MILAGRES COLLEGE
Kallianpur – 576 114, Udupi District, Karnataka
Web: www.milagrescollegekallianpur.edu.in
Email: milagrescollege@gmail.com
Phone: 0820-2580235
Office of the Principal 87626 90235

MANGALORE UNIVESITY

CHOICE BASED CREDIT SYSTEM

COURSE PATTERN AND SCHEME OF EXAMINATION

CORE SUBJECT: CHEMISTRY

Core/ Elective	Paper Code	Title of the Paper	Instruction Hours	Duration of the Examination(Hrs.)	Max. Marks			Credits
					Exam	IA	Total	
I Semester B.Sc.								
Group I Core Subject	Theory BSCCHC131	Chemistry Paper I	4	3	80	20	100	2
	Practical I BSCCHP132	Chemistry Practical I	3	3	40	10	50	1
Group II Elective	Theory BSCCHCE 133	Laboratory Reagents, Laboratory Safety and Domestic Chemicals	2	2	40	10	50	1*
Total number of Credits for Subject in I Semester:04								
II Semester B.Sc.								
Group I Core Subject	Theory BSCCHC181	Chemistry Paper II	4	3	80	20	100	2
	Practical II BSCCHP182	Chemistry Practical II	3	3	40	10	50	1
Group II Elective	Theory BSCCHCE 183	Biomolecules And computer for chemists	2	2	40	10	50	1*
Total number of Credits for Subject in II Semester:04								
III Semester B.Sc.								
Group I Core Subject	Theory BSCCHC231	Chemistry Paper III	4	3	80	20	100	2
	Practical III BSCCHP232	Chemistry Practical III	3	3	40	10	50	1
Group II Elective	Theory BSCCHCE233	Chemistry and Environment	2	2	40	10	50	1*
Total number of Credits for Subject in III Semester:04								
IV Semester B.Sc.								
Group I Core Subject	Theory BSCCHC281	Chemistry Paper IV	4	3	80	20	100	2
	Practical IV BSCCHP282	Chemistry Practical IV	3	3	40	10	50	1
Group II Elective	Theory BSCCHOE283	Chemistry in everyday life	2	2	40	10	50	1*

					Total number of Credits for Subject in IV Semester:04			
V Semester B.Sc.								
Group I Core Subject	Theory BSCCHC331	Chemistry Paper V	3	3	80	20	100	2
	Theory BSCCHC332	Chemistry Paper VI	3	3	80	20	100	2
	Practical V BSCCHP333	Chemistry Practical V	4	4	80	20	100	2
					Total number of Credits for Subject in V Semester:06			
VI Semester B.Sc.								
Group I Core Subject	Theory BSCCHC381	Chemistry Paper VII	3	3	80	20	100	2
	Theory BSCCHC382	Chemistry Paper VIII	3	3	80	20	100	2
	Practical VI BSCCHP383	Chemistry Practical VI	4	4	80	20	100	2
					Total number of Credits for Subject in I Semester to IV Semester:16			
					Total number of Credits for Core Subject in I-VI Semesters:28			

*Credits for Elective Papers will be considered for the entire B.Sc.

BASIS FOR INTERNAL ASSESSMENT, PATTERN OF THEORY QUESTION PAPERS AND PRACTICAL EXAMINATION IN SCIENCE SUBJECTS

1. **Basis of Internal Assessment in Theory and Practical's**

The internal assessment marks in theory papers shall be based on two tests. The tests shall be at least 1 hour duration each and to be conducted after 6 and 12 weeks after the start of a semester. The average of the two tests shall be taken as the internal assessment marks in theory papers.

The practical internal assessment marks shall be based on one test and continuous evaluation during the practicals. The practical test shall be conducted after 10 weeks after the start of a semester. The average of the test and continuous evaluation shall be taken as the internal assessment marks in practicals.

2. **Theory Question Papers Pattern:**

Theory Question Papers in Chemistry shall carry 80 marks. The syllabus of each paper is grouped into four (4) units of 13 teaching hours each in the first 4 semesters and 10 teaching hours each in the 5th and 6th semesters for all the science subjects with practical's. The Question Paper shall consist of Parts A and B, as detailed below.

Part A: Part A Shall contain 12 objective type questions/divisions (Q.No 1) drawn from all the 4 units of the syllabus (3 divisions per unit) carrying 2 marks each (a,b,c,d,e,f,g,h,i,j,k & l). 10 divisions are to be answered 10x2=20 marks.

Part B: Part B shall contain eight (8) brief and long answer questions (Q. Nos 2 to 9) carrying 15 marks each drawn from all the four units of the syllabus (2 questions per units). There shall be three divisions per question. The students are required to

answer 4 full questions, choosing one full question from each unit. 4x15=60 marks.

3. Question paper for Soft core/open elective papers:

The question paper shall carry 40 marks. The question paper shall consist of Part A and Part B as detailed below.

Part A : Part A shall contain6 objective type questions/divisions (Q.No.1) drawn 3 divisions from each Unit.(Unit-I and Unit-II) carrying 2 marks each(a,b,c,d,e,f). 5 division are to be answered.5x2=10 marks.

Part B: Part B shall contain four (4) brief and long answer questions (Q.No.2 to 5) carrying 15 marks each drawn from two units of the syllabus (2 questions per units).There shall be three divisions per question. The students are required to answer 2 full questions, choosing one full question from each unit.2x15=30 marks.

	UNIT I		UNIT II		UNIT III		UNIT IV	
Q. Nos. (Max. Marks 15)	2	3	4	5	6	7	8	9
Marks Splitting	4+4+7 (4+3)	3+5+7 (4+3)	4+4+7 (4+3)	3+5+7 (4+3)	4+4+7 (4+3)	3+5+7 (4+3)	4+4+7 (4+3)	3+5+7 (4+3)

I Semester

B.Sc CHC-131: Chemistry Paper-I

UNIT I

Solid State **7Hours**

Laws of crystallography: Law of constancy of interfacial angle-explanation taking hexagonal crystal system as an example. Law of symmetry. Elements of symmetry- axis of symmetry, plane of symmetry and centre of symmetry- explanation taking cubic crystal system as an example. Law of rationality of indices. Miller indices- calculation of Miller indices for different planes in a cubic crystal system. Bravais lattices. X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl and determination of Avogadro number. Caesium Chloride, Zinc blende structures(Numerical problems to be discussed).

Liquid Crystals **2Hours**

Explanation, classification with examples - smectic, nematic, cholesteric, disc shaped and polymeric. Structures of nematic and cholesteric phases- molecular arrangements in nematic and cholesteric liquid crystals. Application of liquid crystals in LCDs and thermal sensing.

Gaseous State **4Hours**

Maxwell's distribution of molecular velocities- explanation with graph. Most probable, average and RMS velocities. Relation between RMS, average and most probable velocity. Qualitative discussion of the collision number, mean free path and collision diameter. Critical phenomena: P-V isotherms of real gases - Andrews's isotherms of carbon dioxide. Continuity of states - principles. Isotherms of Van der Waals equation. Relationship between critical constants and Van der Waals constants-derivation of the expressions for a, b, T_C, P_C and V_C, Law of corresponding states- statement, reduced equation of state-derivation of the equation.

UNIT II

Chemical Bonding **13Hours**

Covalent bond-Valence bond theory-Concept of hybridization, Valence Shell Election Pair Repulsion (VSEPR) theory, Comparative study of structure and bonding between F_2O and H_2O, H_2S and H_2O, NH_3 and NF_3, ClF_3 and $XeOF_2$. Basic principle of Molecular orbital theory. Molecular orbital diagrams of homo and hetero nuclear species- N_2, O_2, CO, NO and CN^-. Ionic bond- Lattice energy, Born-Lande equation, Solvation and Solubility of ionic solids. Polarising power and Polarizability of ions. Fajan's rules to explain bond character, covalent character of ionic compounds, relative covalent character. Comparative trend in properties: a) Melting point-e.g: NaBr, $MgBr_2$, $AlBr_3$; LiF, LiCl, LiBr, LiI; $CaCl_2$,

$HgCl_2$ b) Solubility-e.g AgF, AgCl, AgBr, AgI c) Thermal stability-e.g $BeCO_3$, $MgCO_3$,$CaCO_3$,$SrCO_3$, $BaCO_3$. Metallic Bond-Application of Band theory.

UNIT III

Nature of Bonding In Organic Molecules: 3Hours

Formation of covalent bond. Types of Chemical bonding- Localised and Delocalised. Conjugation and Cross conjugation. Resonance. Aromaticity-Huckel rule, explanation with examples. Antiaromaticity. Hyper conjugation-relative stabilities of 1^0,2^0 and 3^0 carbonations. Electron displacements in covalent bond. Inductive effect and Field effect - Explanation with examples. Relative strengths of aliphatic and aromatic carboxylic acids-Acetic acid and Chloroacetic acid, acetic acid and Propionic acid, Acetic acid and Benzoic acid. Steric effect- Relative stabilities of trans and cis-2-butene, relative relativities of alkyl halides in S_N2 reaction, steric hindrance in esterification of acids and anomalous basic strength of tertiary alkyl amines.

Mechanism of Organic Reactions 7Hours

Breaking and making of covalent bonds. Substrate and reagent. Notations used to represent electron movements and directions of reactions- arrows, curved arrows, half-headed and double-headed arrows. Types of bond breaking-homolytic and heterolytic. Types of reagents-Electrophiles and Nucleophiles-explanation with examples. Types of organic reactions-Substitution, Addition, Elimination and Rearrangement reactions, explanation with examples. Reactive intermediates- Carbo cations, Carbanions, free radicals, carbenes, arynes and nitrenes- explanation with examples. Mechanism of – Friedel-Craft's reaction, Addition of HBr to propene, Free radical addition of HBr to propene, Cannizzaro reaction, Hofmann rearrangement, Addition of HCN and $NaHSO_3$ to carbonyl compounds.

Electrophilic Addition to Carbon-Carbon Multiple Bonds 3Hours

Addition of halogens to alkenes-carbocation and halonium ion mechanisms. Stereo specificity of halogen addition. Limitations of open carbocation mechanism. Ozonolysis – Mechanism of ozonolysis of propene. Addition of hydrogen halides to alkenes- mechanism, regioselectivity and relative rates of addition. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes-Explanation with examples. Electrophilic addition to conjugated dienes-mechanism of addition of HBr to 1,3-butadiene, effect of temperature. Free radical addition to 1,3-butadiene. Diels-Alder reaction and its importance, 1,3-Dipolar cycloaddition and Pericyclic reaction-explanation with example.

UNIT IV

Chromatography 3Hours

Chromatographic methods for the separation, concentration and identification of organic compounds-Thin layer, paper and column chromatography. R_f value and its significance. Principle and applications of Gas chromatography.

Methods of Analysis 6Hours

Qualitative analysis - Sample size and techniques- macro, semi micro and micro. Type of tests- wet, dry and spot tests. Quantitative analysis - Volumetry, Gravimetry and Instrumental analytical methods. Principles of gravimetric analysis-methods of precipitation, optimum conditions for precipitation and co-precipitation. Solvent extraction-basic principles and applications. Errors in quantitative analysis, types of errors- determinate and indeterminate, methods of minimising errors. Accuracy - absolute error/ relative error. Precision -mean

deviation / relative mean deviation, standard deviation, t-test, F-test and Q-test. Significant figures. Rules for computation of results. (Numerical problems to be solved wherever necessary.

Periodic Properties **4Hours**

Methods of determination of atomic properties -Atomic size by Lande's method, Ionization energy by Discharge tube method, Electron affinity from Born-Haber cycle and Electronegativity from Pauling and Mulliken scales. Predicting and explaining the chemical behaviour of elements on the basis of periodic properties (metallic/non metallic, ionic/covalent, reducing/oxidizing). Effective nuclear charge-shielding effect. Slater's rule and its applications.

BSCCHP132:CHEMISTRY PRACTICALS-I [3HOURS PER WEEK (12X3 =36)]

Volumetric Analysis

1. Microscale experiment-Two burette titration and beral pipette titration.
2. Preparation of standard sodium carbonate solution, standardization of hydrochloric acid and estimation of sodium hydroxide in solution.
3. Preparation of standard solution of potassium biphthalate, standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
4. Preparation of a standard solution of oxalic acid, standardization of potassium permanganate solution and estimation of Mohr's salt in solution.
5. Preparation of standard ferrous ammonium sulphate solution, standardization of Potassium dichromate solution and estimation of ferric chloride in solution.
6. Preparation of standard potassium dichromate solution, standardization of sodium thiosulphate solution and estimation of copper sulphate in solution.
7. Estimation of a mixture of oxalic acid and sulphuric acid in a solution using standard Potassium permanganate solution and standard sodium hydroxide solution.
8. Estimation of calcium content in lime stone as calcium oxalate by permanganometry.
9. Estimation of hardness of water by EDTA method.
10. Estimation of manganese in pyrolusite by volumetric method.
11. Determination of acetic acid in commercial vinegar using NaOH.
12. Determination of alkali content in antacid tablet using HCl.
13. Estimation of glucose using iodine and sodium thiosulphate.
14. Estimation of Vitamin C.

Reference Books

1.A Text Book of Inorganic Chemistry-P.L.Soni.1998, Sultan Chand and Sons.

2.A Text Book of inorganic Chemistry-Puri and Sharma 2000, Shobanlal Nagin Chand.

3. A Text Book of inorganic Chemistry-Gurudeep Raj. Krishna's Educational Publishers.
4. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.
5. A Text Book of Quantitative analysis- A.I_Vogel, ELBS.
6. Physical Chemistry by Samuel Glasstone, 1982 ELBS.
7. A Text Book of Physical Chemistry by P.L.Soni , O.P. Dharmarha and U.N.Dash, Sultan Chand and Sons.

8. Physical Chemistry-Madan and Tuli,2001, S.Chand. NEW DELHI.
9. A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut

10. 0rganic Reaction mechanism by V.K.AhIuwalia and R.K.Parashar(Narosa Publishers).
11. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.(Narosa Publishers)
12. A Guide book to mechanism in Organic Chemistry by Peter sykes. Pearson.
13. Instrumental methods of Chemical analysis. Willard, Merritt, Dean and Skettle, CBS Publishers.
14. Instrumental methods of Chemical analysis -Gurudeep R.Chatval and Sham Anand, I998, Himalaya Publishing House.

Group II Elective

B.Sc CHCE-133 : Laboratory Reagents, Laboratory Safety and Domestic Chemicals

UNIT I

Laboratory Safety **4Hours**

Introduction. General laboratory protocols: Basic rules, Good Laboratory Practices. Chemical hazards, safety data sheets, symbols and hazard information, storage procedure, Physical hazards, Health hazards, Reaction hazards. Assessing the risks of hazards. Minimizing the risks of hazards: fume hood, ventilation, fire extinguisher, personal protective equipment's, Preparedness for emergencies from uncontrolled hazards: Importance of reporting incidents, response to common emergencies such as fires, explosions, chemical spills, chemical exposures, injuries.

Serendipity **3Hours**

The role of Chance in making Scientific Discoveries

What is Serendipity- Some Serendipous Inventions in Science; Guncotton, Velcro, Plastic, X-rays, Microwave, Superglue, Mauve, Teflon, Saccharin, Stainless steel, Matches. Role of Serendipity in Drug discovery; Inventions in Chemistry that enabled the modern world.

Laboratory Reagents: **5Hours**

Preparation of laboratory reagents and maintenance of electrodes and common laboratory equipments. Methods of expressing concentrations of solution, Preparation of reagents for qualitative analysis of organic and inorganic compounds. Precaution and safety measures during reagent preparation.

Unit-II

Domestic Chemicals **8Hours**

Cleansing agents: Preparation Chemical composition of Soaps, detergents, dish washers, drain cleaners, bleaching powder, Tooth paste, mouth wash and shampoo. Stain removers – Explanation with some common examples.

Domestic items: Safety matches, Wax candles, shoe polish, mosquito coils, household germicides and pesticides-their chemical composition.

Cosmetics: Talcum powder, nail polish, thinners, skin care, hair care, Lipsticks, sun protection lotions and creams, eye shadow and eyebrow pencils, antiperspirants, perfumes and deodorants-explanation with examples.

Application Of Colloids **4Hours**

Introduction, Applications: 1) Explanation of natural phenomena –Blue colour of sky, formation of delta region, coagulation blood 2) In industry- Purification of water, cleansing action of soap, tanning of leather, rubber plating, smoke precipitation, sewage disposal, ceramic industry, dyeing industry, preparation of photographic plates &paper., 3) Food. 4) In medicine 5) Artificial rain

Reference Books

1. Chemistry at Home: Exploring the ingredients in everyday products- John Emsley, Royal Society of Chemistry (2015).
2. Chemistry in daily life - Kripal Singh, Third Edition, Eastern Academy Education, PHI Learning Pvt. Ltd, New Delhi(2012).
3. Chemistry in everyday life-Shardendu Kislaya, Discovery Publishing House Pvt.Ltd(2011).
4. Laboratory Safety, theory and Practice, 1st Edition, Editors: Anthony Fuscaldo and others. Elsevier Publications, 1980.
5. Chemical Laboratory Safety and Security: A Guide to Developing Standard Operating Procedures. National Academies Press (2016). Board on Chemical Sciences and Technology, Division on Earth and Life Studies.
6. Chemistry Laboratory Safety Manual, Indian Institute of Science, Education and Research, Tirupati.
7. Laboratory Safety Manual, NCBS, 2016.
8. Practical Chemistry- Dr. O.P.Pandey, D.N. Bajpai, Dr. S. Giri
9. Vogel's Qualitative Inorganic Analysis- G. Svehla
10. Text book of Physical Chemistry By Puri,Sharma and Pathania
11. Science and serendipity: Famous accidental discoveries, Samira Shackle, Thursday,2ndApril 2015- New Humanist.
12. The role of serendipity in drug discovery. Thomas A. Ban, MD, FRCP- Dialogues in Clinical Neuroscience, 2006 Sep; 8(3): 335–344.
13. Five Chemistry Inventions that changed the modern world-The Conversation. June 2, 2015.
14. Hannan, Patrick J. (2006). Serendipity, Luck and Wisdom in Research; Universe. ISBN 0-595-36551-5.

II **SEMESTER**

B.Sc CHC-181 : Chemistry Paper-II

UNIT I

Chemical Kinetics : **4 Hours**

Concentration dependence of rates, differential rate laws of simple chemical reactions, Zero, First, Second, n^{th} and pseudo first order reaction. Derivation of rate constants for second order and nth order reactions with equal initial concentrations. Determination of order of a reaction- Differential, Integration, Half life period and Isolation methods. Transition state theory- Derivation of relationship between rate constant and equilibrium constant. Thermodynamic aspects of activation.

Surface Chemistry: **4Hours**

Adsorption of gases on solids: Freundlich and Langmuir adsorption isotherms. Multilayer adsorption-BET equation. Determination of surface area and area of cross section of a molecule. Adsorption from solution-Gibb's Adsorption isotherm

Solvents: **5Hours**

Physical properties of a solvent - density, dipole moment, specific conductance, dielectric constant. Types of solvents - classification into protic - aprotic, acidic - basic - amphiprotic, ionizing - non ionizing (examples) solvents, Characteristics-liquid range, auto-ionization and solvating properties. Reactions in aqueous and non-aqueous solvents (explanation with examples). Water-hydration, hydrolysis, acid-base, reduction-oxidation, complex formation and precipitation. Ammonia-ammoniation, ammonolysis, acid-base, reduction-oxidation, complex formation, precipitation, alkali metals in ammonia. Levelling effect of solvents - examples.

UNIT II

s-Block Elements : **6Hours**

Hydrogen- position of hydrogen in the periodic table. Hydrides-types, preparation, properties and applications. Structure of NaH and BeH_2. Complex hydrides- $LiAlH_4$, $NaBH_4$. Preparation and applications. Comparative study of Li and Be with other members of the same group. Comparative study of lattice energy, enthalpy of formation, enthalpy of hydration and solubilities of alkali metal and alkaline earth metal halides, hydroxides and sulphates. Comparison of standard reduction potentials and reducing properties of alkali metals and alkaline earth metals. Complexation tendencies of alkali metals with crown ether, Cryptates.

p-Block Elements: **7Hours**

Comparative study of p-Block elements and their compounds-comparison between Boron and other members of the group.

Boranes: Diborane- Preparation, properties, structure and bonding, chemical evidences for the presence of bridge hydrogen. B_4H_{10}, B_5H_9, Preparation and structure, Styx number, Wade's rule-Closo ,Nido and Arachno boranes. Silicates-types, basic units, structure and applications. Hydrazine and hydroxylamine-structure and reducing property. Hypo phosphorous acid, phosphorous acid, phosphoric acid, orthophosphoric acid, meta phosphoric acid and pyro phosphoric acid- structure. Halogens in positive oxidation state. Inter halogen compounds-ICl, BrF_3, IF_5 and IF_7-preparation, properties, structure and uses. Noble gases- Structure and bonding in: Clathrates, XeF_2, XeF_4, XeF_6 and XeO_3.

UNIT III

Reactions Involving Intermediates: 5Hours

Generation, stability and mechanism of reactions- i) carbocations –Dienone-phenol rearrangement ii) carbanions – Perkin reaction, Aldol condensation and Claisen condensation, iii) Free radicals – Sandmeyer's reaction, iv) Nitrenes- Hofmann rearrangement, Curtius rearrangement, v) carbenes- Reimer -Tieman reaction, vi) Arynes- Benzyne mechanism for the conversion of Bromobenzene to aniline. Methods of determination of reaction mechanism-Product analysis, intermediates, isotope effects, kinetic and stereo chemical studies.

Nucleophilic Substitution at Saturated Carbon 2Hours

Mechanism of S_N1 and S_N2 reactions with suitable examples and energy profile diagrams. Stereochemistry and factors affecting S_N1 and S_N2 reactions.

Elimination Reactions 2Hours

Mechanism of E1 and E2 - explanation with suitable examples, evidences, orientation and stereochemistry. Hoffmann and Saytzeff rules.

Aromatic Electrophilic and Nucleophilic Substitutions 4Hours

Aromatic electrophilic substitution-general pattern of the mechanism with energy profile diagram. Role of σ and π-complexes. Activating and de-activating substituents, Orienting influence, ortho-para ratio. Nucleophilic aromatic substitution reactions- Addition-elimination and Elimination-addition mechanism.

UNIT IV

Industrial Chemistry 13Hours

Fuels: Composition, production and applications of natural gas, water gas, producer gas, LPG and bio gas.

Propellants: characteristics and applications.

Glass: Raw materials, manufacture- tank furnace, steps in manufacture and annealing of glass. Types of glasses: composition and uses of - hard, soft, Pyrex, jena, flint, safety, optical, fibre, coloured and Crooke's glasses.

Cement: Raw materials, manufacture of cement, mechanism of setting of cement. RCC –composition and uses.

Ceramics: Raw materials used in modern ceramics, stages in ceramic making, glazing, applications of porcelain.

Paints: Constituents of paints and their functions with examples. Manufacture of white lead and lithopone.

Refractories: Characteristics, classification with examples and applications,

Abrasives: natural abrasives, synthetic abrasives, characteristics and applications. Silicon carbide and boron nitride- structure and production.

Cane sugar: Outline of production and composition, molasses, its composition.

Paper: Production of wood pulp and preparation of paper.

Chemical fertilizers: Primary nutrients, Different types of fertilizers, importance, production of urea, CAN and superphosphate of lime.

BSCCHP182 CHEMISTRY PRACTICAL-II [3 Hrs/Week (12x3 Hrs)]

I. Systematic qualitative analysis of mono and bifunctional organic compounds Determination of melting point/boiling point, preparation of suitable solid derivative and identification compound from literature. Following compounds may be given - Resorcinol, oxalic acid, urea, thiourea, thiophenol, benzoic acid, salicylic acid, phenol, p-cresol, aniline, p-nitroaniline, p-toluidine, benzaldehyde, ethyl methyl ketone,

acetophenone, benzophenone, chlorobenzene, bromobenzene, nitrobenzene and benzamide. 8 weeks .

II. Thin Layer Chromatography: Any two of the following. **2 weeks**

Determination of Rf values and identification of organic compounds,

a) Separation of green leaf pigments (Spinach leaves may be used),

b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60)

c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5: 1.5)

III. Paper Chromatography: Ascending and Circular. Any two of the following **2weeks**

Determination of Rf values and identification of organic compounds,

a) Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid, Leucine and glutamic acid. Spray reagent-ninhydrin.

b) Separation of a mixture of D, L-alanine, glycine, and L-Leucine using n-butanol, acetic acid-water (4:1:5). Spray reagent-ninnydrin,

c) Separation of monosaccharides-mixture of D-galactose and D- fructose using n-butanol:acetone: water (4:5:1), Spray reagent - aniline hydrogen phthalate.

IV. Column Chromatography:

a) Separation of fluorescein and methylene blue.

b) Separation of leaf pigments from spinach leaves.

Reference

1. Analytical Chemistry-John H. Kennedy, l986, Saunder‘s College, New York.
2. Instrumental methods of Chemical analysis. Willard, Merritt, Dean and Skettle, CBS Publishers.
3. Instrumental methods of Chemical analysis by Gurudeep R.Chatval and Sham Anand, I998, Himalaya Publishing House.
4. A Text Book of Inorganic Chemistry by P.L.Soni.1998, Sultan Chand and Sons.
5. A Text Book of inorganic Chemistry by Puri and Sharma 2000, Shobanlal Nagin Chand.
8. A Text Book of inorganic Chemistry by Gurudeep Raj. Krishna’s Educational Publication.
7. A Text Book of inorganic Chemistry by Sathya Prakash, 2001.
8. Concise inorganic Chemistry by J.D.Lee, l998,Blackwell Science Ltd.
9. Principles of inorganic Chemistry by Puri, Sharma and Kalia.2000, Shobanlal Nagin Chand.
I0. Selected Topics in inorganic Chemistry by Madan, Malik,Tuli,2000,S.Chand and Company.
11. Engineering Chemistry-B.K.Sharma,2001,
12. Industrial Chemistry-B.K.Sharma,2001.
13. 0rganic Reaction mechanism by V.K.AhIuwalia and R.K.Parashar (Narosa Publishing).
14. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor(Narosa)
15. A Text Book of Qualitative analysis- A.I_Vogel, ELBS.

Group II Elective

BSCCHCE-183: Biomolecules and Computer for Chemists

UNIT I

Computers for Chemists **8Hours**

Basic structure and functioning of computer with a PC as an illustrative example. Memory, Input/output devices, Secondary storage, Computer languages, Operating systems, Algorithm and Flow chart , programmes and packages, MS-word, Excel, Power Point, Chem Sketch etc. Demonstration, writing and drawing of chemical formulae and structure through chem sketch. Plotting the various graphs such as pressure-volume (PV), pressure- temperature (PT), potentiometric, conductometric and colorimetric plots through Excel.

Buffer Solutions **2Hours**

Definition, Types, Buffer Action, Mechanism of Buffer Action, Henderson's Equation (No Derivation), Principles involved in the preparation of buffer solution, Importance of Buffer solution , Numerical Problems.

Solubility Product **2Hours**

Expression For K_{sp}, of Sparingly soluble salts of types AB, AB_2, And A_2B, Relation shipbetween Solubility and solubility product. Common Ion Effect: Applications of Common Ion effect and solubilty product in Inorganic Qualitative analysis.

UNIT II

Chemotherapy **4Hours**

Introduction. Classification – antibiotics-Chloramphenicol and Penicillin. Synthesis and Uses. Analgesics – Narcotic analgesics and Non-Narcotic analgesics-Examples and their uses. (Simple Synthesis to be included). Sulphonamides-Preparation of sulphonamides.-Examples and their uses. Antiseptics and disinfectants- Examples and their uses. Hypoglycemic agents – Cancer treatment by Chemotherapy. A brief account of medicinally important compounds. Compounds of aluminum as pharmaceutics; compounds of phosphorous as pharmaceutics; Compounds of iron as pharmaceutics. Examples and uses. (Only specific examples).

Biomolecules: **8Hours**

Vitamins: Introduction, classification, Fat soluble vitamins, source of vitamin, vitamin D, Niacin. Water soluble vitamins, pantothenic acid, cyanocobalamin, deficiency diseases.

Photosynthesis of carbohydrate, mechanism of light phase reaction,.

Proteins: Oxytocin and vasopressin, chemical synthesis and biological activity. Antibiotics: Introduction, classification

Lipids: Introduction, occurrence chemical and physical properties, biological functions, Derived .lipids, cholesterol and its biological functions

References

1. Computers and their applications to Chemistry – Ramesh Kamari.
2. Computers in Modern Chemistry – A. Kumar.
3. Organic Chemistry of Natural Products,By Gurudeep R.Charwal (Vol-I and II) edited by M.Arora (Himalaya Publishing House).
4. Pharmaceutical Chemistry by Thyagarajan.
5. A Text Book of Physical Chemistry by P.L.Soni , O.P. Dharmarha and U.N.Dash, Sultan Chand and Sons.
6. Physical Chemistry-Madan and Tuli,2001, S.Chand. New Delhi.
7. A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut

III **SEMESTER**

BSCCHC231: Chemistry Paper-III

UNIT - I

Thermodynamics: 13 Hours

First Law of Thermodynamics: statement, definition of internal energy and enthalpy. Heat Capacity, heat capacities at constant volume and pressure and their relationship. Joule's Law, Joule - Thomson coefficient and inversion temperature. Bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy. Kirchhoff's equation. Second Law of thermodynamics : Need for the Law, different statements of the Law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy, entropy as a state function, entropy change for an ideal gas as a function of V & T , entropy as a function of P & T, entropy change in physical changes- fusion, evaporation, sublimation and transition. Entropy change in mixing of ideal gases. Entropy as a criterion of spontaneity and equilibrium. Third Law of thermodynamics: significance, unattainability of absolute zero. Gibbs and Helmholtz functions; Gibbs function(G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity. Variation of G with P, V and T (Illustrative problems to be worked out).

UNIT - II

Chemistry of d-block elements: 5Hours

Introduction, General characteristics of transitional elements, general electronic configuration, stabilities of oxidation states, complexing ability, colour, magnetic property- expression for magnetic moment –spin only formula μ_s, calculation of μ_s for 3d series elements, Lande's calculation of theoretical magnetic moment. μ_{S+L}, comparison of magnetic moment μ_s and μ_{s+L} with experimental value of μ . Reasons for observed trend, Comparative treatment of 4d, 5d series with their analogues in respect of ionic radii, oxidation states, magnetic behavior and stereochemistry.

Chemistry of f-block elements: 4 Hrs

Introduction, Lanthanide contraction, causes of lanthanide contraction, occurrence, Isolation of lanthanides by ion-exchange method, similarities and comparison between lanthanides and actinides, separation of Neptunium, Plutonium and Americum and Uranium. Problems on calculation of μ_{S+L} for trivalent lanthanide ions,

Nano Chemistry: 4Hours

Introduction, General methods of synthesis, characterization techniques, Scanning Electron Microscopy (SEM)-principle and method of determination, advantages over other microscopes, Fullerenes, Preparation of nanoparticle by chemical method, Application of nanomaterials.

UNIT III

Reactions and reactivity of Phenols: 3Hours

Comparison of acidic properties of phenols with carboxylic acids, alcohols and carbonic acid. Molecular rearrangements- Fries rearrangement, Claisen rearrangement, Synthesis of aryloxy acetic acids.

Structure and reactivity of carbonyl compounds: **7Hours**

Structure of carbonyl group, Nucleophilic additions to carbonyl group, relative reactivities of aldehydes and ketones-explanation, Mechanism of reactions involving- Hydride shift-Tischenko reaction, i) C-C bond formation-Bucherer hydantone synthesis, ii) C=C bond formation-Wittig reaction, iii) C=N bond formation-addition of NH_3 derivatives, iv) C-O bond formation-Acetal formation, Michael addition, α, β-unsaturated aldehydes and ketones.

Ethers and Epoxides: **3 Hours**

Chemical reactions of ethers-Cleavage and auto-oxidation with examples. Zeisel's method. Synthesis of epoxides, Acid and Base catalyzed Ring opening of epoxides, Orientation of epoxide ring opening with energy profile diagram.

UNIT - IV

Acids and Bases : **2Hours**

Lewis concepts of acids and bases. Modern concepts of acids and bases. Usanovich concept, Lux-Flood concept. Hard and Soft Acids and Bases (HSAB): Classification of acids and bases as hard and soft. Pearson's HSAB concept and its applications.

Binary Mixtures: **7Hours**

Liquid-liquid mixtures: Ideal liquid mixtures, Raoult's law, Non-ideal system:

Azeotropes: HCl-H_2O and ethanol-water systems. Partially miscible liquids: Phenol-water, trimethyl amine and water and nicotine - water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature. Immiscible liquids, steam distillation. Nernst distribution law- Definition and applications.

Food Technology: **2Hours**

Introduction to food chemistry, Fundamentals of food processing, Fundamentals of milk processing, Food analysis, Food packing technology, Food laws and quality assurance.

Corrosion Chemistry: **2Hours**

Corrosion - Introduction, Corrosion-an electrochemical phenomenon. Types of corrosion- Galvanic corrosion, Crevice corrosion,, Erosion corrosion, Stress corrosion

BSCCHP232: Chemistry Practical – III **[3 Hrs./Week (12x3 Hrs.)]**

Semi Micro Qualitative Analysis Of Inorganic Salt Mixture:

Systematic qualitative analysis of mixture of two simple inorganic salts (containing two cations and two anions)

Anions : CO_2^{-3}, HCO_3^-, SO_3^{2-}, S^{2-}, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, PO_4^{3-}, SO_4^{2-},

Cations : Pb^{2+}, Cu^{2+}, Bi^{3+}, Cd^{2+}, C_O^{3+}, Ni^{2+}, Al^{3+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+, NH_4^+

Note: First experiment should be exclusively used for explaining the basic principles of qualitative inorganic analysis and demonstration.

Reference Books

1. A Text Book of Inorganic Chemistry by P.L.Soni.1998, Sultan Chand and sons.
2. A Text Book of inorganic Chemistry-Puri and Sharma 2000, Shobanlal Nagin Chand.
3. A Text Book of inorganic Chemistry-Gurudeep Raj.
4. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.
5. Engineering Chemistry-B.K.Sharma,2001,
6. Nano materials by A.K.Bandyopadhyay , New Age Publishers NewDelhi.
7. Nano Science and Technology By VS Muralidharan and A.Subramania, Ane Books Pvt.Ltd. NewDelhi.
8. An Introduction to Metallic corrosion and its Prevention. By Raj Narayan Oxford and IBH publishing Co , NewDelhi.
9. Qualitative Analysis (A Text Book) -A.I.Vogel, ELBS.
10. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.
11. Food Science and Technology by Dev Raje.
12. A Text book of Food and Beverage Management by Sudhir Andrews.

Group II Elective

BSCCHCE233: Chemistry and Environment

Unit I

Corrosion and its Prevention **10Hours**

Introduction, Causes of different types of corrosion. Corrosion rate,-definition, Factors affecting on corrosion rate. Metallic factor-Purity, Electrode Potential of metal, hydrogen over voltage, nature of corrosion product. Environmental factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium.

Prevention of corrosion: Material selection-Metals and alloys, metal purification, non-metallic, Alteration of environment-Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

Water Purification **2Hours**

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

Unit-II

Green Techniques **12Hours**

Introduction, Principles, atom-economy, Prevention of waste, by products, hazardous products/chemicals, water as a solvent for organic reactions, ionic liquids, solidstate-solventless reactions, use of microwaves, careful use of protecting and deprotecting agents, use of catalytic reagents, Phase transfer catalysts and its synthetic applications.

Examples of Green synthesis: Synthesis of adipic acid, catechol, disodium iminodiacetate, Boots synthesis of brufen, Microwave assisted reactions in water-Hofmann elimination, Methyl benzoate to benzoic acid, oxidation of toluene and alcohols

Microwave assisted reactions in organic solvents:-Diels-Alder reaction and decarboxylation reaction, Green synthesis of compostable and widely applicable polylactic acid, plastic from corn.

Limitations of green techniques.

Reference Books:

1. An Introduction to Electrochemistry, By Samuel Glastone. ACS Publications.
2. Text book of Physical Chemistry By Atkin. Oxford University Press.
3. Text book of Physical Chemistry By Bahl and Bahl. S. Chand Pulishers.
4. Text book of Physical Chemistry By Gurudeep Raj. Krishna's Educational Pubklications.
5. New Trends in Green Chemistry - Ahluwalia V.K and Kidwai M.R, Anamalaya Publishers (2005).
6. Green Chemistry - Theory and Practical, Anastas, P.T and Warner J.K : Oxford University Press (1998).
7. Introduction to Green Chemistry- Matlack, A.S. Marcel Dekker (2001).
8. Introduction to Green Chemistry- Ryan, M.A. & Tinnesand, M., American Chemical Society, Washington (2002).
9. An Introduction to Metallic corrosion and its Prevention by Raj Narayan, Oxford and IBH publishing Co , NewDelhi.

IV SEMESTER

BSCCHC281: Chemistry Paper-IV

UNIT I

Solutions, Dilute Solutions and Colligative Properties 7Hours

Ideal and non-ideal solutions, Methods of expressing concentrations- Activity and Activity coefficients. Colligative properties; Raoult's law of relative lowering of vapour pressure. Osmosis and laws of Osmotic pressure. Elevation in boiling point and depression in freezing point. Thermodynamic derivation of the relation between elevation of boiling point/depression of freezing point and molecular mass of solute (Illustrative problems to be worked out).

Physical Properties And Molecular Structure 4Hours

Optical activity, polarization (Clauisius-Mosotti equation), orientation of dipoles in an electric field, dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties-paramagnetism and diamagnetism.

Refractometry: 2Hours

Introduction, Abbe's Refractometer, applications of Refractometry.

UNIT - II

Coordination Compounds: 5Hours

Nomenclature, illustration with example including geometrical and optical isomers, bridging ligands. Isomerism in coordination compounds - ionization isomerism, hydrate isomerism, coordinate isomerism, linkage isomerism. Geometrical isomerism and optical isomerism (coordination numbers 4 and 6).

Metal–Ligand Bonding In Transitional Metal Complexes: **8Hours**

Postulates of Valence Bond Theory (VBT), Examples for sp^3, dsp^2, dsp^3, d^2sp^3 and sp^3d^2 hybridization- $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$, $[Fe(CO)_5]$, $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$. Explanation for magnetic properties. Limitations of Valence bond theory. Crystal field theory-important concepts of CFT, Crystal field splitting in octahedral, tetrahedral and square planar complexes, Jahn- Teller distortion, and crystal field stabilization energy. Calculation of CFSE, weak and strong field ligands, spectrochemical series, explanation for stability, geometry, magnetic and spectral properties. Factors affecting the crystal field splitting. Limitations of CFT.

UNIT III

Reactive Methylene Compounds: 2Hours

Keto-enol tautomerism, ethyl acetoacetate and diethyl malonate, Reactions supporting keto and enol forms. Synthetic applications of reactive methylene compounds-Synthesis of alkyl and dialkyl acetic acids, succinic acid, keto acids, α-β unsaturated acids (crotonic acid), 4- Methyl uracil and antipyrine.

Reagents And Their Synthetic Utility: 8Hours

Different reagents used for the synthesis of organic compounds with reaction mechanism**-** i) $KMnO_4$-Oxidation of alkenes to vicinal diols ii) OsO_4- Synthesis of cis-1,2-diols iii) Per acids-Baeyer-Villiger oxidation iv) Aluminium isopropoxide-Meerwein-Ponndorf-Verley reduction v) $LiAlH_4$- reduction of carbonyl compounds into alcohols vi) $NaNH_2$-Chichibabin reaction vii) N-Bromosuccinimide- Allylic bromination of alkenes viii) H_2O_2 – Dakin reaction ix) NH_2-NH_2(Wolf-Kishner reduction) x) CrO_2Cl_2 (Etard reaction). Explanation with an example for

commonly used synthetic reagents - O_3(Ozonolysis), Periodic acid(Oxidation of vicinal diols into carbonyl compounds), Lead tetra acetate(Oxidative cleavage of vicinal diamines), CrO_3(Sarett oxidation), $NaBH_4$(Reduction of carbonyl compounds into alcohols), Diazomethane(Methylation of carboxylic acids and phenols), Na/ ethyl alcohol(Reduction of ester to alcohol by Bouveault-Blanc reduction).

Structure and Reactions of Carboxylic Acids and Their Derivatives:

3Hours

Structure of carboxylic acid and carboxylate ion, Effect of substituents on the acidity of aliphatic and aromatic carboxylic acids (ortho effect). Reactions of carboxylic acids, with mechanism-i) Homologation-Arndt-Eistert reaction ii) Degradation to alkyl halides-Hunsdiecker reaction iii) Conversion to primary amines-Curtius reaction iv) Conversion to haloacids-HVZ reaction Derivatives of carboxylic acids- acid chlorides, amides esters, anhydrides-preparation. Reactions of acid derivatives-i) Conversion to aldehydes-Rosenmund's reduction.

UNIT IV

Chemical Equilibrium: 4Hours

Derivation of relationship between equilibrium constant and free energy $\Delta G^o = -RTInK_p$. Thermodynamic derivation of law of mass action. Le Chatelier's principle-statement and applications. van't Hoff's reaction Isotherm and reaction isochore (van't Hoff equation) (Illustrative problems to be worked out).

Phase Equilibrium: 7Hours

Phase rule-Statement (mathematical expression) and meaning of the terms. Explanation for the terms phase, component and degrees of freedom with suitable examples for each. Derivation of phase rule from thermodynamic consideration. Explanation of phase equilibria of one component system (water and Sulphur system) using phase diagram. Two component system-classification with examples, simple eutectic system (lead-silver system)- phase diagram and explanation, desilverisation of lead (Pattinson's Process). Solid solutions-compound formation with congruent melting point (Mg-Zn system) -phase diagram and explanation. Compound formation with incongruent melting point (NaCl + water system)-phase diagram and explanation. Freezing mixtures (acetone-dry ice). Solid solution formation.

Radiation and Nuclear Chemistry: 2Hours

Radiolysis of water (using γ rays), radiation dosimetry, dosimeter, applications in organic and inorganic reactions. Application of radioisotopes in the study of organic reaction mechanism, medicine and soil fertility. Industrial applications.

BSCCHP282 Chemistry Practical- IV [3 Hrs / week (12 x 3 Hrs.)]

Determination or study of the following.

1. Specific reaction rate for the acid catalyzed hydrolysis of methyl acetate at room temperature using 0.5N HCl or 0.5N H_2SO_4.
2. Effect of acid strength on the hydrolysis of an ester.
3. Comparison of the catalytic strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.
4. Rate of decomposition of iodide by H_2O_2.

5. Distribution of iodine between water and CCl_4.
6. Distribution of benzoic acid between benzene and water.
7. Preparation of arsenious sulphide sol and comparison of the precipitating power of mono-, bi- and trivalent anions.
8. Density and viscosity of the given liquid (using specific gravity bottle and viscometer.)
9. Percentage composition of a given mixture of glycerol and water by viscometry.
10. Density and surface tension of a liquid.
11. Composition of binary liquid mixture (Alcohol & toluene) by Refractometry.
12. Percentage of NaCl present in phenol-water system.
13. Molecular weight of a non-volatile solute by Walker - Lumsden method.
14. Critical solution temperature of Phenol-water system.

Reference Books

1. Selected Topics in inorganic Chemistry-Madan, Malik,Tuli,2000,S.Chand and Company.
2. A Text Book of inorganic Chemistry-A.K.De, 2001, New Age international.
3. Engineering Chemistry-B.K.Sharma,2001,
4. A Text Book of Quantitative analysis- A.I_Vogel, ELBS.
5. A Text Book of Inorganic Chemistry-P.L.Soni.1998, Sultan Chand and Sons.
6. A Text Book of inorganic Chemistry-Puri and Sharma 2000, Shobanlal Nagin Chand.
7. A Text Book of inorganic Chemistry-Gurudeep Raj.
8. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.
9. Organic Chemistry-Paula Y. Bruise. 3rd edn,_Pearson Education Publishers.
10. Physical Chemistry-Madan and Tuli,2001, S.Chand. NEW DELHI.
11. A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut.
12. A Text Book of Physical Chemistry- B.D. Khosla, 2000, R. Chand.
13. 0rganic Reaction mechanism by V.K.AhIuwalia and R.K.Parashar
14. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.
15. Concise Co-ordination Chemistry by R.Gopalan and V.Ramalingam, Vikas Publishing house Pvt.limited.Noida.

Group II Open Elective

BSCCHOE283 : Food Chemistry and Chemistry in Daily Life

UNIT I

Food Chemistry 5**hours**

Food as source of energy and structural material. Components of food – Carbohydrates, Proteins, Oils and Fats. Micronutrients-Vitamins, minerals. Chemical substances used in food preparation - water, common salt, baking powder, vinegar. Food Processing. Food additives, preservatives and flavours. Explanation with examples for the preservation of food by the use of inhibitors, drying, salting, canning, pickling, smoking, packing and refrigeration. Food safety. Soft drinks-Components. Effects on health.

Food Adulteration **2Hours**

Definition, common harmful effects, detection of adulteration, Prevention, Food adulteration act, artificial ripening of fruits - explanation with examples'.

Chemistry of household materials **5Hours**

Cleansing agents: Chemical composition of Soaps, detergents, dish washers, drain cleaners, bleaching powder, Tooth paste and shampoo. Stain removers – Explanation with some common examples.

Domestic items: Safety matches, Wax candles, shoe polish and mosquito coils,- their chemical composition.

Cosmetics: Talcum powder, nail polish, thinners, skin care, hair care, Lipsticks, sun protection lotions and creams, eye shadow and eyebrow pencils, antiperspirants, perfumes and deodorants-explanation with examples.

UNIT II

Chemistry for our future **12Hours**

Alternative sources of energy: Need for the search of renewable sources of energy.

Solar Energy: Basic properties of solar energy. Applications of solar energy. Transformation of solar energy. Solar heat collectors. Solar photovoltaic collectors. Applications of solar collectors. Examples. Solar power plant.

Wind Energy: Basic properties of wind energy. Applications of wind energy. Transformation of wind energy. Wind turbines. Operative characteristics of wind turbines. Wind power plant. Utilization of wind power. Examples. Trends in wind energy utilization.

Hydro power: Basic properties water energy. Transformation of water energy. Hydro power plant. Utilisation of hydro power. Examples. Trends in hydro power utilization.

Hydrogen energy: Production and applications.

Ocean energy- Principles of ocean thermal energy, conversion system. Principles of wave and tidal energy conversion.

Transformation of biomass energy. Applications of biomass.

Reference Books:

10. Food: The Chemistry of its components -Tom Coultate, Kindle Edition.
11. Food Science and Technology-Geoffrey Campbelt-Platt,Wiley Blackwell, Kindle Edition.
12. Food chemistry by H.K.Chopra and P.S.Panesar (Narosa Publishing).
13. Chemistry at Home: Exploring the ingredients in everyday products-John Emsley, Royal Society of Chemistry (2015).
14. Chemistry in daily life - Kirpal Singh, Third Edition, Eastern Academy Education, PHI Learning Pvt. Ltd, New Delhi(2012).
15. Chemistry in everyday life-Shardendu Kislaya, Discovery Publishing House Pvt.Ltd(2011).
16. Renewable energy sources and emerging technologies-D.P.Kothari, K.C.Singal and Rakesh Ranjan, Eastern Economy Edition.

17. Solar energy: fundamentals and applications- H.P.Garg and J.Prakash, Mc Graw Hill, First Revised Edition.
18. Biomass regenerable energy-D.O.Hall and R.P.Overend, Wiley-Blackwel(1987).
19. Introduction to wind turbine aerodynamics – Alois Peter Schaffarczyk, Springler(2014).
20. Hydrogen and fuel cells: Fundamentals, technologies and applications-Detlef Stolten, Wiley-Vest(2010).

V Semester

BSCCHC331: Chemistry Paper-V

Unit I

Electrochemistry: 4Hours

Strong and Weak electrolytes, Specific conductance, Equivalent conductance and its determination, Debye-Huckel theory, Debye-Huckel-Onsager's equation for strong electrolytes (no derivation). Transport number, definition, determination of transport number by Hittorf's method using attackable and unattackable electrodes and Moving boundary method. Kohlrausch's law and its applications,

Photochemistry : 6Hours

Interaction of radiation with matter, difference between thermal and photochemical processes. primary and secondary processes of a photochemical reaction, Laws of photochemistry: Grotthuss - Draper law, Stark - Einstein law, (only statement) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quantum yield-definition, reasons for low and high quantum yield. Explanation for low and high quantum yield reactions taking combination of H_2 and Br_2 and combination of H_2 and Cl_2 as examples. Photosensitized reactions-energy transfer processes definition of photosensitization. (e.g.: Photosynthesis in plants, dissociation of H_2, Isomerization of 2-butene and butadiene).

Unit II

Application of Metal Complexes and Complexation: **2Hours**

Applications of complexes and complex formation in metallurgy-Ag, Au, Al, Ni extractions, Volumetric analysis- complexometry, masking, demasking techniques with example, Qualitative analysis-test for ferrous and ferric ions, nitrate and ammonium ions, Gravimetric analysis-Precipitation of nickel, magnesium and aluminum ions.

Thermodynamic and Kinetic Aspects of Metal Complexes 3Hours

A brief outline of thermodynamic stability of metal complexes. Stepwise formation and overall formation constants and factors affecting the stability of complexes. Substitution reactions of square planar complexes, Trans effect, theories and applications of Trans effect.

Magnetic Properties of Transition Metal Complexes: 3Hours

Origin of magnetism, terms used in Magnetochemistry- Magnetic induction, Magnetic flux density, Magnetic moment and Magnetic susceptibility, Magnetic permeability. Magnetic behavior of substances-Types of magnetic behavior, Methods of determining magnetic susceptibility-Gouy's method. Temperature dependence of magnetic properties, Curie temperature, Neel temperature, Application of magnetic moment data of 3d-metal complexes.

Supramolecular Chemistry 2Hours

Introduction – Definition, basics of Supra molecular chemistry, Classification of Supra molecules, Host and guest compounds, Driving forces for the formation of supramolecular structures , Applications

Unit III

Organic Compounds of Nitrogen **3Hours**

Nitroarenes**-** reduction in acidic, neutral and alkaline media. Mechanism of nucleophilic substitution in nitroarenes. Amines-Separation of mixture of primary, secondary and tertiary amines (Hinsberg and Hofmann's method). Mechanism of electrophilic aromatic substitution in aryl amines.

Stereochemistry of Organic Compounds **7Hours**

Configurational isomerism-optical, geometrical and conformational. Optical isomerism-elements of symmetry, molecular chirality, stereogenic centre-chiral and achiral molecules with two stereogenic centres-Eg., Lactic acid and Tartaric acid. Enantiomers-properties. Resolution of enantiomers.

Diastereomers-definition & examples, threo and erythro diastereomers, meso compounds-definition and examples. Inversion (of sugars) and racemization. Relative and absolute configuration, sequence rules, D&L, R& S systems of nomenclature. Geometric isomerism:-determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism-conformational analysis of ethane and 1,2-dichloroethane. Conformations of cyclohexane-Newman projection. Differences between configuration and conformation.

Unit IV

Rotational Spectroscopy **4Hours**

Derivation of equation for moment of intertia of diatomic molecule, Diatomic molecule as rigid rotor ; derivation of equation for moment of Inertia of diatomic molecule, energy levels of a rigid rotor, selection rules, spectral intensity, determination of bond length, qualitative description of non-rigid rotor, isotope effect.

Vibrational Spectroscopy: **6Hours**

Molecular vibrations, vibrational degrees of freedom, Hooke's law, Energy levels of a simple harmonic oscillator, selection rules, Instrumentation and measurement of IR spectrum intensity and position of IR bands, determation of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion, Fingerprint region and functional group region. Characteristic absorptions of various functional groups and interpretation IR spectra of simple organic compounds.

V Semester

BSCCHC332 : Chemistry Paper- VI

Unit I

Elementary Quantum Mechanics **8Hours**

Black-body radiation, Planck's radiation law, photoelectric effect, Compton effect. De Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Setting up of Schrodinger wave equation for H-atom (no separation of variables or solution), quantum numbers and their importance.

Raman Spectroscopy **2Hours**

Classical and Quantum theory of Raman effect. Concept of polarisability. Rotational and Vibrational Raman Spectra. Selection Rules.

UNIT II

Electronic Spectra of Transition Metal Complexes **5Hours**

Introduction, Russel –Saunder's coupling, microstates, Spectroscopic ground state for d^n system, Terms generated by ligands, Types of electronic spectra, Selection rules for d-d transitions, Relaxation of selection rules, Spectrochemical series. Orgel-energy level diagram for d^1 and d^9 systems, discussion of the electronic spectra of $[Ti(H_2O)6]^{3+}$ and $[Cu(H_2O)_6]^{+2}$complex ions.

Organometallic Compounds **5Hours**

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li and Hg, mononuclear carbonyls and the nature of bonding in metal carbonyls, evidences in support of back bonding, Industrial applications of organometallic compounds-Hydrogenation of alkenes-Wilkinson's catalyst, Fischer Tropsch synthesis.

UNIT III

Heterocyclic Chemistry **8Hours**

Classification and nomenclature, Molecular orbital pictures and explanation for the aromatic characteristics of pyrrole, furan, thiophene, pyridine, pyrazole, oxazole and thiazole. Comparison of aromaticity of these compounds. General methods of synthesis (any two) and reactions of these compounds, mechanism of electrophilic substitution in furan. Mechanism of electrophilic and nucleophilic substitution in pyridine, comparison of basicity of pyridine, piperidine and pyrrole, condensed five and six membered heterocycles- explanation with examples. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer- Indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis, Mechanism of electrophilic substitution reactions of indole and quinoline.

Nucleic Acids **2Hours**

Components of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

UNIT IV

Flame photometry **2Hours**

General principles, Instrumentation, Interference and applications

Thermo Analytical Methods **2Hours**

Principles and applications (TG, DTA & DTG)

Bioinorganic chemistry **3Hours**

Essential and trace elements in biological processes, Biological role of metals - Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Fe^{2+}, Cu^{2+}, Zn^{2+}. Effect of excess intake of metals, metalloporphyrins with reference to haemoglobin and myoglobin. chlorophyll.

Symmetry and Point Groups **3Hours**

Symmetry elements and associated symmetry operations. Types of symmetry elements-axis of symmetry, plane of symmetry, centre of symmetry, identity, rotation reflection axes. Classification of molecules based on symmetry elements- Schoenflies notation, taking the examples of H_2O, NH_3, BF_3, trans N_2F_2 and HCl. Flow chart for assigning point group.

BSC CHP 333 : Chemistry Practical –V. [4Hours / Week (12 x 4 Hours.)]

1. Inorganic gravimetric Experiments :
a) Estimation of barium as barium sulphate in barium chloride solution.
b) Estimation of copper as cuprous thiocyanate in copper sulphate solution.
c) Estimation of Ni as nickel dimethyl glyoximate in nickel ammonium sulphate solution.
d) Estimation of iron as ferric oxide in ferrous ammonium sulphate solution.
e) Estimation of chloride/silver as AgCl in NaCl/silver nitrate solution.
f) Estimation of magnesium as oxinate in magnesium sulphate solution.
2. Solvent Extraction : Separation and estimation of Mg(II) and Fe(II) ions.
3. Colorimetry : Verification of Beer-Lambert Law, Job's and Mole-ratio methods.
4. Food Adulteration : Determination of adulteration in food stuffs.
5. Effluent analysis : Analysis of effluent water.
6. Steam Distillation : Steam distillation of Naphthalene from its suspension in water / clove oil from cloves / Separation of o- and p-nitrophenols.
7. Resolution of racemic mixture of (±) mandelic acid.
8. Stereo chemical study of organic compounds via models :
a) R and S configuration of optical isomers.
b) E and Z configuration geometrical Isomers.
c) conformational analysis of cyclohexanes and substituted cyclohexane.

Note: First experiment should be exclusively used for explaining the principle of gravimetric analysis and demonstration.

Reference Books

1.Basic concepts of Analytical Chemistry - S.M.Khopkar, ll Edn. 1993, New Age International Publishers.

2. Instrumental methods of Chemical analysis- B.K. Sharma, 199. Goel Publishing House.

3. Instrumental methods of Chemical analysis -Gurudeep R.Chatwal and Sham Anand, I998, Himalaya Publishing House.

4. instrumental methods of Chemical analysis. Willard, Merritt, Dean and Skettle, CBS Publishers.

5. A Text Book of inorganic Chemistry-Gurudeep Raj.

6. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.

7. Concise inorganic Chemistry-J.D.Lee, l998,Blackwell Science Ltd.

8. Principles of inorganic Chemistry-Puri, Sharma and Kalia.2000, Shobanlal Nagin Chand.

9. Selected Topics in inorganic Chemistry-Madan, Malik,Tuli,2000,S.Chand and Company.

10.A Text Book of inorganic Chemistry-A.K.De, 2001, New Age international.

12. A Text Book of Quantitative analysis- A.l_Vogel, ELBS,

13. Inorganic Polymers-G.R.Chatwal, l993, Himalaya Publishing House.

14. Theoretical principles of Inorganic Chemistry-Manku, 2001, Tata Mc Graw Hills.

15. A Text Book of inorganic Chemistry-Cotton and Wilkinson. 1992, Wiley — lnterscience.

16. A Text Book of inorganic Chemistry- Emeleus and Anderson. l992, New Age Publications.

17. Organic Chemistry-Paula Y. Bruise. 3rd edn,_Pearson Education Publishers.

18. Agricultural Chemistry -B.A. Yagodin, 1976. Mir Publishers (Moscow).

19. Physical Chemistry-Madan and Tuli,2001, S.Chand. New Delhi.

20. A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut.

21 A Text Book of Physical Chemistry- B.D. Khosla, 2000, R. Chand.

22. Fundamentals of molecular spectroscopy-C.Banwell and E.M Mc Cash,1982,Himalaya Publishing.

23 Physical Chemistry-Colin N.Banwell, l998, Himalaya Publishing.

24- Physical Chemistry—Glasstone, 1982 ELBS.

25. A Text Book of Physical Chemistry-P.L.Soni , O.P.Dharmarha and U.N.Dash, Sultan Chand and Sons.

26. Organic Spectroscopy-William Kemp, ELBS.

27. Elementary Organic Spectroscopy-Y.R.Sharma, New Age.

28. Systematic experiments in chemistry- Arun Sethi, New Age Publishers.

29. Organic spectroscopy by S.K,Dewan_

30. 0rganic Reaction mechanism by V.K.AhIuwalia and R.K.Parashar

31. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.

32.Introduction to Supramolecular chemistry by Asim K Das and Mahua Das.

33.Bioorganic , bioinorganic and Supramolecular Chemistry by PS Kalsi

34.Advanced Physical Chemistry by Gurudeep Raj (Krishna Prakashan)

39. Bio-Inorganic Chemistry by K. Hussain Reddy , New Age Publishers,New Delhi.

40. Group Theory and Symmetry in Chemistry by Gurudeep Raj , Ajay

Bhagi and Vinod Jain, 4 th edition.
41. Chemical applications of group theory (third edition) by F A Cotton.
42. Advanced inorganic chemistry Vol II by S P Banerjee.
43.Group theory and its applications in Chemistry (second edition) by Salahuddeen Kunju and G. Krishnan.
43.Essentials of Nuclear Chemistry by H.J.Arnikar ,Wiley Eastern.
44.Organometallic chemistry by R.C.Mehrotra and A.Singh , New age International ,New Delhi.
45. Heterocyclic Chemistry by Raj K.Bansal ,New Age International ,NewDelhi.
46. MedicinalChemistry by G.R. Chatwal Himalaya Publishing House.

VI Semester

BSCCHC381: Chemistry Paper- VII

Unit I

Electrochemistry II : **8Hours**

Application of conductivity measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt and conductometric titrations. Reference electrodes : Calomel electrode quinhydrone electrode and Ag/AgCl electrode. EMF of a cell and its measurements. Computation of cell EMF. Relation between G and K for a cell reaction, decomposition potential and its applications and hydrogen overvoltage. Concentration cell with and without transport, Liquid Junction potential, Application of concentration cells- determination of valency of ions and solubility product, potentiometric titrations. Determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods.

Fuel Cells **2Hours**

Importance, Working of Hydrogen Oxygen fuel cell and Methanol-oxygen fuel cell

Unit II

Inorganic Polymers : **4Hours**

Preparation, properties, structure and applications of Silicones, Fluorocarbons and Phosphonitrilic halides. Production and structural features of borazine ,boron nitride, sulphur nitride (SN)x and silicon carbide.

Synthetic Polymers : **4Hours**

Introduction, general classes of synthetic polymers-Addition and condensation with examples, Types of polymerization (i)Free radical polymerization (ii) Cationic polymerization and (iii) Anionic polymerization of vinyl polymers with one example each , Zeigler-Natta polymerization.

Condensation polymers-Phenol formaldehyde resins- Bakelite, urea-formaldehyde resins, Epoxy resins and polyurethanes-preparation and applications. Natural rubber-composition. vulcanization, Synthetic rubbers: Buna-S and SBR-preparation and applications, advantages of synthetic rubbers over natural rubbers.

Composites : **2Hours**

Introduction, role of matrix in composites, types of matrix, different matrix materials, reinforcement, classification of composites and applications of composites in industry.

Unit III

Alkaloids: 3Hours

Classification with examples–Pyridine, piperidine, Quinoline, Isoquinoline and indole alkaloids. General properties–formation of salts and exhaustive methylation, physical properties and physiological activity. Structural elucidation of nicotine including synthesis. Structural formulae of atropine and cocaine.

Terpenes: 3Hours

Classification with examples, Isolation from plant sources. Structural elucidation of citral including synthesis. Structural formulae of geraniol, menthol, α-pinene and camphor ,Industrial synthesis of camphor.

Pesticides, fungicides and herbicides: 2Hours

Introduction to the Structure and properties of Pesticides: i)organochlorine compounds-DDT,BHC-, ii)Orgnophosphorus compounds-Malathion, Parathion, Endosulphan iii) others-Pyrethrin, Aleprin, Baygon.Herbicides:2,4-dichlorophenoxy acetic acid. Fungicides: Bordeaux mixture, Dithoicarbamate.

Green Chemistry: 2Hours

Green Chemistry for sustainable development. Designing a Green Synthesis, Prevention of Waste bye products, concept of atom economy, Prevention/ minimization of hazardous/ toxic products reducing toxicity. Green solvents–examples.

Unit IV

Mass spectrometry : 4Hours

Principle and instrumentation of mass spectrometer. Applications in the determination of molecular mass and isotopic abundance. Nitrogen rule, even electron rule, Meclafferty rearrangement. Differentiation between 2-methyl butanal and 3-methylbutanal by Meclafferty rearrangement

Petroleum and Petrochemicals: 3Hours

Composition of Petroleum, Petroleum refining, Fractional distillation-fractions and their uses. Cracking of Petroleum-Thermal and catalytic. Fixed bed catalytic cracking. Synthetic petrol and its production by Bergius process. Knocking, Octane number and Cetane number. Catalytic and thermal reforming. Important petrochemicals and their applications.

Polymers: 3Hours

Conducting polymers: Introduction, definition and examples-polyaniline, polyacetylene. Mechanism of conduction. Qualitative treatment of doping, Properties- elasticity with high electrical conductivities, Engineering and biological applications.

Biodegradable polymers: Introduction, Structure and Properties, Mechanism of breakdown, Applications and uses

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VI Semester

BSCCHC382: Chemistry Paper- VIII

UNIT I

Colorimetry and Spectrophotometry 3Hours

Introduction, theory of colorimetry and spectrophotometry. Beer-Lambert's law. Instrumentation and applications of colorimetry and spectrophotometry.

Ultraviolet (UV) absorption spectroscopy 7Hours

Absorption laws -Beer-Lambert law, Concept of molar absorptivity, energy level, types of electronic excitations, Frank-Condon principle(explanation about red shift and blue shift), presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes dienones and α-β unsaturated carbonyl compounds. Woodward Fieser's rules (problems to be discussed).

UNIT II

Nuclear magnetic resonance (NMR) Spectroscopy 8Hours

Introduction, origin of spectra, instrumentation of PMR spectrometer, solvents used, scales, nuclear shielding and deshielding, number of signals obtained from the sample, position of signals and chemical shift and molecular structure, spin-spin splitting, spin notation and coupling constants, area of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromo ethane and ethyl acetate.

Photoelectron Spectroscopy 2Hours

Basic principles, valence and core binding energies, shifts in energies due to chemical forces, photoelectron spectra of simple molecules.

UNIT III

Carbohydrates 3Hours

Monosaccharides: interconversions of glucose and fructose, chain lengthening of aldoses (Kiliani-Fischer method), Chain shortening (Ruff degradation) Conversion of glucose and mannose–epimerisation, Mechanism of osazone formation-Amadori rearrangement, Formation of glycosides, ethers (methyl), esters (acetates). Configuration of glucose and fructose-deduction, Determination of ring size of monosaccharides (methylation and periodic acid method), Elucidation of cyclic structure of D(+) glucose, Mechanism of muta rotation.

Amino Acids, Proteins and Peptides 3Hours

Classification based on functional group, Essential and nonessential amino acids, structure and stereochemistry of amino acids- explanation, Acid–base behaviour, isoelectric point and electrophoresis- explanation, Preparation of α amino acids from α halogenated acids, Strecker synthesis and Gabriel synthesis. Reactions due to -COOH and -NH_2 groups, Action of heat, structure and nomenclature of di-, tri- and polypeptides, classification of proteins based on chemical composition and molecular shape. Peptide structure determination – end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid phase peptide synthesis, levels of protein structure- primary, secondary, tertiary and quaternary structures, Denaturation of proteins.

Vitamins and Hormones 2Hours

Definition, Classification with example and their importance. Synthesis of vitamin C from D-glucose. Synthesis of vitamin A from β-ionone. Synthesis of Adrenaline form catechol . Synthesis of thyroxine from p-nitroanilin

Retrosynthesis 2Hours

Retrosynthesis: Introduction, general terms, synthon, synthetic equivalent, target molecule, general guidelines for disconnection. Retro analysis and synthesis of benzocaine, 4-methoxy acetophenone, saccharin.

Unit IV

Lipids **5Hours**

Introduction, Classification. Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic and linolenic acids). Essential fatty acids – definition with examples Triglycerides–Structure of simple and mixed glycerides. Biological importance of triglycerides. Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Cholesterol – definition, types (HDL, LDL and VLDL) Sphingolipids–structure and biological significance of ceramide.

Drugs and Chemotherapeutic agents: **2 Hours**

Classification with examples. Synthesis of antipyrine, Chloramine-T, sulphathiazole and sulphanilamide.

Organo Sulphur Compounds: **3Hours**

Thiols(Mercaptans): Methods of preparation (any two). Reactions-action of sodium, formation of salts, formation of thiol esters and oxidation. Uses of mercaptans.

Thioethers: Methods of preparation(any two). Reactions-Addition of halogens and alkyl halides, Oxidation and hydrolysis. Structure and uses of sulphonal.

Sulphonic acids: Methods of preparation(any two). Reactions of benzene sulphonic acid- i)involving H atom of $–SO_3H$ group ii)involving -OH group of $–SO_2OH$ group iii)involving $–SO_3H$ group iv)involving benzene ring. (One example each).

BSCCHP383 : Chemistry Practical- VI [4 Hrs / week (12 x 4 Hrs)]

Organic Preparations :(Students should be taught how to select a solvent for crystallization, and how crystallization should be carried out)

1. Preparation of acetanilide from aniline / Benzoylation of aniline.
2. Preparation of p-bromoacetanilide
3. Nitration of acetanilide to p-nitroacetanilide and hydrolysis to p-nitroaniline.
4. Preparation of iodoform from ethanol
5. Preparation of m-dinitrobenzene
6. Preparation of adipic acid from cyclohexanol.
7. Preparation of benzoic acid from toluene/benzaldehyde
8. Preparation of tribomoaniline from aniline and conversion to tribromo benzene.

Instrumental Methods

9. To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) conductometrically using standard alkali solution.
10. To determine the dissociation constant of a weak acid by potentiometric method.
11. To determine equivalent conductance of sodium chloride by conductometric method.
12. To determine the ionization constant of a weak acid conductometrically.
13. Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the red-ox potential of Fe^{3+} / Fe^{2+} system on the hydrogen scale.
14. To study the rate of inversion of cane sugar.

15. To determine the concentration of cupric ions present in a solution using a colorimeter.

Preparation of Complexes:

16. Preparation of sodium trisoxalatoferrate (III), $Na_3[Fe(C_2O_4)_3]$
17. Preparation of tetraammine copper (II) sulphate, $[Cu(NH_3)_4]SO_4$
18. Preparation of hexaaminecobalt (III) chloride, $[Co(NH_3)_6]Cl_3$.

Note: Principles of physical chemistry experiments, organic preparation and complex preparation are to be discussed in the laboratory.

Reference Books:

1. Instrumental methods of Chemical analysis -Gurudeep R.Chatval and Sham Anand, I998, Himalaya Publishing House.
2. Analytical Chemistry-John H. Kennedy,l986, Saunder's College, New York.
3. Instrumental methods of Chemical analysis. Willard, Merritt, Dean and Skettle, CBS Publishers.
4. A Text Book of Inorganic Chemistry-P.L.Soni.1998, Sultan Chand and Sons.
5. A Text Book of inorganic Chemistry-Puri and Sharma 2000, Shobanlal Nagin Chand.
6. A Text Book of inorganic Chemistry-Gurudeep Raj.
7. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.
8. Concise inorganic Chemistry-J.D.Lee, l998,Blackwell Science Ltd.
9. Principles of inorganic Chemistry-Puri, Sharma and Kalia.2000, Shobanlal Nagin Chand.
I0. Selected Topics in inorganic Chemistry-Madan, Malik,Tuli,2000, S.Chand and Company.
11. A Text Book of inorganic Chemistry-A.K.De, 2001, New Age international.
12. Industrial Chemistry-B.K.Sharma,2001.
14. A Text Book of Quantitative analysis- A.l_Vogel, ELBS,
15. Inorganic Polymers-G.R.Chatwal, l993, Himalaya Publishing House.
16. Theoretical principles of Inorganic Chemistry-Manku, 2001, Tata Mc Graw Hills.
17. A Text Book of inorganic Chemistry-Cotton and Wilkinson. 1992, Wiley — lnterscience.
18 A Text Book of inorganic Chemistry- Emeleus and Anderson. l992, New Age Publications.
19. Organic Chemistry-Paula Y. Bruise. 3rd edn,_Pearson Education Publishers.
20. Agricultural Chemistry -B.A. Yagodin, 1976. Mir Publishers (Moscow).
21. Physical Chemistry-Madan and Tuli,2001, S.Chand. NEW DELHI.
22.A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut.
23. Fundamentals of molecular spectroscopy-C.Banwell and E.M Mc Cash,1982,Himalaya Publishing.
24- Physical Chemistry—Glasstone, 1982 ELBS.
25. A Text Book of Physical Chemistry-P.L.Soni , O.P.Dharmarha and U.N.Dash, Sultan Chand and Sons.
26. Organic Spectroscopy-William Kemp, ELBS.
27 Elementary Organic Spectroscopy-Y.R.Sharma, New Age.
28. Systematic experiments in chemistry- Arun Sethi, New Age Publishers.

29. Organic spectroscopy by S.K,Dewan_
30 0rganic Reaction mechanism by V.K.AhIuwalia and R.K.Parashar
31. 0rganic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.
32. Advanced Physical Chemistry by Gurudeep Raj (Krishna Prakashan)
33. Fuel Cells: Chemical and Electrochemical energy systems by R Narayanan, B Vishvanathan. (University Press India Pvt ltd.).
34. Polymer Composite By M.C.Gupta and A.P.Gupta New Age International Limited , Publishers NewDelhi
35. Green chemistry by V.K.Ahluwalia ,Ane Books ,India.2006.
36. A Hand book of Sustainable polymers by Vijay Kumar Thakur and Manju Kumari Thakur.
37. Degradable polymers, Principles and Applications by Gerald Scott. Kluwer Academic Publications.
38. Hand book of Biopolymers edited by Shakeel Ahmed, Suvardhan Kanchi, Gopalkrishnan Kumar.
38. Polymer Science - A Text Book by V.K.Ahluvalia and Anuradha ,Ane Books India , NewDelhi.

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc – I Semester BSCCHP132: Chemistry Practical – I

Duration: 3Hrs **Max. Marks: 40 (Practical-30; class record- 10)**

The practical examination shall consist of the following:

Q.1. Exercise set for procedure writing 10marks:

Outline of the procedure including calculations is to be written within the first 15 minutes. Any one of the exercises may be given for this purpose, irrespective of whether a candidate has carried out experiment or not.

1. Estimation of manganese in pyrolusite by volumetric method.
2. Estimation of glucose using iodine and sodium thiosulphate.
3. Estimation of vitamin-C.
4. Determination of acetic acid in Vinegar using NaOH.
5. Determination of alkali content in antacid tablet using HCl

Q.2. Exercise to be set for actual estimation. 30 marks:

Any one of the following exercises is to be set for actual estimation. Examiners shall provide the candidates a detailed procedure for the exercise set:

1. Preparation of standard decinormal solution of sodium carbonate and standardization of hydrochloric acid and estimation of sodium hydroxide in solution.
2. Preparation of standard decinormal solution of potassium biphthalate and standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
3. Preparation of standard decinormal solution oxalic acid and standardization of potassium permanganate solution and estimation of Mohr's salt in solution.
4. Preparation of standard decinormal solution of ferrous ammonium sulphate (Mohr's salt) and standardization of potassium dichromate solution and estimation of ferric chloride in solution.

5. Preparation of standard decinormal solution of potassium dichromate and Standardization of sodium thiosulphate solution and estimation of copper sulphate in solution.
6. Estimation of a mixture of oxalic acid and sulphuric acid in a solution using potassium permanganate solution and standard sodium hydroxide solution.

Note:a) AR/GR chemicals should be used for preparing the stock solutions and reagents.

b) At least grade B pipette should be used.

c) The candidates must be provided with 250cm^3 volumetric flask and 25 cm^3 pipettes.

d)The different volumes(in the range 20-30 cm^3) of 1N solutions meant for estimation should be pipetted out by the examiners in 250 cm^3 volumetric flasks so that not more than 3 candidates in a batch get the same value of 1N solutions distributed.

VALUATION SCHEME:

1. Class records: **Marks-10**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7 marks

ii) Marks for neatness : 3 marks

2. Procedure writing **Marks-10**

Essential details of procedure=6 marks

Tabulation and calculation =4marks.

3. Actual estimation: **Marks-20**

i) Titre values 16 marks:

Errors	**Standardization** (Marks)	**Estimation** (Marks)
±0.2 cm^3	8	8
±0.3 cm^3	7	7
±0.4 cm^3	5	5
±0.5 cm^3	4	4
±0.6 cm^3	3	3
Any other value	2	2

NOTE: Candidates should retain only three titre values on each set of titrations out of which t two concordant values are to be considered. All other values must be struck off by the candidates . If a candidate records more than three titre values ,first three values are to be considered and extra titre values are to be ignored .In case the candidate records only one titre value , only 50% of the marks are to be awarded in each case . Examiners are requested to bring this to the notice of the candidates. Every burette reading shall be attested by one of the examiners.

ii) Calculations (4 marks)

Normality of prepared solution = 1 mark

Normality of link solution = 1 mark

Final step = 2 marks

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc –II Semester BSCCHP182: Chemistry Practical – II

Duration: 3Hrs **Max. Marks: 40 (Practical-30; Class Record- 10)**

The practical examination shall consist of the following:

Q.1. Exercise set for procedure writing 10 Marks:

Outline of the procedure to be written within first 15 minutes. Any of the exercise in the syllabus under chromatography may be given for this purpose, irrespective of whether a candidate has carried out experiment or not.

Determination of R_f values and identification of organic compounds

A. Thin Layer Chromatography

1. Separation of green leaf pigments.
2. Separation of mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

B. Paper Chromatography: Ascending and Circular

1. Separation of mixture of phenylalanine and glycine, alanine and aspartic acid, Leucine and glutamic acid. Spray reagent – ninhydrin.

2. Separation of mixture of D,L-alanine, glycine, L- Leucine using n-butanol-acetic acid-water(4:1:5). Spray reagent – ninhydrin.

C. Column Chromatography:

1. Separation of Fluorescein and methylene blue.
2. Separation of leaf pigments from spinach leaves.

Q.2. Exercise set for Organic analysis. 20 Marks:

Any one of the following compounds may be given for analysis:

Resorcinol, oxalic acid, Urea, thiourea, Benzoic acid, p-Cresol, p- toluidine, Chlorobenzene, Bromobenzene, Nitrobenzene, Benzaldehyde, Acetophenone, Benzamide, Aniline.

VALUATION SCHEME:

1. Class records: **10 marks**

The records certified by the teacher in charge and head of the chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7 marks

ii) Marks for neatness : 3 marks

2. Procedure writing **10 Marks**

Essential details of procedure 8 marks

Calculation	2marks	
3. Organic analysis		**20 Marks**
Preliminary tests	1 mark	
Physical constant	3 marks (<2% error)	
Detection of elements	4 marks	
(Tests for nitrogen, halogen and sulphur)		
Solubility	4 marks	
Reactions of functional group	6 marks	
(Any two)		
Name and structure	2 marks	

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc – III Semester BSCCHP232: Chemistry Practical – III

Duration: 3Hrs **Max. Marks: 40 (Practical-30; Class Record- 10)**

The practical examination shall consist of the following:

Q.1 Written viva on the principle of qualitative inorganic analysis 6 Marks

Q.2 Exercise set for inorganic qualitative analysis 24 marks

1. Inorganic systematic qualitative analysis of a mixture of two simple salts containing two anions and two cations using semi micro technique
2. A simple powdered mixture of inorganic salts containing two anions and two cations is to be prepared on the spot by examiners from simple salts having the following anions and cations.

Anions: CO_3^{2-}, Cl^-, Br^-,I^-, NO_3^-,BO_3^{3-}, PO_4^{3-},SO_4^{2-}

Cations: Pb^{2+},Cd^{2+},Al^{3+},Mn^{2+},Zn^{2+},Ba^{2+},Ca^{2+},Sr^{2+},Mg^{2+},Na^+,K^+,NH_4^+

Note:

1. Mixture requiring elimination of phosphate and borate radicals must be avoided (avoid cations such as Ba^{2+}, Ca^{2+},Sr^{2+},Mg^{2+} when borate or phosphate radicals are given)
2. Mixtures of salts which on double decomposition form precipitates insoluble in dilute HCl (like $BaSO_4$, $SrSO_4$, $PbSO_4$) should not be given.
3. Combination like NO_3^- and Br^-, NO_3^- and I^-, $Cl^-$and I^-, Cl^- and Br^-, Cl^- and NO_3^-, Br^- and I^- must be avoided.
4. The cations should belong to different groups. For example, a combination of Ca^{2+} and Sr^{2+}, Ba^{2+} and Ca^{2+}, Ba^{2+} and Sr^{2+}, $Mg^{2+}$and Na^+, Na^+ and K^+, Mg^{2+} and K^+, $Al^{3+}$and Mn^{2+}, Mn^{2+} and Zn^{2+}, must be avoided.
5. AR or GR grade chemicals should be used for preparing mixtures.
6. Different mixtures should be prepared and distributed to the candidates (by lots) so that not more than three candidates in a batch get the same mixture.
7. In case of cations, recording of tests are to be done until two cations are detected and confirmed.

Valuation scheme

1. Class records:

10marks

The records certified by the teacher in charge and head of the chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7 marks

ii) Marks for neatness : 3 marks

2. Written viva **6 marks**

Viva questions should be exclusively from the prescribed practical syllabus.

3. Inorganic qualitative analysis **24 marks**

The radicals should be reported along with proper chemical tests done systematically.

Four radicals reported correctly	24 marks
Three radicals reported correctly	18 marks
Two radicals reported correctly	12 marks
One radicals reported correctly	6 marks

Note:

1) For detecting only the group to which the cations belong , two marks for each correct group should be given

2) If more than four radicals are reported, reduce six marks for each extra radical reported

3) In the case of anions, confirmatory test is not to be expected for SO_4^{2-} and CO_3^{2-}

4. In the case of cations, confirmatory test is to be expected only in the case of NH_4^+
5. Flame test may be considered only as one of the preliminary test and not as a conclusive test for cations
6. In case of anions, positive tests should be recorded in detail while the essential negative tests may be record in brief.
7. If the charge on the radical not reported correctly deduct one mark for each wrong report.

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc – IV Semester BSCCHP282: Chemistry Practical – IV

Duration: 3Hrs **Max. Marks: 40 (Practical-30; Class Record- 10)**

The practical examination shall consist of the following:

Q.1. Written viva 6 Marks

Any one of the exercises prescribed for the practical IV may be given for this purpose.

2. Any one of the following physical chemistry experiments may be set for the actual experimental work 24 marks:

1. Determination of density and surface tension of the given liquid (specific gravity bottle and stalagmometer to be supplied).
2. Determination of density and Viscosity of the given liquid (specific gravity bottle and viscometer to be supplied).
3. Determination of molecular mass of the given non-volatile solute by Walker-Lumsden method (molecular mass of the solute should not be more than 140. Electrolyte such as KCl, NaCl, $BaCl_2.2H_2O$ also may be included).
4. a)Determination of miscibility temperature of the following systems.
   - i)5cm^3 of phenol+4cm^3 of water+1cm^3 of 1% NaCl solution
   - ii) 5cm^3 of phenol+3cm^3 of water+2cm^3 of 1% NaCl solution
   - iii) 5cm^3 of phenol+2cm^3 of water+3cm^3 of 1% NaCl solution
   - iv) 5cm^3 of phenol+1cm^3 of water+4cm^3 of 1% NaCl solution
   - v) 5cm^3 of phenol+5cm^3 of 1% NaCl solution of unknown concentration

   b) From the data obtained, find out the unknown concentration of the sodium chloride solution

graphically. (Pipettes with safety device be provided for pipetting out phenol).

5. Determination of specific reaction rate for the acid hydrolysis of methyl acetate at a given temperature using 0.5N HCl or 0.5N H_2SO_4 (acid to be provided by the examiners)

6. Determination of % of toluene in a mixture of toluene + alcohol by refractometry.

Valuation scheme

1. Class records: : 10marks

The records certified by the teacher in charge and head of the chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7 marks

ii) Marks for neatness : 3 marks

2. Written viva 6marks

Viva questions should be exclusively from the prescribed practical syllabus.

3. Physical chemistry experiments 24marks

Experiment (1): Density and Surface tension

Marking of density values

Errors ±1% : 10 marks
± 2% : 8 marks
± 3% : 7 marks
± 5% : 5 marks
±10% : 3marks
Any other value : 2 marks
Calculations : 2+2= 4

surface tension values

Errors upto :±8% : 10 marks
±8% to± 12% : 8 marks
±12% to ±15 % : 5 marks
± 15% to ±25% : 3 marks
any other value : 2 marks

Experiment (2): Density and Viscosity

Marking of density values

Errors ±1% : 10 marks
± 2% : 8 marks
± 3% : 7 marks
± 5% : 5 marks
±10% : 3marks
Any other value : 2 marks
Calculations : 2+2= 4

Viscosity values

Errors upto :±5% : 10 marks
±8% to± 7% : 8 marks
±12% to ±9 % : 5 marks
± 15% to ±12% : 3 marks
any other value : 2 marks

Experiment (3): Molecular mass

Error upto± 10% : 20 marks
±10% to± 15 % : 18 marks
±15% to ±20% : 16 marks
±20% to ±25% : 12 marks
±25% to ±30% : 8 marks
Any other value : 4 marks
Calculation : 4 marks

NOTE: Candidates shall not retain more than three values in the answer book. Out of which best two values are to be considered for valuation. If a candidate records more than three values, first three recorded are to be considered.

Experiment (4) : Miscibility Temperature

a) 1% NaCl stock solution should be provided by the examiners

b) Unknown concentration to be given should be in between 0.3% - 0.7%

C) Graph drawn : 4 marks

(Proportionate marks are to be deduced, if the graph is not properly drawn for the given set of points.)

Error in concentration (unknown)

Upto ± 5%	: 20 marks
±5% to± 8%	: 18 marks
±8% to± 12%	: 16 marks
±12%to±15%	: 12marks
15%to20%	: 8 marks
Any other values	: 4 marks

Experiment (5) Chemical kinetics

Graph drawn: 5 marks Calculation: 5 marks

Error Up to ± 5%	: 14marks
±5% to± 10%	: 12marks
±10% to± 15%	: 10 marks
±10%to±15%	: 8marks
15%to20%	: 6 marks

Any other values: 3marks

Experiment (6): Analysis of a liquid Mixture by Refractometry.

a) Graph drawn: 4 marks

Best straight line graph with at least 4 points - 4 marks.

Less than four points - 3marks.

b) Percentage composition of the given mixture in the range.

±5%	: 20marks
±7%	: 16marks
±9%	: 12 marks
±12%	: 8marks
Any other values	: 4marks

Standard binary liquid mixtures of known compositions are to be prepared fresh by the candidates. Unknown is given by the examiners.

NOTE: In all the above experiments if the calculation is wrong no marks to be given for calculation part, but the examiners are required to calculate the values and award the marks as per scheme.

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc – V Semester BSCCHP333: Chemistry Practical – V

Duration: 4Hrs **Max. Marks: 80 (Practical-70; Class Record- 10)**

The practical examination shall consist of the following:

Q.1. `Written viva **10 marks**

Q2.Gravimetric Exercise: **45 Marks**

Examiners shall supply the solution in two 400cm^3 beakers, for each of the candidates, such that the mass of the precipitate will be in the range of 0.2 to 0.3g. A brief outline of the procedure is to be given. The candidates are required to perform two trials each using the given solutions.

One of the following exercises may be set for the gravimetric exercise.

1. Estimation of barium as barium sulphate in barium chloride solution.
2. Estimation of copper as cuprous thiocyanate in copper sulphate solution.
3. Estimation of Ni as Nickel dimethyl glyoximate in nickel ammonium sulphate solution.
4. Estimation of iron as ferric oxide in ferrous ammonium sulphate solution.
5. Gravimetric estimation of chloride / silver as AgCl in NaCl/$AgNO_3$ solution.
6. Estimation of magnesium as oxinate in magnesium sulphate solution.

Q3.Colorimetry/Food Adulteration: **15 marks**

One of the following experiments may be set:

a. To verify Beer-Lambert Law by Job's or Mole-ratio method

b. Detection of adulterants in food stuffs

VALUATION SCHEME:

Distribution of marks:

1. Class records: **10 marks**

The records certified by the teacher in charge and head of the chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7 marks

ii) Marks for neatness : 3 marks

2. Written viva **10 marks**

Viva questions should be exclusively from the prescribed practical syllabus.

3. Gravimetric Exercise: **45 Marks**

i) Marks for mass of precipitate

±2%	40
±3%	35
±4%	30
±5%	25
±6%	20

Any other value 10

ii) Calculation 5 marks

3. Colorimetry / Food Adulteration: 15 marks

Experiment (a):

i) Good plot : 10 marks

(Proportionate marks are to be deducted, if the graph is not properly drawn for the given set of points.)

ii) Tabulation and Calculation : 5 marks

Experiment (b):

Adulterated milk, ghee /butter, edible oil / sugar are to be given

Detecting adulterants in milk : 5 marks

Detecting adulterants in ghee/ butter: : 5 marks

Detecting adulterants in sugar/edible oil : 5 marks

MANGLORE UNIVERSITY

Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practicals

BSc – VI Semester BSCCHP383: Chemistry Practical – VI

Duration: 4Hrs Max. Marks: 80 (Practical-70; Class Record- 10)

The practical examination shall consist of the following:

Q.1.Exercise set for procedure writing 10 Marks

Outline the procedure for preparation of any one of the following inorganic complexes with equation within 15 minutes.

a.Preparation of sodium trisoxalato ferrate (III), $Na_3[Fe(C_2O_4)_3]$

b.Preparation of copper tetraammine complex, $[Cu(NH_3)_4]SO_4$

c.Preparation of hexaammine cobalt (III) chloride, $[Co(NH_3)_6]Cl_2$

Q. 2.Prepare any one of the following organic compound, determine its melting point and present the crude and recrystallised sample for inspection. 15 Marks

a. Acetanilide

b. p-bromoacetanilide

c. Benzoic acid

Q.3. Perform one of the following experiments 35 Marks

a) To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) conductometrically using standard alkali solution.

b) To determine the equivalent conductance of sodium chloride by conductometric method.

c) Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{3+} / Fe^{2+} system on the hydrogen scale.

d) To determine the dissociation constant of a weak acid by potentiometric method

e) To determine the concentration of Cupric ions present in a solution using a colorimeter.

Q.4. Viva to be conducted during practicals 10 marks

Viva questions should be exclusively from the prescribed practical syllabus.

VALUATION SCHEME:

Distribution of marks:

I. Class records: **10 marks**

The records certified by the teacher in charge and head of the chemistry Department should be valued by the examiners.

i) Marks for experiments recorded : 7

ii) Marks for neatness : 3

2. Procedure writing: **10 marks**

Outline with essential details : 8 marks

Chemical Equation : 2marks

3. Viva to be conducted during practicals **10 marks**

4. Preparation of organic compounds **15 marks**

i) Marks for preparation of crude sample 7

ii) Yield (upto ±20% of theoretical value) 3 any other value : 1

iii) Marks for recrystallisation 2

vi) Marks for melting point (upto ±3%) 3 any other value:1

5. **Instrumental method** **35 marks**

a. To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) Conductometrically using standard alkali solution

i. Graph	(good plot)	10
	other plots	6
ii. Error in titre values	± 0.2 ml	10+10
	± 0.3 ml	8+8
	± 0.4 ml	6+6
	± 0.5 ml	4+4
	Other values	2+2
iii. Calculation of strength		5

b. To determine the equivalent conductance of sodium chloride by conductometric method.

i. Cell constant		
Calculation		2
Correct value		3
ii. Equivalent conductance		
Calculation of equivalent conductance values		15
iii. Graph	(good plot)	10
	other plot	6
iv. Correct value of equivalent conductance at infinite dilution		5

c. Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{3+} / Fe^{2+} system on the hydrogen scale

i) Graphs	(good plots)	16	(8+8)
	Other plots	8	(4+4)
ii) Error in titre value	± 0.2 ml	15	
	± 0.3 ml	12	
	± 0.4 ml	9	
	± 0.5 ml	6	
	Other values	3	

iii. Calculation of redox potential 4

d. To determine the dissociation constant of a weak acid by potentiometric method

I Graph	(good plots)	10(5+5)
	Other plots	6 each
ii. Error in titre value	± 0.2ml	15
	± 0.3ml	12
	± 0.4ml	9
	± 0.5ml	6
	Other values	3
iii. Calculation of dissociation constant		10

e. To determine the concentration of Cupric ions present in a solution using a colorimeter
(The unknown solution should be in the range of 4 to 6 mM concentration)

i. Graph	(good plot)	10
	Other plots	6
ii. Error in concentration	± 0.2 mM	25
	± 0.3 mM	20
	± 0.4 mM	15
	± 0.6mM	10
	Other values	5

MANGALORE UNIVERSITY

Mathematics Syllabus for B. Sc. Choice Based Credit System Programme from the academic year 2019-20

(Semester Scheme)

Preamble:

The Mathematics syllabus for B. Sc. (Credit Based Semester System) in use at present was introduced from the academic year 2014-15. As per the directions and guidelines of the University Grants Commission, and also with instructions from the Higher Education Council of Government of Karnataka, the Mangalore University has recently framed the regulations governing the Choice Based Credit System for the undergraduate graduate degree programmes so as to enable its programmes to be on par with global standards. Hence the following revised and restructured syllabus for the Mathematics as an optional subject in B.Sc. Choice Based Credit System programme has been prepared as per the new regulations of the University, by modifying the earlier syllabus, including Lab components and introducing new text and reference books. The Board observed that many universities in Karnataka have included Lab components in Mathematics subject of their B.Sc. programmes. The following new syllabus for Mathematics as an optional subject in the B.Sc.(Choice Based Credit System) of Mangalore University, framed by the U.G.B.O.S., has also taken into consideration the syllabus recommended by the UGC curriculum development committee and syllabi of other Universities of Karnataka. The syllabus is meant to be introduced from the academic year 2019-20.

Aims and objectives of introducing new syllabus

- To give greater exposure to the syllabus through open electives
- To improve the perspective of students on mathematics as per modern requirement
- To develop a spirit of inquiry and scientific temper in the student
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics
- To make learning process student-friendly
- To foster experimental, problem-oriented and discovery learning of mathematics
- To orient students towards relating mathematics applications
- To improve retention of mathematical concepts in the student
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of FOSS tools on a computer
- To provide scope for greater involvement of both the mind and the hand
- To help the student build interest and confidence in learning the subject

CHOICE BASED CREDIT SYSTEM
COURSE PATTERN AND SCHEME OF EXAMINATION
CORE SUBJECT: MATHEMATICS

		Particulars	Instruction Hours/Week	Duration of Exams	Marks			Credits
					IA	Exam	Total	
I Semester B.Sc.								
Group I Core Subject	Theory BSCMTC131	Course I	4	3	20	80	100	2
	Practical BSCMTP132	Lab I	3	3	10	40	50	1
Group II Core Elective	Theory	Course A	2	2	10	40	50	1*
Total number of Credits for Core Subject in I Semester: 04								
II Semester B.Sc.								
Group I Core Subject	Theory BSCMTC181	Course II	4	3	20	80	100	2
	Practical BSCMTP182	Lab II	3	3	10	40	50	1
Group II Core Elective	Theory BSCMTCE183	Course B	2	2	10	40	50	1*
Total number of Credits for Core Subject in II Semester: 04								
III Semester B.Sc.								
Group I Core Subject	Theory BSCMTC231	Course III	4	3	20	80	100	2
	Practical BSCMTP232	Lab III	3	3	10	40	50	1
Group II Core Elective	Theory BSCMTCE233	Course C	2	2	10	40	50	1*
Total number of Credits for Core Subject in III Semester: 04								
IV Semester B.Sc.								
Group I Core Subject	Theory BSCMTC281	Course IV	4	3	20	80	100	2
	Practical BSCMTP282	Lab IV	3	3	10	40	50	1
Group II Open Elective	Theory BSCMTOE283	Course D	2	2	10	40	50	1*
Total number of Credits for Core Subject in IV Semester: 04								
V Semester B.Sc.								
Group I Core Subject	Theory BSCMTC331	Course V	3	3	20	80	100	2
	Theory BSCMTC332 BSCMTC333	Course VI(a)/ Course VI(b)	3	3	20	80	100	2
	Practical BSCMTP334	Lab V	4	3	10	40	50	2
Total number of Credits for Core Subject in V Semester: 06								
VI Semester B.Sc.								
Group I Core Subject	Theory BSCMTC381	Course VII	3	3	20	80	100	2
	Theory BSCMTC382 BSCMTC383 BSCMTC384	Course VIII(a) Course VIII(b) Course VIII(c)	3	3	20	80	100	2
	Practical BSCMTP385	Lab VI	4	3	10	40	50	2
Total number of Credits for Core Subject in VI Semester: 06								
Total number of Credits for Core Subject in I-VI Semesters: 28								

*Credits for Elective Courses will be considered for the entire B.Sc. Programme

Note:

1. Group I: For 5th and 6th semesters, Course V and Course VII respectively are compulsory Courses. In the 5th semester, a student has to choose one of the special Courses either VI(a) or VI(b). In the 6th semester, a student has to choose one of the special Courses from VIII(a), VIII(b), and VIII(c).

2. Group II: The student can opt any one of the elective courses (Course A to D) in each semester (I - IV). The core elective courses A, B and C can be taken by B Sc. students studying Mathematics, as one of the core elective subjects in group II. The open elective course D is for students of other streams in group II.

Group I

I Semester

BSCMTC131	Course I: Calculus and Analytical Geometry	2 Credits (48 Hours, 4 hours/week)

Unit I (12 Hours)

(Recapitulation: Increasing decreasing functions, critical points, local extrema). Rolle's Theorem, The mean value theorem. Concavity, Points of inflection, Second derivative test for concavity, Second derivatives test for local extrema, Asymptotes (horizontal, vertical and oblique), Sketching curves $y = f(x)$, Applied Optimization Problems.

Unit II (12 Hours)

Integration: Upper and Lower Riemann sums, Limits of Riemann sums, definite integrals, Integrable and non-integrable functions, Area under the graph of a non-negative function, Average value of a continuous function, Mean value theorem for definite integrals, Fundamental theorem of calculus (Part 1 and 2).
Derivation of reduction formulae for $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \log^n x\,dx$, $\int \sec^n x\,dx$, $\int \sin^n x \cos^m x\,dx$, etc. Evaluation of integrals using reduction formulae.

Unit III (12 Hours)

Functions of several variables: Domain, Range, Interior points, Boundary points, Closed, Open, Bounded and unbounded regions in the plane, Level curves and Level surfaces. Limits and Continuity, Two-Path tests for non-existence of limits, Partial derivatives, Implicit partial differentiation, Partial derivatives and continuity, Higher order partial derivatives, Mixed derivative theorem, Differentiability, Chain rule for differentiation.

Unit IV (12 Hours)

Conic sections : Conic sections and Quadratic equations (Recapitulation: Standard forms of equations of conics), Asymptotes of Hyperbolas and graphing, Shifting conic sections, Classifying conic sections by eccentricity, Quadratic equations and Rotations - The cross product term, Angle of rotation, Removal of cross product term, Discriminant test.

References

[1] Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, *Thomas' Calculus*, 11th Ed., Pearson, 2008.

[2] Louis Leithold, *Calculus with Analytic Geometry*, 5th Ed., Harper and Row International, 1986.

[3] George B. Thomas and Ross L. Finney, *Calculus and Analytic Geometry*, Addison-Wesley, 1992.

[4] Joseph Edwards, *Integral Calculus for Beginners*, Arihant Publishers, 2016 (original 1896).

BSCMTP132	Lab I	1 Credit

Practicals for I Semester

Practicals: Lab I

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1) Introduction to Scilab.
2) Introduction to Maxima.
3) Commands for plotting functions in Scilab/Maxima.
4) Plotting of standard Cartesian curves using Scilab/Maxima-I.
5) Plotting of standard Cartesian curves using Scilab/Maxima-II.
6) Continuous and discontinuous functions using Scilab/Maxima.
7) Left hand and right hand limits using Scilab /Maxima.
8) Differentiability using Scilab/ Maxima.
9) Techniques of Integration in SciLab/Maxima.
10) Maxima commands for reduction formula with or without limits.
11) Solutions of optimization problems.
12) Integration of functions.
13) Obtaining partial derivative of some standard functions.
14) Conic sections, Rotation of Conics.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

II **Semester**

BSCMTC181	Course II: Number Theory and Calculus	2 Credits (48 Hours, 4 hours/week)

Unit I (12 Hours)

Number Theory: Division Algorithm, The Greatest Common Divisor (g.c.d), Euclidean Algorithm, Diophantine Equations, Fundamental Theorem of Arithmetic.

The Theory of Congruences, Basic Properties of Congruences, Binary and Decimal Representation of Integers.

Unit II (12 Hours)

Number Theory: Linear Congruences and The Chinese Remainder Theorem, Fermat's Theorem, Wilson's Theorem, Quadratic Congruence.

Euler's Phi-Function, Euler's Theorem, Some Properties of Phi-Function.

Unit III (12 Hours)

Calculus: Cauchy's Mean Value Theorem, Indeterminate Forms (all types), L'Hospital's Rules (First form and stronger form), Taylor Series, Maclaurin's series.

Vector Calculus: Directional Derivatives, Gradient of Functions of Two or Three Variables, Properties of Directional Derivatives, Gradients and Tangents to Level Curves, Level Surfaces, Tangent Planes and Normal Lines to Level Surfaces.

Unit IV (12 Hours)

Polar coordinates: Relating Cartesian and Polar Equations, Graphing in Polar Coordinates, Symmetry, Test for Symmetry, Slope of Curves. Areas and Lengths in Polar Coordinates: Area in the Plane, Area Between the Curves, Length of a Polar Curve.

Multiple Integrals: Doubles Integrals over Rectangles, Double Integrals as Volume, The Fubini's Theorem (First Form), Double Integrals over Bounded Non-rectangular Regions, Fubini's Theorem (Stronger Form), Finding Limits of Integration, Properties of Double Integrals. Reversing the Order of Integration.

References

[1] David M. Burton., *Elementary Number Theory*, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, *Elementary Number Theory*, Springer, 1998.

[3] Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, *Thomas' Calculus*, 11th Ed., Pearson, 2008.

[4] Louis Leithold, *Calculus with Analytic Geometry*, 5th Ed., Harper and Row International, 1986.

BSCMTP182	Lab II	1 Credit

Practicals for II Semester

Practicals: Lab II

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1) Euclidean Algorithm.
2) Divisibility tests.
3) Solving system of congruences.
4) Euler's Phi-function.
5) Plotting polar curves.
6) Plotting standard parametric curves.
7) Evaluation of indeterminate forms.
8) Verification of Cauchy's mean value theorem.
9) *n*th derivatives.
10) Evaluation of limits by L'Hospital's rule.
11) Finding Taylor/Maclaurin series.
12) Evaluation of the double integral with variable limits.
13) Level curves and level surfaces.
14) To demonstrate the physical interpretation of gradient, divergence and curl.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

III Semester

BSCMTC231	Course III: Sequences, Series and Differential Equations	2 Credits (48 Hours, 4 hours/week)

Unit I (12 Hours)

Sequences: Functions, Sequences, The range, Bounds of a sequence, Convergence of sequences, Some theorems, Limit points of a sequence, Convergent sequences, Non-convergent sequences, Cauchy's general principle of convergence, Algebra of sequences, Some important Theorems, Monotonic sequences, Subsequences.

Unit II (12 Hours)

Infinite Series: A necessary conditin for convergence, Cauchy's general principle of convergence for series, Some preliminary theorems, Positive term series, Geometric series, A comparision test, Comparision tests for positive term series (first and second type), Cauchy root test, D'Alembert's test, Raabe's test, Logarithmic test, Integral test, Cauchy's integral test,

Alternating series, Absolute convergence, Conditional Convergence.

Unit III (12 Hours)

Differential Equations: (Recapitulation of Variable separable and homogeneous equations, Linear equation of order one). Exact equations, Integrating factors found by inspection, The determination of integrating factors, Bernoulli's equation, Co-efficients linear in the two variables.

Applications: Velocity of escape from the earth, Newton's law of cooling, Simple chemical conversions, Orthogonal trajectories - rectangular co-ordinates, Orthogonal trajectories - polar co-ordinates.

Unit IV (12 Hours)

Differential Equations: Linear equation with constant coefficients: Definition, operator D, complementary function of a linear equation with constant coefficients, Particular integral, General method of finding particular integral, Special methods for finding particular integral when RHS of the non-homogeneous differential equation is of the form: e^{ax}, $\cos ax$, $\sin ax$, x^m. Linear equations with variable coefficients. Special methods to solve any second order equation: (i) Reduction to normal form, (ii) Change of independent variable, (iii) Reduction of order, (iv) Variation of parameters.

References

[1] S.C Mallik, *Principles of Real Analysis*, New Age International Publications, 2008.

[2] Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, *Thomas' Calculus*, 11th Ed., Pearson, 2008.

[3] Donald R. Sherbert and Robert G. Bartle, *Introduction to Real Analysis*, 4th Ed., John Wiley & sons, 2011.

[4] Ajith Kumar and S. Kumaresan, *A Basic Course in Real Analysis*, CRC Press, 2014.

[5] Earl D Rainville and Philip E Bedient, *A Short Course in Differential Equations*, Macmillan Ltd., 4th Ed., 1969.

[6] Narayanan and Manicavachagom Pillay, *Differential Equations*, Viswanathan (Printers and Publisher) PVT Ltd., 1991.

[7] William E. Boyce, Richard C. DiPrima, *Elementary Differential Equations*, 10th Ed., Wiley Publishers, 2012.

BSCMTP232	Lab III	1 Credit

Practicals for III Semester

Practicals: Lab III

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1) Illustration of convergent, divergent and oscillatory sequences.

2) Illustration of convergent, divergent and oscillatory series.

3) Programs to find the sum of the series.

4) Using Cauchy's criterion to determine convergence of a sequence (simple examples).

5) Using Cauchy's criterion on the sequence of partial sums of the series to determine convergence of a series.

6) Testing the convergence of binomial, exponential and logarithmic series and finding the sum.

7) Solution of Differential equation and plotting the solution - I.

8) Solution of Differential equation and plotting the solution - II.

9) Solution of Differential equation and plotting the solution - III.

10) Solution of Differential equation and plotting the solution - IV.

11) Solution of Differential equation and plotting the solution - V.

12) Solution of Differential equation and plotting the solution - VI.

13) Determination and Plotting of Orthogonal trajectories.

14) Applications of differential equations.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

IV Semester

BSCMTC281	Course IV: Algebra and Complex Analysis	2 Credits (48 Hours, 4 hours/week)

Unit I (12 Hours)

Group Theory: Binary Operations, Associativity, Commutativity, Examples for Binary Operations, Definition of a Group, Examples, Right inverse, Left inverse, Some properties, Abelian and Non-abelian groups, Laws of exponents, Subgroups, Intersection of subgroups, Centralizer of an element, Normalizer of a subgroup, Product of subgroups, Order of products of subgroups, Cyclic groups, Properties, Number of generators.

Unit II (12 Hours)

Group Theory: Permutation groups, Transpositions, Cycles, Cayley's theorem. Cosets, Lagrange's theorem, Index of a subgroup, Homomorphism, Kernel of a homomorphism, Properties of homomorphic images of groups, Isomorphism, Automorphisms, Normal subgroups, Quotient groups, First isomorphism theorem.

Unit III (12 Hours)

Complex Analysis: (Recapitulation of algebra of Complex numbers.) Polar and Exponential Forms, Powers and roots, Functions of a Complex variable, Limits, Continuity, Differentiability, Cauchy Riemann Equations, Analytic functions, Entire functions.

Unit IV (12 Hours)

Complex Analysis: Harmonic functions, Elementary functions: Exponential function, Trigonometric functions, Hyperbolic functions and Logarithmic functions.

References

[1] N. S Gopalakrishnan, *University Algebra*, 3rd Ed., New Age International Publications, 2015.

[2] G. D. Birkoff and S Maclane, *A brief Survey of Modern Algebra*, 2nd Ed., IBH Publishing Company, Bombay, 1967.

[3] Joseph Gallian, *Contemporary Abstract Algebra*, Narosa, 1999.

[4] I. N. Herstein, *Topics In Algebra*, 2nd Ed., Wiley Publishers, 1975.

[5] James Ward Brown, Ruel V. Churchil, *Complex Variables and Applications*, 8th Ed., Mc Graw Hill Publications, 2009.

[6] H.S. Kasana, *Complex variables theory and applications*, 2nd Ed., PHI Learning Pvt Ltd., New Delhi, 2005.

BSCMTP282	Lab IV	1 Credit

Practicals for IV Semester

Practicals: Lab IV

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1) Verifying whether given operation is binary or not.

2) (i) To find identity element of a group.
(ii) To find inverse element of a group.

3) Finding all possible subgroups of a finite group.

4) Examples to verify Lagrange's theorem.

5) Examples for finding left and right coset and finding the index of a group.

6) Finding generators of a cyclic group and computation of quotient group.

7) Determination of center and all possible normal subgroups of groups.

8) Some problems on Cauchy-Riemann equations (Cartesian and polar form).

9) Implementation of methods of constructing analytic functions(simple examples).

10) Illustrating orthogonality of the surfaces obtained from the real and imaginary parts of an analytic function.

11)Verifying real and imaginary parts of an analytic function being harmonic (in polar coordinates).

12) Illustrating the angle preserving property of simple entire functions such as z^2, $\exp(z)$, etc.,

13) Showing nth roots of unity is a group and plotting them on the unit circle.

14) Branches of the multiple valued functions: $\sqrt{z}$ and $\log z$.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

V **Semester**

BSCMTC331	Course V: Algebra and Laplace Transforms (Compulsory Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)

Rings and Fields: Rings, unit element, commutative ring, Properties. Zero divisors, Integral domains (finite and infinite), Fields (finite and infinite).

Vector spaces: Vector spaces, Subspaces, Linear span, Sum of subspaces, Direct sum of subspaces, Linear dependence and independence, Bases, Generating sets, Minimal generating sets, Maximal linearly independent sets, Dimension.

Unit II (12 Hours)

Vector spaces: Extending a linearly independent set to a basis, Extracting a basis from a generating set, Dimensions and bases of subspaces. Inner product spaces, Schwarz inequality, Orthonormal sets, Gram Schmidt's orthogonalization process, Orthogonal complement of a subspace.

Unit III (12 Hours)

Laplace transforms: Transforms of elementary functions, Transforms of derivatives, Derivatives of the transforms of the gamma function, Periodic functions.

Inverse transforms: A step function, Convolution theorem, Simple initial value problems, Spring problems.

References

[1] N. S Gopalakrishnan, *University Algebra*, 3rd Ed., New Age International Publications, 2015.

[2] G. D. Birkoff and S Maclane, *A brief Survey of Modern Algebra*, 2nd Ed., IBH Publishing Company, Bombay, 1967

[3] Joseph Gallian, *Contemporary Abstract Algebra*, Narosa, 1999

[4] I. N. Herstein, *Topics In Algebra*, 2nd Ed., Wiley Publishers, 1975.

[5] Earl D Rainville and Philip E Bedient, *A Short Course in Differential Equations*, Macmillan Ltd., 4th Ed., 1969.

[6] Erwin Kreyszig, *Advanced Engineering Mathematics*, 8th Ed., Wiley Eastern, 2011.

BSCMTC332	Course VI(a): Graph Theory (Special Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)

Definition of graph and examples, incidence and degree, subgraphs, isomorphism, complement of a graph, operation on graphs. Walks, trails and paths, connectedness and components, cut-points and bridges, blocks.

Unit II (12 Hours)

Eulerian graphs, Konigsburg bridge problem, Hamiltonian graphs. Trees, characteristics of

trees, center of a tree. Planarity of Graphs.

Unit III (12 Hours)
Colourability, chromatic number, Chromatic Polynomial, five-colour theorem, four-colour problem. Matrix associated with graphs: Incidence matrix, Adjacency matrix.

References

[1] S. Arumugam and S. Ramachandran, *Invitation to graph theory*, Scitech Publications (India) Pvt. Ltd., 2013.

[2] Narsingh Deo, *Graph Theory with Applications to Engineering and Computer Science*, PHI Learning Private Limited, 2004.

[3] Douglas B. West, *Introduction to Graph Theory*, Pearson, 2017.

[4] K.Chandrasekhara Rao, *Discrete Mathematics*, Narosa Publishing House, 2012.

[5] John Clark, D.A. Holton, *A first look at Graph Theory*, World Scientific, 1991.

[6] Robin J Wilson, *Introduction to Graph Theory*, 5th Ed., Pearson, 2010.

BSCMTC333	Course VI(b): Discrete Mathematics (Special Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)
Graphs and Planar Graphs: Introduction, Basic terminology, Multigraphs and Weighted graphs, Digraphs and relations, Representation of graphs, Operations on graphs, Paths and circuits, Eulerian paths and circuits, Hamiltonian paths and circuits, Planar graphs, Graph colouring.

Unit II (12 Hours)
Trees and Cut-sets: Trees, Rooted trees, Path lengths in rooted trees, Prefix codes, Spanning trees and cut-sets, Minimum spanning trees; Kruskal's Algorithm, Prim's algorithm, Shortest path Alogrithms.

Unit III (12 Hours)
Discrete numeric functions and Generating functions: Introduction, Manipulation of numeric functions, Asymptotic behavior of numeric functions, Generating functions.
Recurrence relations and Recursive Algorithms: Introduction, Recurrence relations, Linear recurrence relations with constant coefficients, Homogeneous solutions, Particular solutions.

References

[1] C. L. Liu and D P Mohapatra, *Elements of Discrete Mathematics - A Computer Oriented Approach*, 4th Ed., Tata Macgraw Hill Publishers, 2013.

[2] J. P. Trembley and R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, Tata Magraw Hill Publishers, 1975.

[3] K. Chandrasekhara Rao, *Discrete Mathematics*, Narosa Publishing House, 2012.

[4] Swapan Kumar Sarkar, *A Text Book of Discrete Mathematics*, S Chand and Company, New Delhi, 2008.

[5] J. K. Truss, *Discrete Mathematics for Computer Scientists*, Addison Wesley, 1999.

BSCMTP334	Lab V	2 Credits

Practicals for V Semester

Practicals: Lab V

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1) Examples on different types of rings.
2) Finding zero divisors and units in finite rings.
3) Examples of integral domains and fields, and construction of finite fields.
4) Vector space, subspace – illustrative examples.
5) Examples on linear dependence and independence of vectors.
6) Generating sets, Basis and Dimension – illustrative examples.
7) Finding an orthonormal basis from given basis of an real inner product space.
8) Implementing Gram-Schmidt's orthogonalization process.
9) Finding orthogonal complements of subspaces in inner product sapces.
10) Finding the Laplace transforms of some standard functions.
11) Functions of Class-A and Properties of gamma function.
12) Finding the inverse Laplace transform of simple functions.
13) Implementing Laplace transform method of solving ordinary linear differential equations of first and second order with constant coefficient.
14) Solving spring problems.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

VI Semester

BSCMTC381	Course VII: Numerical Analysis (Compulsory Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)

Errors in Computation: Accuracy of numbers, Errors, Useful rules for estimating errors, Error propagations, Error in the approximation of a function. Errors in a series approximation. Solutions of Algebraic and Transcendental Equations: Initial approximation, Bisection method, Regula-falsi method, Iteration method, Newton-Raphson method.

Solution of linear homogeneous equations: Direct Methods - Gauss elimination method,

Gauss-Jordan method. Iterative methods of solution - Jacobi's iteration method, Gauss-Seidel iteration method.

Unit II (12 Hours)

Finite differences: Introduction, Finite differences, differences of a polynomial, to find one or more missing terms. Interpolation: Introduction, Newton's forward interpolation formula, Newton's backward interpolation formula, Interpolation with unequal intervals, Lagrange's interpolation formula. Divided differences: Newton´ıs divided difference formula, Inverse interpolation. Numerical differentiation - Formulae for derivatives using forward difference, and backward difference formulae, Maximum and minimum values of a tabulated function.

Unit III (12 Hours)

Numerical integration: General formula, Trapezoidal rule, Simpson's 1/3 - rule, Simpson's 3/8 - rule.

Numerical Solution of Ordinary Differential Equations: Introduction, Solution by Taylor's series method, Picard's method, Euler's method, Modified Euler's method, Runge-Kutta Methods, Predictor-Corrector Methods - Adam's Bashforth Method.

References

[1] S. S. Sastry, *Introductory Methods of Numerical Analysis*, 4th Ed., PHI Learning Pvt Ltd., 2009.

[2] Dr. B .S. Grewal, *Numerical methods in Engineering and Science with Programs in C, C + +*, 9th Ed., Khanna Publications, New Delhi, 2010.

[3] T. Veerarajan and T. Ramachandran, *Numerical Methods*, Sigma series, Tata McGraw-Hill Education, 2007.

[4] Erwin Kreyszig, *Advanced Engineering Mathematics*, 8th Ed., Wiley Eastern, 2011.

[5] Abhishek Gupta, *Numerical Methods using MATLAB*, Apress, 2015.

BSCMTC382	Course VIII(a): Linear Algebra (Special Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)

Linear transformations : Kernel, Isomorphism of any n-dimensional space and F^n, Quotient space, Dimension of quotient space, Vector space structure of $L(V, V^r)$.

Matrices and linear transformations: Idempotent, Nilpotent, Diagonal, Triangular, Singular, Non-singular matrices, Matrix of a linear transformation, Isomorphism between $L(V, V^r)$ and $M_{mn}(\mathsf{F})$, Relation between matrices of a linear transformation with respect to two different bases, Rank of a matrix.

Unit II (12 Hours)

Matrices: Elementary row and column operations, Row reduced echelon form of a matrix, Finding rank of a matrix and inverse of a non-singular matrix by row reducing, Rank and nullity of linear transformations and matrices.

Linear equations: Homogeneous and non-homogeneous equations, Testing consistency and

solving a system of linear equations.

Unit III (12 Hours)
Minimal Polynomial of a matrix, Minimal polynomial of a Linear transformation, Characteristic roots and characteristic vectors, Cayley Hamilton theorem and applications.

References

[1] N. S Gopalakrishnan, *University Algebra*, 3rd edition, New Age International Publications, 2015.

[2] G. D. Birkoff and S Maclane, *A brief Survey of Modern Algebra*, 2nd Ed, IBH Publishing Company, Bombay, 1967.

[3] Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice - Hall of India Pvt. Ltd., New Delhi, 2004.

[4] Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.

[5] Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007

[6] S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999

BSCMTC383	Course VIII(b): Linear Programming (Special Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)
Mathematical formulation of the problem, Graphical method of solving LPP, Simplex algorithm, Non canonical LPP.

Unit II (12 Hours)
Duality equation, Duality theorem, Dual non-canonical LPP, Matrix games, Two Persons Zero sum Matrix game, The Von Neumann Minimax theorem.

Unit III (12 Hours)
Transportation problems: The balanced Transportation Problem, Vogel Advance start Method, Transportation algorithm, Unbalanced Transportation problem.
Assignment problem: The Hungarian Algorithm, Network-Flow problem, The Max-Flow Min-Cut theorems, The Maximal flow algorithm.

References

[1] P. M. Karak, *Linear programming and theory of games*, New central book agency (P) ltd., 2012.

[2] James K. Strayer, *Linear Programming and its Applications*, Springer-Verlag, 1989.

[3] Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.

[4] F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research - Concepts and Cases*, 9th Ed., Tata McGraw Hill, 2010.

[5] Hamdy A. Taha, *Operations Research - An Introduction*, 9th Ed., Prentice - Hall, 2010.

BSCMTC384	Course VIII(c): Partial Differential Equations (Special Course)	2 Credits (36 Hours, 3 hours/week)

Unit I (12 Hours)

Total Differential Equations: Total Differential forms and Total Differential equations and solutions.

Unit II (12 Hours)

Partial Differential Equations of the First Order: Classification of Integrals, Derivation (Origin) of Partial Differential Equations, Lagrange's Method of Solving the Linear Equations, Charpit's Method, Special types of first order equations.

Unit III (12 Hours)

Higher Order Partial Differential Equations: Origin of the second order differential Equations, Classification of Second Order Partial Differential Equations, Linear Partial Differential Equations with constant Coefficients.

References

[1] I. N. Snedon, *Elements of Partial Differential Equations*, Dover Publications, Mineola, New york, 2006.

[2] Narayanan and Manicavachagom Pillay, *Differential Equations*, Viswanathan (Printers and Publisher) PVT Ltd. 1991.

[3] K. Sankara Rao, *Introduction to Partial Differential Equations*, 3rd Ed., PHI, 2010.

[4] T. Amarnath, *An Elementary Course in Partial Differential Equations*, Narosa, 1997.

[5] M D Raisinghania, *Advanced Differential Equations, Revised Edition*, S Chand & Company Ltd., 2018.

[6] Shepley L Ross, *Differential Equations*, 3rd Ed., Wiley India (P.)Ltd., 1984.

BSCMTP385	Lab VI	2 Credits

Practicals for VI Semester

Practicals: Lab VI

Mathematics practicals with Free and Open Source Software (FOSS) tools for computer programs

1. Solving algebraic equation (Bisection method and Regula-Falsi).
2. Solving algebraic equation (Iteration and Newton-Raphson methods).

3. Solving system of equations (Jacobi and Gauss-Seidel methods).
4. Interpolations with equal intervals.
5. Interpolations with unequal intervals.
6. Derivatives using forward difference formulae
7. Derivatives using backward difference formulae.
8. Extreme values of tabulated functions.
9. Integrals using Trapezoidal rule, Simpson's 1/3 rule, and Simpson's 3/8 rule.
10. Solving ordinary differential equations by Picard's method.
11. Solving ordinary differential equations by Taylor's series method.
12. Solving ordinary differential equations by Euler's method and modified Euler's method.
13. Solving ordinary differential equations by Runge-Kutta Method.
14. Solving ordinary differential equations by Adam's Bashforth Method.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

Group II

BSCMTCE133	Core Elective - A : Functions and Applications	1 Credit (24 Hours, 2 hours/week)

Unit I (12 Hours)

Straight line: Straight line in economics, Break-Even point, System of straight lines, Effect of a Tax or Subsidy.

Parabola: Parabola in in economics, The non-linear model.

Rectangular hyperbola: Rectangular hyperbola in economics.

Circle: Circle in economics.

Inequalities and absolute values: Properties of inequalities, Linear inequality in one variable, Absolute values. Applications in economics.

Unit II (12 Hours)

Derivatives of functions: Economic applications, Demand function, Price demand, income demand, Cross demand, Law of supply, Revenue functions, Short-run production function, Short-run cost function, Relation between marginal product and marginal cost.

The maxima and minima of functions: Applications of maxima and minima of functions in economics and business.

References

[1] R S Bharadwaj, *Mathematics for Economics and Business*, 2nd Ed., Excel Books, 2007.

[2] M Ragahvacahri, *Mathematics for Management : an introduction*, Tata McGraw-Hill, 1980.

[3] Teresa Bradley, *Essential Methematics for Economics and Business*, 2nd Ed., Wiley India Publishers, 2008.

[4] Frank Werner and Yuri N. Sotskov, *Mathematics of Economics and Business*, Taylor & Francis, 2006.

BSCMTCE183	Core Elective - B : Vector Calculus	1 Credit (24 Hours, 2 hours/week)

Unit I (12 Hours)

Vector functions, Limits, Continuity, Derivative, Differentiation Rules, Integrals of vector functions, Modeling Projectile Motion, Arc length, Unit Tangent Vector, Curvature, Unit Normal Vector, Torsion, Unit Binormal vector.

Unit II (12 Hours)

Integration of Vector functions: Line Integrals, Vector fields, Gradient fields, Work, Circulation, Flux, Path independence, Potential Functions, Conservative fields, Exact Differential Forms, Green's Theorem, Surface Area, Surface Integrals, Parameterized surfaces, Stokes' Theorem, The Divergence Theorem.

References

[1] Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, *Thomas' Calculus*, 11th Ed., Pearson, 2008.

[2] Shanthi Narayan and P. K. Mittal, *A Text book of Vector Calculus*, S Chand & Company PVT. Ltd., 2014.

[3] Paul C. Matthews, *Vector Calculus*, 1st ed., Springer-Verlag Publishers, 1998.

[4] Murray R Spigel and Seymour Lipschutz, Vector Analysis, 2nd Ed., Schaum's Outline, McGrew Hill Publishers, 2009.

BSCMTCE233	Core Elective - C : Skill Development Techniques in Algebra and Calculus	1 Credit (24 Hours, 2 hours/week)

Unit I (12 Hours)

Real number system, properties, order, Inequalities. Groups, Examples, short answer problems in subgroups, normal subgroups, Lagrange's theorem homomorphisms, isomorphisms. Rings, Integral domain and Fields, ideals homomorphisms, isomorphisms, short answer problems.

Unit II (12 Hours)

Derivatives, Applications of derivatives, increasing and decreasing functions, critical number, maxima, minima, Curvature and poles, short answer problems.

References

[1] Rashmi Gupta and Suraj Ssingh, *A Complete Resource Mannual - Mathematics - M.Sc. Entrance Examination*, Unique Publishers, 2017.

[2] Amit Rastogi and Vicky Sain, *Post graduate Entrance Exam Mathematics*, Arihant Publications, 2016.

[3] R. Gupta, *Mathematics for Higer Level Competitive Examinations*, Ramesh Publications, 2016.

[4] Lloyd. R. Jaisingh and Frank Ayres, *Abstract Algebra*, 2nd Ed., Schaum outlines, Macgraw Hill Publications, 2003.

BSCMTOE283	Open Elective - D : Applications of Basic Arithmetics	1 Credit (24 Hours, 2 hours/week)

(For other Streams)

Unit I (12 Hours)

Number System, Decimal Fractions, Simplifications, Average, Problems on numbers, Problems on ages.

Unit II (12 Hours)

Concepts of Time and distance, Related problems, technique for problems related to Time and Work, Situations in Boats and Streams, velocity related problems, Simple problems on trains and other moving objects, different types of problems in Calendar, number of days, dates etc., Positions of hour hand and minute hand in Clocks, related problems.

References

[1] R. S. Agarwal, *Quantitative Aptitude*, S. Chand & company Pvt. Ltd., 2014.

[2] A. Balaraju, *Mental ability*, S M V Publishers, Kolar, 2015.

[3] B. S. Sijwalii and Indu Sijwali, *Verbal and Analytical Reasoning*, Arihant Publishers, 2014.

[4] H. S. Hall and F. H. Stevens, *An Elementary Course of Mathematics*, Macmillan and Co. Ltd., 1899.

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Question Paper Patterns

Group I - Optional: For B.Sc. Mathematics

Theory

For I /II / III/ IV Semesters

End Semester Exam 80 marks + Internal Assessment 20 marks = 100 Total marks

End Semester Exam

Duration: 3 hours Max. Marks: 80

PART -A	
I. Answer any 10 questions (10 × 2 = 20)	
Question Number	Unit Number
1 to 7	Unit - 1, 2
8 to 14	Unit - 3, 4
PART -B	
II. Answer any 6 questions (6 × 5 = 30)	
Question Number	Unit Number
1 to 9	Unit - 1, 2
PART -C	
III. Answer any 6 questions (6 × 5 = 30)	
Question Number	Unit Number
10 to 18	Unit - 3, 4

For V/VI Semesters

Duration: 3 hours Max. Marks: 80

PART -A	
I. Answer any 10 questions (10 × 2 = 20)	
Question Number	Unit Number
1 to 14	Unit - 1, 2, 3
PART -B	
II. Answer any 12 questions (12 × 5 = 60)	
Question Number	Unit Number
1 to 18	Unit - 1, 2, 3

Internal assessment: Internal assessment marks should be based on two tests of 90 minutes duration each.

Practicals

For I /II / III/ IV Semesters

End Semester Practical Exam 40 marks + Lab Internal Assessment 10 marks = 50 Total marks

End Semester Practical Exam: Question paper for each Lab exam of 2 hour duration shall contain TWO questions on lab programmes which are to be executed.

Lab Internal assessment: Lab internal assessment marks should be based on two lab tests of 90 minutes duration each.

For V/VI Semesters

End Semester Practical Exam 80 marks +Lab Internal Assessment 20 marks =100 Total marks

End Semester Practical Exam: Question paper for each Lab exam of 3 hour duration shall contain THREE questions on lab programmes which are to be executed.

Lab Internal assessment: Lab internal assessment marks should be based on two lab tests of 2 hours duration each.

Group II - General Electives

For Core/Open Electives A, B, C, D

End Semester Exam 40 marks + Internal Assessment 10 marks = 50 Total marks

Duration: 2 hours Max. Marks: 40

PART -A	
I. Answer any 5 questions ($5 \times 2 = 10$)	
Question Number	Unit Number
1 to 4	Unit -1
5 to 8	Unit -2
PART -B	
II. Answer any 3 questions ($3 \times 5 = 15$)	
Question Number	Unit Number
1 to 5	Unit -1
III. Answer any 3 questions ($3 \times 5 = 15$)	
6 to 10	Unit -2

Internal assessment: Internal assessment marks should be based on two tests of 60 minutes duration each.

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MANGALORE UNIVERSITY

B. Sc. CHOICE BASED CREDIT SYSTEM (2019-2020)

COURSE PATTERN AND SCHEME OF EXAMINATION

CORE SUBJECT: PHYSICS

Core/Elective	Course Code	Title	Instruction hrs/week	Duration of the Exam (hrs)	Max. Marks			Credits
					IA	Exam	Total	
I Semester								
Group I Core Subject	BSCPHC131	General Physics I	4	3	20	80	100	2
	BSCPHP 132	Physics Practicals I	3	3	10	40	50	1
Group II Elective	BSCPHCE 133	Basics of Radiation and Environment	2	2	10	40	50	1*
					Total number of Credits for Core Subject in I Semester: 04			
II Semester								
Group I Core Subject	BSCPHC 181	General Physics Paper II	4	3	20	80	100	2
	BSCPHP 182	Physics Practicals II	3	3	10	40	50	1
Group II Elective	BSCPHCE 183	Physics of Nano Science and Smart materials	2	2	10	40	50	1*
					Total number of Credits for Core Subject in II Semester: 04			
III Semester								
Group I Core Subject	BSCPHC 231	Optics	4	3	20	80	100	2
	BSCPHP 232	Physics Practicals III	3	3	10	40	50	1
Group II Elective	BSCPHCE 233	Electrical Appliances	2	2	10	40	50	1*
					Total number of Credits for Core Subject in III Semester: 04			
IV Semester								
Group I Core Subject	BSCPHC 281	Electricity &X-ray Crystallography	4	3	20	80	100	2
	BSCPHP 282	Physics Practicals IV	3	3	10	40	50	1
Group II Elective	BSCPHOE 283	Basics of Communication and Astronomy	2	2	10	40	50	1*
					Total number of Credits for Core Subject in IV Semester: 04			
V Semester								
Group I Core Subject	BSCPHC 331	Modern Physics	3	3	20	80	100	2
	BSCPHP 333	Physics Practicals V	4	3	20	80	100	2
Group I Core Subject	BSCPHC 332	Condensed Matter Physics	3	3	20	80	100	2
					Total number of Credits for Core Subject in V Semester: 06			
VI Semester								
Group I Core	BSCPHC 381	Nuclear Physics	3	3	20	80	100	2

SYLLABUS
FIFTH SEMESTER

CH 301 : Chemistry Paper V **3 Hrs / week (40 Hrs)**

UNIT I

Application of metal complexes and complexation : **3 Hrs**

Applications of complexes and complex formation in metallurgy, -Ag, Au, Al, Ni extractions. Volumetric analysis - Complexiometry, masking, demasking, external indicator.

Qualitative analysis - Test for Ferrous and Ferric ions, seperation of copper from Cadmium.

Gravimetric analysis - Presibitation of Nickel, Magnesium and Aluminium ions.

Thermodynamic and Kinetic Aspects of Metal Complexes **3 Hrs**

Thermodynamic stability of metal complexes (Brief outline), stepwise formation of complexes, stepwise formation and overall formation constants. Relation between K and β, $\Delta G = -2.303\ RT \log \beta$.

Factors affecting the stability - chelate effect, account for high ΔS values. Labile and inert nature of complexes. Substitution reactions of square planner complexes - Pt(II) complexes, syntheses of cis and trans $[Pt(NH_3)_2Cl_2]$ complexes, trans effect.

Magnetic Properties of Transition Metal Complexes **4 Hrs**

Origin of magnetism, magnetic Induction, magnetic flux density, magnetic moment per unit volume χ_M , χ_M^{corr}. Types of magnetic behaviour - dia, phara, Ferro magnetic and anti ferromagnetic properties - examples, cause (origin), magnetic susceptibility -data, sign, magnitude, temperature and field dependence.

Factor's determining para-magnetism, study of magnetic behaviour of first raw transition elements. Methods of determining magnetic susceptibility, Gouy's method, expression for μ_{eff}, and χ_M^{corr}. (no derivation) spin-only formula. Correlation of μ_s and μ_{eff}, values, $\mu_{eff} = \mu_s\ (1-\alpha \frac{\lambda}{\Delta})$. orbital contribution to magnetic moments, quenching of orbital angular moment. Application of magnetic moment data for 3d-metal complexes - predicting geometry of complexes.

SYLLABUS

FIFTH SEMESTER

CH-302 Chemistry Paper VI 3 Hrs / We

UNIT - I

Elementary Quantum Mechanics :

Quantum theory of radiation (Black-body radiation), Planck's radiation law, he solids, photoelectric effect, Compton effect, De-Broglie hypothesis, Heisenber principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave e and its importance, physical interpretation of the wave function, postulate mechanics (statements only), particle in a one dimensional box, setting of Sch equation for H-atom (no separations of variables or solutions), quantum num importance.

Raman spectroscopy :

Classical and quantum theories of Raman effect. Concept of polarizability and ellipsoid. Rotational and vibrational Raman spectra, selection rules.

UNIT-II

Electronic spectra of Transition Metal Complexes :

Introduction , L-S coupling or R-S coupling. Term symbol, Micro states, ground states for d^{1-9} system, Terms generated by ligands. Electronic Spectr metal complexes,Types of d-d Transition,or crystal field transitions, Charge ligand to metal and metal to ligand, intraligand transitions, Selection rules for Spin selection rule, Laporte selection rule, relaxation of selection rule (vibronic multiplicity, forbidden transition, Orgel energy level diagram Explanations, Org diagram for d^1 and d^9states,discussion of electronic spectra of [Ti (H_2O $(NH_3)_4]SO_4$ complexes.

Flame photometry.

General principle, instrumentation, interferences and applications.

Thermoanalytical methods : Principle, instrumentation and ap Thermogravimetric analysis, Derivative Thermpgravimetry and Differe Analysis. Nature of TGA, DTA & DTA curves

SYLLABUS VI SEMESTER

CH 351 : Chemistry Paper VII — **3 Hrs/ week (40 Hours)**

UNIT I

Inorganic Polymers : — **4 Hrs**

Preparation, properties, structure and applications of Silicones, Fluorocarbons and Phosphonitrilic halides. Production and structural features of borazine boron nitride, sulphur nitride (SN)x and silicon carbide.

Composites : — **2 Hrs**

Introduction, role of matrix in composites, types of matrix, different matrix materials, reinforcement, classification of composites and applications of composites in industry.

Synthetic Polymers : — **4 Hrs**

Types of polymerization (i) radical polymerization (ii) cationic polymerization and (iii) anionic polymerization. Zeigler-Natta polymerization. Phenol formaldehyde risins-e.g. Bakelite, urea-formaldehyde risins, epoxy resins and polyurethanes-preparation and applications. Natural rubber-composition. Synthetic rubbers: Buna-S and SBR-preparation and applications, advantages of synthetic rubbers over natural rubbers.

UNIT - II

Photochemistry : — **6 Hrs**

Interaction of radiation with matter, difference between thermal and photochemical processes. primary and secondary processes of a photochemical reaction, Laws of photochemistry : Grothus - Drapper law, Stark - Einstein law, (only statement) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield defination, reasons for low and high quantum yield, one example for low quantum yield (combination of H_2 and Br_2) and one example for high yield (combination of H_2 and Cl_2), photosensitized reactions-energy transfer processes definition of photosensitisation. (e.g.: Photosynthesis in plants, dissociation of H_2, dissociation of ethylene, Isomerisation of 2-butene).

Radiation and Nuclear Chemistry : — **4 Hrs**

Radiolysis of water, radiation dosimetry, dosimeter, applications in organic and inorganic reactions. Application of radioisotopes in the study of oganic reaction mechanism, medicine and soil fertility. Industrial applications.

UNIT III

Carbohydrates : — **6 Hrs**

Monosaccharides : Interconversion of glucose and fructose, chain lengthening of aldoses. (Kiliani-Fischer method),Chain shortening (Ruff degradation), Conversion of glucose into mannose-epimerisation, Mechanism of osazone formation - Amadori rearrangement, Formation of glycosides, ethers (methyl), esters (acetates) Configuration of glucose and fructose-deduction. Determination of ring size of monosaccharides (methylation and periodic acid method). Elucidation of cyclic structure of D(+) glucose. Mechanism of mutarotation.

Amino Acids, Proteins and Peptides : 4 Hrs

Classification based on functional group, Essential and non essential aminoacids, structure and stereochemistry of amino acids- explanation, Acid-base behaviour, Isoelectric point and electrophoresis-explanation, Preparation of α amino acids from α halogenated acids, Strecker synthesis and Gabriel synthesis. Reactions due to COOH and NH_2 groups. Action of heat, structure and nomenclature of di-, tri- and polypeptides. Classification of proteins based on chemical composition and molecular shape. Peptide structure determination- end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid phase peptide synthesis, levels of protein structure-primary, secondary, tertiary and quaternary structures, Denaturation of protiens.

UNIT - IV

Structure and reactions of Carboxylic acids and their derivatieves : 5 Hrs

Structure of carboxylic acid and carboxylate ion, Effect of substituents on the acidity of aliphatic and aromatic carboxylic acids(ortho effect). Reactions of carboxylic acids, with mechanism-i) Homologation-Arndt-Eistert reaction ii) Degradation to alkyl halides-Hunsdiecker reaction iii) Conversion to primary amines-Curtius rearrangement iv) Conversion to haloacids-HVZ reaction. Derivatives of carboxylic acids- acid chlorides, amides, esters, anhydrides-preparation and reactions.

Alkaloids: 5 Hrs

Classification with examples-pyridine, piperidine, quinoline, isoquinoline and indole alkaloids. General properties-formation of salts and exhaustive methylation, physical properties and physiological activity. Structural elucidation of nicotine and Ephedrine including synthesis. Structural formulae of atropine, cocaine, hygrine and morphine.

CH 352 : Chemistry Paper VIII 3 Hrs/Week(40Hrs)

UNIT I

Colorimetry and Spectrophotometry : 4 Hrs

Introduction, theory of colorimetry and spectrophotometry. Beer-Lambert's law. Instrumentation and applications of colorimetry and spectrophotometry.

Ultraviolet (UV) absorption spectroscopy : 6 Hrs

Absorption laws -Beer-Lambert law, Concept of molar absorptivity, energy level, types of electronic excitations, Frank-Condon principle(explanation about red shift and blue shift), presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes dienonesand, β-unsaturated carbonyl compounds.

UNIT - II

Nuclear magnetic resonance (NMR) Spectroscopy : 8 Hrs

Introduction, origin of spectra, instrumentation of PMR spectrometer, solvents used, scales, nuclear shielding and deshielding, number of signals obtained from the sample, position of signals and chemical shift and molecular structure, spin-spin splitting, spin notation and