorganic Chemistry, 4th edition,ELBS.
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page.
5. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity.
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
7. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

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S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- III			
PAPER-II			
Course Name: General Chemistry - IV(30 Lectures)			**Course Code** VGVUSMCH302
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory Internal		**40**
Unit			**No. of Periods**
Unit - I	**11.1 Chemical Kinetics - II** 1.1.1. Types of Complex Chemical reactions: Reversible or opposing, consecutive parallel reactions (No derivations, only examples expected), 1.1.2 Thermal chain reactions: H and Br Reaction (only steps involved, no kinetic expression expected). 1.1.3. Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (E_a). (Numericals expected). 1.1.4. Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories. (Qualitative treatment only) **1.2 Solutions** 1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure - composition and temperature composition curves of ideal and non-ideal solutions. 1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol - Water, Triethanolamine – Water and Nicotine – Water systems 1.2.3 Immiscibility of liquids - Principle of Steam distillation. Nernst distribution law and its applications, solvent extraction. (Numericals extraction. (Numericals expected).		**06** **04**

Unit – II	**2.1 Chemistry of Boron** 2.1.1. Electron deficient compounds- BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications. 2.1.2. Preparation of simple boranes like diborane and tetraborane. 2.1.3. Structure and bonding in diborane and tetraborane ($2e^-$ 3c bonds). 2.1.4. Synthesis of Borax. **2.2Chemistry of Silicon and Germanium** 2.2.1 Silicon compounds: Occurrence, Structure and inertness of SiO_2 2.2.2. Preparation and structure of $SiCl_4$. 2.2.3. Occurrence and extraction of Germanium. 2.2.4 Preparation of extra pure Silicon and Germanium.	**5 L** **5 L**
Unit – III	**3.1Carbonyl Compounds** 3.1.1. Structure, general methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes 3.1.2. General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions. 3.1.3. Reactions of aldehydes and ketones with NaHSO3, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$. 3.1.4. Keto-enol tautomerism: Mechanism of acid and Base catalyzed enolization 3.1.6. Synthesis of enamines; alkylation and acylation of enamines. **3.2 Epoxides** 3.2.1. Nomenclature and methods of preparation. 3.2.2. Reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.	**06 L** **04 L**

❖ **Learning Outcomes:**

On studying the syllabi, the learner will be able to:

- Classify the type of complex reactions.
- Interpret the effect of temperature on the rate of the reaction through Arrhenius equation,
- Compare the collision theory with the activated complex theory and to justify the concepts through problem solving.
- Apply the Nernst distribution law to solvent extraction techniques and to describe the principle of steam distillation.
- Describe the extraction of Germanium. Write the electronic configuration of group 15 elements; identify different trends in chemical reactivity, understand the method of preparation of oxides of nitrogen.

- Identify the different methods for the synthesis of aldehydes and ketones.
- Synthesize simple compounds using alkylation and acylation of enamines.
- List the different methods for the synthesis of epoxides.

❖ **Reference Books:**

1. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009).
2. B. S. Bahl and G. D. Tuli 'Essentials of Physical Chemistry,' S.Chand and Company(Pvt) Ltd, New Delhi.
3. J.D.Lee, Concise Inorganic Chemistry, 4^{th} edition,ELBS.
4. R Gopalan, Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
5. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd.
6. Pub. Graham Solomons, T.W. Organic Chemistry, John Wiley &Sons, Inc.

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S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- III			
PAPER– III			
Course Name: Fundamentals of Analytical Chemistry-I (30 lectures)			**Course Code** VGVUSMNCH303
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory Internal		**40**
Unit			**No. of Periods**
Unit - I	**1.1 Introduction to Analytical Chemistry and Sampling** .1.1 Classical and Non-Classical Methods of Analysis; their types and mportance **1.2Role of Analytical Chemistry** 1.2.1 Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 1.2.2 Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, Semi-micro and Microanalysis). **1.3 Sampling** 1.2 Significance of Sampling in Analytical Chemistry 1.2.1 Terms involved in Sampling 1.2.2 Types of Sampling 1.2.3 Sampling techniques		**06** **04**

Unit – II	**Titrimetry** 2.1 **Precipitation Titration** 2.1.1 Introduction 2.1.2 Construction of the titration curve 2.1.3 Volhard's Method 2.1.4 Mohar's Method 2.1.5 Theory of Adsorption indicator 2.2 **Complexometric Titrations** 2.2.1 Introduction, construction of titration curve 2.2.2 Use of EDTA as titrant and its standardization, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant.	**5 L** **5 L**
Unit – III	**Instrumental Methods - I** 3.1 Basic Concepts in Instrumental methods, Relation between the Analyte, Stimulus and measurement of change in the observable property. 3.2 Block Diagram of an Analytical instrument. 3.3 Types of Analytical Instrumental methods based on: a. Optical interactions (E.g., Spectrometry: UV-visible, Polarimetry). b. Electrochemical interactions (E.g., Potentiometry, Conductometry). c. Thermal interactions (E.g., Thermogravimetry). **3.4 Colorimetry & Spectrophotometry** 3.4.4 Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers. 3.4.5 Block Diagrams for Single beam and Colorimeter, and spectrophotometer (Principles, Construction and working-Details of Components expected i.e, source, Sample holder, Filters/Monochromators, Detectors such as Photomultiplier tube). **3.4.6 Applications of UV-Visible Spectrophotometry** a) Qualitative analysis such as Identification of functional groups in Organic compounds, Chromophores and Auxochrome, cis and trans isomers. b) Quantitative analysis by Calibration curve method 3.4.7 **Photometric Titrations:** Principle, Instrumentation, Types of Photometric titration Curves with examples	**03** **03** **02** **02**

❖ Learning Outcomes:

- On studying the syllabi, the learner will be able to Outline the various instrumental methods of analysis
- Identify the advantages of using instruments to make measurements
- Discover the various observable properties of a given analyte and the stimulus best suited for its analysis.
- Illustrate about a generalized diagram of an analytical instrument
- Choose a suitable instrumental method for analysis and learn the basic terms in spectrometry Compare the relationship between absorbance (and its variations) and concentration of the analyte.

❖ Reference Books:

1. 1.Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R.Crouch.
2. Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15.
3. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal,Sham K.Anand pp2.107- 2.148.
4. Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley StudentsEdition, Chapter No. 8,9,10.
5. Modern Analytical Chemistry, David Harvey (page numbers 232-265) 6. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.

S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- III			
VSC			
Course Name: Chemical and Instrumental Analysis (60 Hrs)			**Course Code:** VGVUSVSCHP305
Practicals Per week :(1 Practical = 2Hrs.)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	4.0	100
	Theory Internal	--	--
Unit			**No. of Periods**
Unit - I	**1. Conductometry** **i.** To determine solubility of sparingly soluble salts (any two) conductometrically. **2. pH Metry** i) To determine amount of strong acid pH-metrically ii) Determination of buffer capacity of acid buffer and basic buffer **3. Water Analysis** i) To determine chemical oxygen demand of water sample ii) To Estimate total hardness of water **4. Organic preparation** i. Cyclohexanone oxime from cyclohexanone. ii. Tribromoaniline from aniline. iii. p-Bromoacetanilide from acetanilide **5. Gravimetric Estimations** Nickel as nickel-dmg **6. Estimation of drugs** Estimation of aspirin. **7. Electrochemistry:** i. Determination of redox potential of the Fe in ferricyanide sample by usingcyclic voltammetry method. ii. Electrochemical deposition of metal by using two electrode system. **8. Spectrophometry:** i. Detection of phenolphthalein by spectrophotometric method		

	9. Titration i. To determine the percentage of ammonia from ammonium salts by neutralization method. ii. To determine the percentage purity of sodium benzoate in non-aqueous medium	

❖ **Learning outcomes**

- To understand the basic concept of chemistry.
- To impart practical skills and learn the chemistry behind estimation experiments.
- Importance of Lab safety and chemical toxicity while performing experiments in laboratory.
- Use of microscale techniques for purification and wherever required.
- To prepare background for advanced and applied studies in chemistry.

❖ **Reference Books:**

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)
5. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
6. Mann, F. G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
7. Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
9. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
10. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.
11. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J. B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.
12. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.
13. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (I961).
14. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).

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Practicals

(Major/Minor)

Semester: III

COURSE CODE: VGVUSMNCHP304 **CREDITS: 02**

I) Conductometry

To verify Ostwald's dilution law for weak acid conductometrically.

II) Phase equilibria

Phase equilibria: To determine the critical solution temperature (CST) of Phenol – Water system.

III) Chemical kinetics

To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants.

IV) Water Analysis

i) To determine alkalinity of water sample.

ii) To determine Acidity of water sample.

V) Organic Preparations

A. Short organic preparation and their purification

Use 0.5-1.0g of the organic compound. Purify the product by recrystallization.

B.Report theoretical yield, percentage yield and melting point of the purified product:

1. Glucosazone from dextrose or fructose.
2. m-Dinitrobenzene from nitrobenzene.
3. Phthalic anhydride from phthalic acid by sublimation.
4. Acetanilide from aniline.

VI) Gravimetric Estimations

Barium as Barium sulphate.

- **Learning Outcomes**
  - Identify the importance of reagents used in the synthesis of organic compounds
  - To prepare background for advanced and applied studies in chemistry.
  - To impart practical skills and learn the chemistry behind estimation experiments.

Reference Books:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).
5. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972).
6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
7. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
9. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
10. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.
11. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J. B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. ParikshitGogoi.
12. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.
13. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman,London (I961).
14. R.V. Dilts. “Analytical Chemistry. Methods of Separation,” van Nostrand,N.Y. (1974).

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S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- IV			
PAPER– I			
Course Name: General Chemistry-V (30 Lectures)			**Course Code:** VGVUSMCH401
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory Internal		**40**
Unit			**No. of Periods**
Unit - I	**1.1 Electrochemistry II** 1.1.1 Electrochemical conventions, Reversible and Irreversible cells. 1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from Emf data. (Numericalsexpected) 1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected) 1.1.5 pH determination using hydrogen electrode and quinhydrone electrode (Numericals expected) **1.2 Phase Equilibria** 1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. 1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria.(Numerical expected) 1.2.3 Phase diagrams of one-component systems (water and sulphur). 1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system)		**06** **04**

Unit – II	**2.1 Comparative Chemistry of Transition Metals** 2.1.1 Definition, general characteristics of Transition elements 2.1.2 Chemistry of 3d transition elements with reference to: Variable oxidation states, colour, magnetic property ability to form complexes, colour, magnetic property, ability to form complexes, catalytic property **2.2 Coordination Chemistry** 2.2.1 Historical perspectives, Molecular compound – double salt, complex salt 2.2.2 Werner's theory of Coordination compounds 2.2.3 Basic terms complex ion, charge on the complex, ligand and their types Coordination number and Nomenclature 2.24 Effective atomic number Rule, Eighteen electron rule. 2.2.5 Isomerism(Structural, Stereo, Optical) of coordination compounds (CN=4,6). 2.2.6 Evidences for formation of coordination compounds 2.2.7 Applications of coordination compounds 2.2.8 Nature of the Metal-Ligand Bond i) Valence Bond Theory: Hybridization of the central metal orbitals sp^3, dsp^2/sp^2 d, sp^3d, sp^2d^2,$sp3d^3$. ii) Inner and Outer orbital complexes (suitable examples). iii) Electroneutrality principle and back bonding. iv) Limitations of ValenceBond Theory.	**4 L** **6 L**
Unit-III	**3.1 Carboxylic Acids and their Derivatives** 3.1.1 Structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 3.1.2 General methods of preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles. 3.1.3 Reactions: Acidity, salt formation, decarboxylation, Reduction of Carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 3.1.4 Acid derivatives: Mechanism of nucleophilic acyl substitution and acid-catalyzed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. **3.2 Sulphonic acids** 3.2.1 Nomenclature, preparation of aromatic sulfonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene. 3.2.2 Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, sulphonation. Reaction with alcohol, Phosphorous pentachloride, IPSO substitution.	**6 L** **4 L**

❖ **Learning Outcomes:**

On studying the Syllabi, the learner will be able to

- Identify a chemical cell from a concentration cell and correlate thermodynamic concepts with electrochemistry
- Discuss the importance of pH of a solution and its determination by electrochemical cells. Define and explain the concept of phase, components and degree of freedom.
- Predict various properties of transition elements on the basis of their electronic configuration List the structures of possible isomers of a given complex.
- Discuss the different methods for the synthesis of carboxylic acids.
- Write the mechanism of nucleophilic acyl substitution reactions
- Design synthesis of simple carboxylic acids and their derivatives by interconversion.

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Reference Books:

1. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
2. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
3. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., New York (1985).
4. K. L. Kapoor A textbook of Physical chemistry.
5. J. D. Lee, Concise Inorganic Chemistry, 4^{th} edition, ELBS.
6. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002.
7. F. A Cotton and G. Wilkinson 'Basic Inorganic chemistry' John Wiley & Sons.
8. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.

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S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- IV			
PAPER– II			
Course Name: General Chemistry-VI (30 Lectures)			**Course Code** VGVU SMCH 402
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory Internal		**40**
Unit			**No. of Periods**
Unit - I	**1.1 Solid State** 1.1.1 Recapitulation of laws of crystallography and types of crystals. 1.1.2 Characteristics of simple cubic, face centered cubic and bodycentered cubic systems, interplanar distance in cubic lattice(Onlyexpression for ratio of interplanar distances are expected). 1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (Derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected) **1.2 Catalysis** 1.2.1 Types of catalysis, catalytic activity, specificity and selectivity,inhibitors, Catalyst poisoning and deactivation. 1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. 1.2.3 Effect of particle size and efficiency of nanoparticles as catalyst.		**06** **04**
Unit – II	**2.1 Ions in aqueous medium** Acidity of Cations and Basicity of Anions 2.1.1 Hydration of cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations- effect of charge and radius. 2.1.2 Latimer Equation. Relationship between pK_a, acidity and z^2/r ratio of metal ions graphical presentations. 2.1.3 Classification of cations on the basis of acidity. Category-Non acidic, 07 Moderately acidic, strongly acidic, very strongly acidic, with pK_a values range and with examples. 2.1.4 Hydration of Anions; Effect of charge and radius; Hydration of anion concept, diagram classification on the basis of basicity.		**6 L**

	2.2Metallurgy: 2.2.1 Types of metallurgies. 2.2.2 General Steps of Metallurgy**:**Concentration of ore, calcinations, roasting, reduction and refining. 2.2.3 Metallurgy of copper: Occurrence, physico chemical principles, Extraction of copper from pyrites and refining by electrolysis. Extraction of titanium and vanadium.	**4 L**
Unit-III	**3.1 Nitrogen containing compounds and heterocyclic compounds** **3.1.1Amines:** Nomenclature, basicity, factors affecting basicity of aliphatic and aromatic amines; **3.1.2Preparation:** Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn – aceticacid, reduction of nitriles, ammonolysis of halides, reductive amination Hofmann bromamide reaction (no mechanism) **3.1.3 Reactions:** Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM), Hofmann- elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. **3.1.4 Five membered Heterocyclic compounds:** Nomenclature, structure and aromaticity in five membered heterocycliccompound containing one heteroatom. Paal Knorr synthesis for furan,thiophene and pyrrole; reactivity of pyrrole, furan and thiophene towardselectrophilic aromatic substitution reactions; General mechanism of Electrophilic aromatic substitution; Diels Alder reaction of furan;Basicity and acidity of pyrrole. **3.2 Stereochemistry - II** 3.2.1Elements of symmetry: Mirror Plane symmetry (inversion center), rotation-reflection (alternating) axis. 3.2.2 Chirality of compounds without stereogenic center: allenes, spirans and biphenyls. 3.2.3 Stability of cycloalkanes: Strains in cycloalkanes- angle, eclipsing, Trans annular (3 to 8 membered). 3.2.4 Conformations of cyclohexane, chair, boat and twist boat forms, relative stability with energy.	**4 L** **6 L**

❖ **Learning Outcomes:**

- On studying the syllabi, the learner will be able to
- Interpret the crystal structure by X ray diffraction method and determine the value of Avogadro number
- Identify the type of catalysis
- Evaluate the mechanism of acid-base catalyzed reactions
- Identify acidic and basic nature of salts in aqueous medium.
- Explain predominance diagram, Define metallurgy.
- Outline the product of organic reactions involving amines as substrates

- Synthesize diazonium salts and apply them to designing synthesis of substituted aromatic compounds
- Define the different symmetry elements in a molecule and identify the symmetry elements.
- Discuss the strain involved in cyclic compounds

Reference Books:

1. Solid state chemistry and its Applications by A. R. West, Wiley publications, Second edition 2015/16.
2. Solid state Chemistry-An Introduction' by L. Smart and E. Moore, CRC Press Taylor and Francis group, 3rd Edition 2005.
3. "Chemical Kinetics and Catalysis" by Masel R I January 1 2015.
4. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
5. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
6. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton, W. David Ollis.
7. Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

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S. Y. B. Sc. Chemistry: Choice Based Credit System			
Semester- IV			
PAPER– III			
Course Name: Fundamentals of Analytical Chemistry - II (30 Lectures)			**Course Code** VGVU SMNC H403
Periods per week (1 period 60 minutes)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	**2.0**	**60**
	Theory Internal		**40**
Unit			**No. of Periods**
Unit - I	**Separation Techniques in Analytical Chemistry** **1.1** An Introduction to Analytical Separations and its importance in analysis. **1.2** Estimation of an analyte without effecting separation. **1.3Types of separation methods** 1.3.1 Based on Solubilities (Precipitation, filtration Crystallization) 1.3.2 Based on Electrical Effects-Electrophoresis 1.3.3 Based on retention capacity of a Stationary Phase-Chromatography; 1.3.4 Based on distribution in two immiscible phases 1.3.5 Based on capacity to exchange with a resin-Ion Exchange; 1.3.6 Based on Gravity-Centrifugation 1.3.7 Based on volatility-Distillation **1.4 Solvent extraction** 1.4.1 Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. 1.4.2 Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. 1.4.3 Single step and multi - step extraction, percentage extraction for single step and multistep extraction. Separation factor. 1.4.4 Batch and continuous extraction (Numericals Expected).		**6 L** **4L**

Unit – II	**Instrumental Methods – II** nstruments based on the electrochemical properties of the analytes **2.1 Potentiometry** 2.1.1 Principle 2.1.2 Role of Reference and indicator electrodes 2.1.3 Applications in Neutralization reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode) Graphical methods for detection of endpoints **2.2 Electrogravimetry** 2.2.1 Introduction, principle, 2.2.2 Instrumentation 2.2.3 Factors affecting the nature of the deposit 2.2.4 Applications. **2.3 Conductometry** 2.3.1 Principle 2.3.2 Conductivity cell its construction and care 2.3.3 Applications in Neutralization Titrimetry with respect to i) Strong Acid-Strong Base ii) Strong Acid-Weak Base iii) Strong Base-weak Acid iv. Weak Acid- Weak Base. 2.3.4 Advantages & limitations of conductometric titrations.	**03 L** **03 L** **04 L**
Unit-III	**Statistical Treatment of Analytical Data-I** **3.1 Results of Analysis** 3.1.1 Errors in Analysis and their types 3.1.2 Precision and Accuracy in Analysis 3.1.3 Corrections for Determinate Errors (Problems including Numericals expected wherever required. **3.2 Nature of Indeterminate Errors** 3.2.1 The true and acceptable value of a result of analysis 3.2.2 Measures of central tendency: mean, median. mode, average 3.2.3 Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation, (s, sigma) variance, coefficient of variation. **3.3 Distribution of random errors** 3.3.1 Gaussian distribution curve. 3.3.2 Equation and salient features of Gaussian distribution curve. 3.3.3 Concept of Confidence limits and confidence interval and its computation using Population standard deviation, Student's test, Range 3.3.4 Criteria for rejection of doubtful result 2.5 d rule, 4.0 d rule, Q test 3.3.5 Test of Significance Null hypothesis, F-test (variance ratio test)	**02 L** **04 L** **04 L**

❖ **Learning Outcomes:**

On studying the syllabi, the learner will be able to

- Discover the importance of separation in sample treatment
- Choose a method of separation of an analyte from the matrix
- Discuss the principle of solvent extraction and various terms involved therein
- Interpret the effects of various parameters on solvent extraction of a solute
- Assess the classification of Chromatographic methods
- Interpret the principles of Paper and thin layer chromatography and make use of it in practice.
- The use of statistical methods in chemical analysis.
- The randomness of such errors and its distribution around a correct or acceptable result
- Method to draw best fitting straight line.

❖ **Reference Books:**

1. 1.D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch – Fundamentals of Analytical chemistry, 8th edition.
2. G.H. Morrison and H. Freiser, Solvent extraction in analytical chemistry.
3. P. G. Swell and B. Clarke, Chromatographic separations, Analytical chemistry by open Learning, John Wiley and sons, 1987.
4. Modern Analytical Chemistry, David Harvey (page numbers 596 -606).
5. Principles of Instrumental analysis, D. A. Skoog, 3rd edition, Saunders college publishing. Chapters: 20, 23 Page no: 600 - 605, 631, 704 - 711.
6. Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman. Chapters: XIV, XV Page no: 566 - 601, 615 – 625.
7. Instrumental methods of analysis, B. K. Sharma, Goel publishing house. Miscellaneous methods: Chapters: 1, 3, 4 Page no: 1 - 14, 21 - 57.
8. Modern Analytical Chemistry, David Harvey (page numbers 53 -84).
9. Fundamentals of analytical chemistry – Skoog and West.

S. Y. B. Sc. Chemistry: Choice Based Credit System

Semester- IV

SEC

Course Name: Analytical Chemistry, Tools and Techniques (60 Hrs)			**Course Code:** VGVUSVSCHP405
Practicals Per week (2 Practical 2 Hrs. each)			**02**
Credits			**02**
Evaluation System		**Hrs**	**Marks**
	Theory Examination	4.0	100
	Theory Internal	--	--
Unit			**No. of Periods**

Unit - I

I)Statistics of Analysis:

1.The calculations of Population mean (x), Median and Standard deviation (S) for the given data of analysis**.**

II) Complexometric titration/ Volumetric analysis

1.Determination of Ca^{2+} (CaO and/or CaCO3) and Mg^{2+} (MgO) in talcum powder by complexometric titration method.

III) Food Analysis:

1.Analysis of salt from butter sample

IV) Electrochemistry:

1.Determination of electrochemical active surface area of modified electrode by using Randles-Sevcik equation cyclic voltammetrically.

2.Determination of amount of Fe (III) in ferricyanide sample by using cyclic voltammetry method.

V) Commercial Sample Analysis:

1.Assay of saline sample conductometrically by using silver nitrate.

2.Assay of cola sample for phosphoric acid pH metrically.

3.Assay of Ca^{2+} and Mg^{2+} in face powder complexometrically.

4. Determination of percentage purity of Fe (II) in the given iron tablet

VI)Separation Techniques:

1.Demonstration of TLC and Paper chromatography techniques.

2.The separation of volatile components from mixture by simple distillation technique.

3.Separation of Cu (II) from a mixture of Cu (II) and Fe (III) by solvent extraction and titration with EDTA**.**

	VII)Industrial Visit	

References

1. Chattopadhyay, K. and Mandal, M. *Analytical Chemistry skill enhancement course,*CBS Publishers & Distributors Pvt. Ltd. 2022
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
5. Prof. Robert H. Hill Jr., David C. Finster Laboratory Safety for Chemistry Students, 2nd Edition Wiley ISBN: 978-1-119-02766-9 May 2016

6. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.

7. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman,London (I961).

8. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand,N.Y.(1974).

9. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. ParikshitGogoi.

PRACTICALS

(MAJOR/MINOR)

SEMESTER: IV

COURSE CODE: VGVUSMNCHP404 **CREDITS: 02**

I) Potentiometry

1. To determine the amount of HCl in the given sample potentiometrically.
2. Estimation of Fe (II) in the given solution by titrating against K2Cr2O7 potentiometrically.

II) Inorganic Preparations

1. Sodium Hexanitrocobaltate (III)
2. Bis ethylenediamine copper (II) sulphate.
3. Potassium diaqua bis(oxalato) cuprate(II)

III) Qualitative Analysis of organic compounds including bi-functional groups on the basis of

1. Preliminary examination
2. Solubility profile.
3. Detection of elements C, H, (O), N, S, X.
4. Detection of functional groups
5. Determination of physical constants(M.P./B.P.)

Solid or liquid Compounds containing not more than two functional groups from among thefollowing classes may be given for analysis to be given:
Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halide.

Students are expected to write balanced chemical reactions wherever necessary.
(Minimum 6 compounds to be analyzed)

IV) Conductometry

Estimation of given acid by conductometric titration with strong base.

Reference Books:

1. Khosla B. D., Garg V. C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J. W. and Shoemaker D. P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A. M. and McBane G. C., Experimental Physical Chemistry, 3rd Ed., W. H. Freeman and Co., New York (2003).
4. Athawale V. D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)
5. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

7. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
9. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
10. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp.345-381.
11. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (I961).
12. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N. Y. (1974).
13. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Syllabus for S.Y. BA/B.Com. Students

Semester III and IV

Choice Based Credit System (NEP 2020)

(To be implemented from the academic year, 2024-2025)

Open Elective Courses (OE)

Semester – III

Paper III

Course Code: VGVUOE303

Credits: 2

(Open Elective Paper - III)

CHEMISTRY OF FRAGRANCE AND FLAVORS

Unit 1	**Fragrances** 1.1 Introduction to fragrances, types of fragrances (Fragrance families and classification), 1.2 History of perfumes, Perfumery raw materials, classification of odour, odour type and odorants. 1.3 India in the context of Fragrance Industry. 1.4 Chemistry of aromatic compounds in perfume making, composition of fragrances. 1.5 Current trends in fragrances, sensory analysis of different products. 1.6 Study of the raw materials used in perfumery (origin). 1.7 Extraction of essential oils used in perfumery. Difference between alcohol and oil-based perfumes. 1.8 Outline of health, safety and sustainability parameters in perfumer.	**10 L**
Unit 2	**Introduction to Flavours** 2.1 Introduction to flavours, types of flavours, flavour raw materials. 2.2 Understanding of terms: Flavour and Flavouring agents. 2.3 Attributes of flavour, taste, odour, odour stimulation, basic tastes and the human olfactory system. 2.4 Stability of flavour in food. 2.5 Sensory evaluation of flavours in foods and Various flavour formulation. 2.6 Systematic approach to understanding flavour formation during food processing, food matrix, interaction of added flavours.	**10 L**
Unit 3	**Manufacturing of Flavors and its application**	**10 L**

	3.1 Flavour enhancers, modifiers, precursors, suppressors, solvents. 3.2 Key chemical reactions for conversion of raw materials to flavours. 3.3 Forms of flavour and the manufacturing processes involving all types of flavours. Aroma recovery during processing. 3.4 Biogenesis of flavours in fruits and vegetables, reaction flavours, off flavours. 3.5 Selection and application of flavours in foods and beverages. 3.6 Legal aspects (natural flavours and natural flavouring substances, natural identical flavoring substances, artificial flavoring substances), and the FSSA act.	

❖ **Learning Objectives:**

- To make the students understand the applications of chemistry in the world of flavors and fragrances.
- The use of fragrance is ubiquitous and is a global human phenomenon.
- Over the course of time, countless numbers of flavors and fragrances have found their way into everyday life, notably into foods, beverages and confectionery items; into personal care products (soaps, toothpastes, mouthwashes, deodorants, bath lotions and shampoos), perfumes, and other cosmetics as well as pharmaceutical formulations. Indeed, flavors and aromas are added to make such products more attractive or to mask the taste or smell of less pleasant ones.

❖ **Learning Outcomes:**

By the end of this course student will be able to learn:

- Synthesis of various fragrance and flavour ingredients
- Formulation methods, how different factors affects the formulation process in Fragrance and Flavour industry
- Uphold safety regulation and execute quality processes
- Quality control in manufacturing process, legal aspects, classification of odor and odorants.
- Different methods used for separation, purification and isolation of perfumes and flavors like distillation, extraction, crystallization, etc.

References:

1. Arctander, S. (2008), **Perfume and flavour materials of Natural origin,** Allured Publishing Corporation, USA
2. Arctander, S. (2017), Volume I and II, **Perfume and Flavour Chemicals**, (Aroma Chemicals), Allured Publishing Corporation, USA
3. Curtis, T.; Williams, D. C. (2001) 2nd Edition, **An Introduction to Perfumery**, Micelle Press, USA.
4. Sell, C. (2008), **Understanding Fragrance Chemistry,** Allured Publishing Corporation, USA
5. Calkin, R. R., Jellinek, J.S., **Perfumery: Practice and Principles,** John Wiley & Sons Inc.
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Semester – IV

Paper IV

Course Code: VGVUOE403

Credits: 2

(Open Elective Paper - IV)

CHEMISTRY FOR SUSTAINABLE ENERGY AND THE ENVIRONMENT

Unit 1	**General Introduction of Energy and Environment** 1.1 Introduction, chemistry and energy. 1.2 Conversion of chemical energy to electrical energy. 1.3 Carbon cycle. 1.4 Greenhouse gases, Global warming and climate change. 1.5 Carbon footprint, zero carbon or low-carbon energy. 1.6 Electrical energy and steam energy, Energy Alternatives. 1.7 Hidden Costs of Energy.	**10 L**
Unit 2	**Sources of Energy** 2.1 Production methods for electric power: Non-Renewable (conventional) sources of energy 2.2 Fossil fuels: Coal, petroleum and Natural gas. 2.3 Renewable energy sources: solar, hydropower, wind, geothermal, wave, ocean thermal, tidal, ocean currents, nuclear energy, biomass.	**10 L**
Unit 3	**Pollution, effects and its prevention measures** 3.1 Types of pollution: Air Pollution, Water pollution, Soil Pollution. 3.2 Urban and Indoor Air Pollution. 3.3 Pollution and waste reduction measures. 3.4 Chemical remediation of air pollution. 3.5 Effect of pollution on health and economy.	**10 L**

❖ Learning Objectives

On studying the syllabi, the learner will be able to

- To develop basic understanding of energy, issues related to energy, importance of energy in terms of economy, health and the environment.
- To make the students understand the adverse effect of pollution, and possible remediations.

❖ Learning Outcomes

By the end of this course student will be able to learn:

- Describe basic energy concepts
- Account for conventional and renewable energy technologies and their application
- Pollution and waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality, Use of materials that are non-toxic, ethical and sustainable
- Consideration of the environment in design, construction and operation

References:

1. Rao, C S., **Environment pollution control Engineering**, New Age International reprint 2015, 2nd edition
2. Bharucha, E., **Textbook of Environmental Studies**, Universities Press (2005)
3. Wright, R.T., **Environmental Science-Towards a sustainable Future**, Prentice Hall (2008) 9th edition.
4. Ahluwalia, V. K., **Energy and Environment**, The Energy and Resources Institute (TERI) (2019)