Part B
Syllabus Prescribed for Three Year UG/PG Programme
Programme: B.Sc. with Chemistry
Semester 5

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE 5S (T)	**Chemistry 5S (DSC)**	**84**

COs:

By the end of this course, the students will be able to:

1. apply concepts of coordination compounds and crystal field theory for different types of compounds
2. compare the electronic spectra of transition metal complexes
3. compare heterocyclic chemistry through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
4. select correct synthetic approach to prepare derivatives of industrially important heterocyclic compounds, dyes, and drugs
5. apply the concepts of quantum mechanics.
6. apply the concepts from advanced mathematics to solve the derivation of different chemical formulae

Unit	Content
Unit I	**Coordination Compounds:** Important terms namely molecular or addition compounds, double salts, complex salts, complex ion, ligand, coordination number, central metal ion, etc. Werner's theory of coordination and its experimental verification based on conductance data and formation of AgCl precipitate in case of cobalt ammines. Sidgwick's electronic interpretation and its drawbacks, effective atomic number. IUPAC rules for nomenclature of coordination compounds. Structural isomerism-ionization, linkage, and coordination in complexes. **Geometrical isomerism** in octahedral complexes of the type Ma_4b_2, Ma_3b_3, $Ma_2b_2c_2$ Ma_4bc, $M(AA)_2b_2$. Square planar complexes of the type Ma_2b_2 and Ma_2bc.Optical isomerism in octahedral complexes of type $Ma_2b_2c_2$, Mabcdef, $M(AA)_3$, $M(AA)_2$ b_2 and tetrahedral complexes of the type Mabcd and $M(AA)_2$. **Optical isomerism** in square planar complexes, Mabcd Mab_2c, Ma_2bc. M(AB)with suitable example of metal complexes **Periods: 14**
Unit II	**A) Crystal Field Theory:** Postulates of CFT, Crystal field splitting in octahedral, distorted octahedral, square planar and tetrahedral complexes, concept of CFSE, high spin and low spin complexes based on crystal field splitting energy and pairing energy, distribution of electrons in t_{2g} and e_g orbitals in high spin and low spin octahedral complexes. Factor affecting magnitude of crystal field splitting in octahedral complexes. **B) Electronic Spectra of transition metal complexes:** Introduction to spectra, selection rules for d-d transitions, spectroscopic terms-determination of ground term symbols for d^1 to d^{10}, spectra of d^1 and d^9 octahedral complexes, Orgel diagram for d^1 and d^9 states, electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. Spectrochemical series **Periods: 14**
Unit III	**A) Heterocyclic Compounds:** Nomenclature, Pyrrole: Synthesis from acetylene, succinimide and furan, Basicity, Electrophilic substitution reactions (orientation) - nitration, sulphonation, acetylation and halogenation, Molecular orbital structure. Pyridine: Synthesis from acetylene and pentamethylene diamine hydrochloride, Basicity, Electrophilic substitution reactions (orientation) - nitration, sulphonation, Nucleophilic substitution reactions (orientation) – $NaNH_2$, C_6H_5Li and KOH. **B) Organometallic Compounds:** Grignard Reagents: Methyl magnesium bromide- synthesis from methyl bromide (Only reaction) Synthetic applications: Electrophilic substitution reactions -formation of alkanes, alkenes, higher alkynes and other organometallic compounds, Nucleophilic substitution reactions-Reactions- Reactions with aldehydes and ketones, ethylene oxide, acetyl chloride, methyl cyanide and CO_2. Methyl Lithium- Synthesis and reaction with water, formaldehyde, acetaldehyde, acetone, ethylene oxide and CO_2. **Periods: 14**
Unit IV	**A) Dyes** Classification on the basis of structure and mode of application, Preparation and uses of Methyl orange, Crystal violet, Phenolphthalein, Alizarin and Indigo. **B) Drugs** Analgesic and antipyretics: Synthesis and uses of phenylbutazones. Sulha drugs: Synthesis and uses of sulphanilamide and sulphadiazine. Antimalarials: Synthesis of chloroquine from 4, 7-dichloroquinoline and its uses. **C) Pesticides** Insecticides: Synthesis and uses of malathion. Herbicides: Synthesis and uses of 2,4-dichloro phenoxy acetic acid (2,4-D). Fungicides: Synthesis and uses of Thiram (tetramethyl thiuram disulphide). **Periods: 14**
V	**Elementary quantum mechanics** Introduction, Black body radiation and energy quantization, The photoelectric effect and photons, The Bohr's theory of hydrogen atom, The de Broglie hypothesis, Heisenberg uncertainty principle, The quantum mechanics, The time independent Schrodinger wave equation in one dimension and its extension to three-dimensional space. Well behaved wave function, physical significance of wave function (Born interpretation). Application of Schrodinger wave equation to a particle in one-dimensional box. Concept of atomic orbital. Numericals. **Periods :14**
VI	**Thermodynamics**: Gibbs and Helmholtz free energy functions, Physical significance of Gibbs free energy, change in free energy as a criteria of spontaneity and equilibrium, variation of free energy G with pressure and temperature, Derivation of Gibbs-Helmholtz equation and it's applications, Nernst heat theorem,

	Statement of third law, Chemical potential or partial molar free energy, Derivation of Gibb's-Duehm equation, Variation of chemical potential with pressure, Chemical potential of an ideal gas in gases mixture, Derivation of Vant Hoff's reaction isotherm and its application to equilibrium states, Numericals. **Periods :14**
SEM :	1. Numerical associated with quantum mechanics, and thermodynamics 2. Safety data sheet for selected drugs or pesticides or dyes 3. Model preparation to display shapes of co-ordination compounds 4. Charts for Crystal field splitting in different types of complexes
	COs: By the end of this module, the students will be able to: 1. Create models associated with stereochemistry of coordination compounds 2. Use safety datasheets for different types of compounds 3. Solve numerical problem associated with quantum mechanics, and thermodynamics.
Activities	Model creation, poster, chart preparation, memory maps, class tests, assignments, project, survey, group discussion, industrial visit, or any other innovative pedagogical method. Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.

Text books:

1. A Text Book of Chemistry for Fifth Semester of B.Sc. by AUCTA Association and DnyanPath Publication

Reference Books:

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia- S. Naginchand & Co., Delhi.
2. Inorganic Chemistry by A.K. De, Wiley East Ltd.
3. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan, S. Chand & Co.
4. Concise Inorganic Chemistry by J.D. Lee, ELBS.
5. Inorganic Chemistry by J.E. Huheey- and Kettle, Harper & Row.
6. Advanced Inorganic Chemistry, Vol-I, Satya Prakash, Madan, Tuli, Basu.
7. Organic Chemistry Vol. I, II and III by Mukharjee, Singh and Kapoor- Wiley Eastern.
8. Organic Chemistry by S.K. Ghosh.
9. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.
10. Stereochemistry and mechanism through solved problems by P.S. Kalsi.
11. Organic Chemistry by TWG Solomons, 8th edition, John Wiley
12. Organic chemistry by R. K. Bansal
13. Physical Chemistry: Walter, J. Moore, 5th edn., New Delhi.
14. Physical Chemistry: G.M. Barrow, McGraw Hill, Indian Edn.
15. Principles of Physical Chemistry: Maron and Prutton.
16. Principles of Physical Chemistry: Puri, Sharma, and Pathania.
17. Physical Chemistry: P.W. Atkins, 6th Edn.
18. Physical Chemistry: Levine
19. Practical Organic Chemistry by F.G. Mann, B.C. Saunders, Orient Longman.
20. Comparative Practical Organic Chemistry (Qualitative Analysis) by V.K. Ahluwalia and Sunita Dhingra, Orient Longman.
21. Comprehensive Practical Organic Chemistry (Preparation and Qualitative Analysis) by V.K. Ahluwalia and Renu Agrawal, Orient Longman.
22. Practical Physical Chemistry: Palit and De.
23. Practical Physical Chemistry: Yadao.
24. Practical Physical Chemistry: Khosla.
25. Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Pulishing House, Meerut.

Weblink to Equivalent MOOC on SWAYAM if relevant:

https://archive.nptel.ac.in/courses/104/105/104105034/

https://onlinecourses.nptel.ac.in/noc24_ph15/preview

https://onlinecourses.nptel.ac.in/noc20_ce27/preview

Weblink to Equivalent Virtual Lab if relevant:

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

https://www.youtube.com/watch?v=bxu5HlE1jT0

Part B

Syllabus Prescribed for Three Year UG/PG Programme

Programme: B.Sc. with Chemistry

Semester 5

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE(5S) PR	**Chemistry 5S Practical**	**30 Sessions**

COs:

By the end of this course, the students will be able to:

1. prepare different types of coordination compounds
2. interpret the effect of reaction conditions on yield of the product
3. calculate different properties of metal complexes, practical and theoretical yield
4. estimate compounds in a given sample
5. synthesize some commercially available drugs
6. estimate neutralizing power of a commercially available antacid tablet.

*** List of Practical/Laboratory Experiments/Activities etc.**

Exercise-1: Inorganic Preparations	
Que: Prepare the following complexes and Comment on Valance Band structure of Complex, Theoretical Yield, Practical Yield, Colour of the complex, calculate magnetic properties like paramagnetic or diamagnetic and Melting Point).	
1	Preparation of tetraamminecopper (II)sulphate.
2	Preparation of Hexamminenickel (II)chloride.
3	Preparation of potassiumtrioxalate aluminate (III).
4	Preparation of Prussian blue.
5	Preparation of chrome alum.
6	Preparation of sodium thiosulphate and dithionite.
Exercise-2: Organic Chemistry	
1	Estimation of formaldehyde.
2	Estimation of Glycine.
3	Estimation of Ascorbic Acid (Vitamin-C).
4	Estimation of Aniline by Bromination Method.
5	Estimation of Phenol by Bromination Method.
6	Estimation of formaldehyde.
8	Synthesis of Paracetamol.
9	Synthesis of Aspirin
10	Isolation of Caffeine from Tea Leaves
11	Determine the acid neutralizing power of a commercially available antacid tablet.

Reference books:

1. Practical Organic Chemistry by F.G. Mann, B.C. Saunders, Orient Longman.
2. Comparative Practical Organic Chemistry (Qualitative Analysis) by V.K. Ahluwalia and Sunita Dhingra, Orient Longman.
3. Comprehensive Practical Organic Chemistry (Preparation and Qualitative Analysis) by V.K. Ahluwalia and Renu Agrawal, Orient Longman.
4. Practical Physical Chemistry: Palit and De.
5. Practical Physical Chemistry: Yadao.
6. Practical Physical Chemistry: Khosla.
7. Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Publishing House, Meerut.

Distribution of Marks for Practical Examination

Time : 04 hours (One Day Examination)

Total Practical Marks 50, Duration of Exam 04 Hours	
Internal Practical Exam (25 Marks)	**External Practical Exam* (25 Marks)**
Attendance, Students' Performance, Activity, Practical Record Book / Laboratory Manual/Journal Report : 20 Internal Viva/Assignment/Quiz/Test : 05	Experiment 1 Performance / Demonstration : 10 Experiment 2 Performance / Demonstration : 10 External Viva (by External and Internal Examiner: 05
Total : 25	**Total : 25**

*Note: One practical from respective exercise

Part B

Syllabus Prescribed for Three Year UG/PG Programme

Programme: B.Sc. with Chemistry

Semester 6

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE (6S) T DSE-Ia	**Chemistry 6S (DSE-Ia)**	**84**

COs:

By the end of this course, the students will be able to

1. Use valence bond theory for structure prediction and properties of metal-complexes
2. Apply the concept of kinetic and thermodynamic stability to different types of compounds
3. Understand the effect of different factors on substitution reactions of metal-complexes
4. Understand the role of different metal ions in biological processes
5. Interpret and compare the given spectral data
6. Apply the concepts of nuclear chemistry
7. Understand the concepts of molecular spectroscopy
8. Use the concepts of quantum mechanics to solve the problems of atomic structure

Unit	Content
Unit I	**A) Kinetic aspect of metal complex:** Thermodynamic and kinetic stability of the complexes, factors affecting stability of complexes. Brief idea about substitution reactions, SN^1-dissociative, SN^2-associative mechanism and SNCB (substitution reactions of conjugates base) mechanism. Labile and inert complexes. Factors affecting lability of complexes namely arrangement of d-electrons (based on VB theory), size of central metal ion, charge of central metal ion, geometry of complexes. Substitution reactions in square planar complexes mechanism. **B) Valence bond theory** as applied to structure and bonding in complexes of 3d-series elements (Only 4 and 6 coordinates complexes). Inner and outer orbital complexes. Magnetic properties of complexes of 3d series elements. Limitations of VB theory. **Periods :14**
Unit II	**A) Organometallic Chemistry:** Definition, nomenclature and classification of organometallic compounds. Metal carbonyls- definition and classification. Preparation, properties, structure and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$. Nature of M-C bond in metal carbonyls. **B) Bioinorganic Chemistry:** Essential and trace elements in biological processes. Biological role of Na^+, K^+, Ca^{2+} and Mg^{2+} ions. Metalloporphyrins- Haemoglobin and Myoglobin and their role in oxygen transport**.** Comment on structure, function and applications Vitamin B_{12} Cobalamin Metalloenzymes. **C)** Definition and introduction of Chromatography, Classification of chromatography, Advantage and disadvantage of chromatography, Retention Factor (R_f) - Definition of R_f, Calculation of R_f value, factors affecting R_f values, Principle of paper chromatography, Principle of TLC, and their applications. **Periods: 14**
Unit III	**A] Electronic spectroscopy**: Introduction, theory, instrumentation, types of electronic transitions, presentation of electronic spectrum, terms used- chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect, Applications in the structure determination of dienes, alpha,beta-unsaturated aldehydes and ketones, aromatic compounds. **B] Infrared spectroscopy**: Introduction, Types of molecular vibrations- stretching and bending, Calculation of vibrational modes, force constant, instrumentation, interpretation of IR, H-stretching, triple bond, double bond and Fingerprint regions, IR spectra of H2O, CO2, C2H5OH, CH3CHO, CH3COOHand CH CONH2 **Periods: 14**
Unit IV	**A] NMR spectroscopy**: Introduction, spin quantum number, instrumentation, Aspects of NMR- number of signals (equivalent and non-equivalent protons), positions of signals (chemical shift), intensities of signals, splitting of signals (spin-spin coupling), coupling constant, applications. **B] Mass spectroscopy**: Introduction, theory, instrumentation-(ion sources), Mass spectra of neopentane and methanol, molecular ion peak, base peak, metastable peak, Rules of fragmentation, applications. **Periods: 14**
Unit V	**Nuclear chemistry:** The nucleus: subatomic particles, nuclear force (Meson theory), nuclear size and density. Stability of nucleus: n/p ratio, binding energy, packing fraction, structure of nucleus: shell model and liquid drop model. Radioactivity: natural and induced, Radioactive decay-α-decay, β-decay, γ-decay; neutron, emission, positron emission and electron capture, group displacement law and radioactive series, Measurement of radioactivity: Ionization chamber, Geiger counter, scintillation counters. Applications: Carbon dating, neutron activation and isotope dilution analyses. **Periods: 14**
Unit VI	**Molecular Spectroscopy:** Electromagnetic radiation, Characterization of EMR in terms of wavelength, frequency, wave number and energy of photon, Spectrum of electromagnetic radiations. Energy level diagram of a molecule indicating electronic, vibrational and rotational transitions. **Rotational Spectroscopy:** Condition for pure rotational spectrum, Selection rule for rotational transitions, Derivation of expression for moment of inertia of a diatomic rotor. Isotope effect. Applications of microwave spectroscopy for the determination of moment of inertia and bond length. **Vibrational Spectroscopy:** Condition for exhibiting vibrational spectrum, Selection rule for vibrational

	transitions, Vibrational energy levels of a simple harmonic oscillator, Zero-point energy, Position of a spectral line, Determination of force constant of covalent bond. **Raman Spectroscopy:** Raman effect, Raman spectrum of a molecule, Condition for exhibiting Raman spectrum, Selection rule for rotational transitions, Pure rotational spectrum of diatomic molecule, Vibrational Raman spectrum of a diatomic molecule, Numerical **Periods: 14**
SEM :	• Numerical associated with molecular spectroscopy and nuclear chemistry • Chart preparations of molecular spectroscopy, selection rule, condition of microwave and vibrational spectroscopy • Comparative chart preparations of role of essential and trace elements in biological processes • Model for metal-complexes • Comparative spectral analysis of different compounds
	COs: By the end of this module, the students will be able to: 1. Create models associated with spectroscopy 2. Solve numerical problem associated with nuclear chemistry and molecular spectroscopy.
Activities	Model creation, poster, chart preparation, memory maps, class tests, assignments, project, survey, group discussion, industrial visit, or any other innovative pedagogical method. Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.

Suggested Readings:

Text books:

1. A Text Book of Chemistry for Sixth Semester of B.Sc. by AUCTA Association and DnyanPath Publication

Reference Books:

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia- S. Naginchand & Co., Delhi.
2. Inorganic Chemistry by A.K. De, Wiley East Ltd.
3. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan, S. Chand & Co.
4. Concise Inorganic Chemistry by J.D. Lee, ELBS.
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6. Advanced Inorganic Chemistry, Vol-I, Satya Prakash, Madan, Tuli, Basu.
7. Organic Chemistry Vol. I, II and III by Mukharjee, Singh and Kapoor- Wiley Eastern.
8. Organic Chemistry by S.K. Ghosh.
9. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.
10. Stereochemistry and mechanism through solved problems by P.S. Kalsi.
11. Organic Chemistry by TWG Solomons, 8th edition, John Wiley
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13. Physical Chemistry: Walter, J. Moore, 5th edn., New Delhi.
14. Physical Chemistry: G.M. Barrow, McGraw Hill, Indian Edn.
15. Principles of Physical Chemistry: Maron and Prutton.
16. Principles of Physical Chemistry: Puri, Sharma, and Pathania.
17. Physical Chemistry: P.W. Atkins, 6th Edn.
18. Physical Chemistry: Levine

Part B
Syllabus Prescribed for Three Year UG/PG Programme
Programme: B.Sc. with Chemistry
Semester 6

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE(6S) PR) DSE-Ia	**Chemistry 6S Practical (LAB on DSE-Ia)**	**30 Sessions**

COs:

By the end of this course, the students will be able to

1. Identify acid and basic radicals in a given mixture
2. Use different solvents to prepare original solutions
3. Prepare different solutions required for analysis and separation of mixtures
4. Understand the chemical properties of different ions in different solvents
5. Estimate different compounds in a given sample
6. Synthesize commercially used polymers
7. Analyze the given spectral data for a compound
8. Interpret the given spectral data of a compound
9. Deduce the structure of compound from the given spectral data

*** List of Practical/Laboratory Experiments/Activities etc.**

Exercise-1 Inorganic Mixture Analysis	
Que: Semimicro qualitative analysis of inorganic salt mixture containing two acidic radicals and two basic radicals of same or different groups. At least five mixtures to be given. Analysis of basic radicals to be done by using spot test reagents. The Results writing to write the finding two acid and two basic Radicals and confirmation test of Radical and their group it may be belong. **Following radicals to be given:** Carbonate, Nitrite, Sulphite, Sulphide, Chloride, Bromide, Iodide, Nitrate And Sulphate, Silver(I), Lead (II), Copper (II), Bismuth (III), Cadmium (II), Tin (II), Arsenic (III), Antimony (III), Iron (III), Chromium (III), Aluminium (III), Nickel (II), Cobalt (II), Manganese (II), Zinc (II), Calcium (II), Strontium (II), Barium (II), Magnesium (II). **(Any 6 mixtures)**	
Exercise-2: IT skill-based experiments and Organic Chemistry	
1	Illustrate the complete curly arrow mechanism of a chemical reaction. Choose a reaction (e.g., nucleophilic substitution, addition reaction) and draw the step-by-step mechanism, including any intermediates and transferring it to MS Word and/or MS PowerPoint (Overall Reaction and its mechanism expected) using chemistry drawing software.
2	Drawing the 2D-structures of at least three marketed drugs and reporting their IUPAC name, usage, and mechanism of action using chemistry drawing software.
3	Drawing 2D- structures of ten heterocyclic compounds and their bi- and tri-substituted derivatives (four derivatives each) using chemistry drawing software.
4	Estimation of Urea by hypobromite method
5	Estimation of unsaturation by Bromination Method
6	Synthesis of Phenol- formaldehyde Resin (Bakelite)
7	Acetylation of Aromatic Primary Amine (Green Chemistry Approach)
8	Separation of a mixture of methyl orange and methylene blue by thin layer chromatography (using benzene)
9	Separation of a mixture of 2,4-dinitro phenyls of acetaldehyde and benzaldehyde by thin layer chromatography (using benzene:petroleum ether = 3:1).
9	Separation of a mixture of dyes by thin layer chromatography (using cyclohexane:ethyl acetate = 8.5:1.5)
10 to 13	Interpretation of given spectra: characteristic peaks and their assignments. (Four different molecules with different functional groups). It is suggested that the UV, IR, H^1 NMR, and Mass of unknown organic compounds has to be provided to the students and from this information they should find out the structure of organic compound. (Ethyl alcohol, but-2-ene, ethyl bromide, acetic acid, nitrobenzene, pyridine, isopropyl alcohol, Acid chloride, Urea, benzaldehyde)

References:

1. Analytical Chemistry: G. D. Christian, Wiley, 6th edn.
2. Sharma, Y. R. (2013). Elementary Organic Spectroscopy: Principles and Chemical Applications (Revised V Edition). New Delhi: S. Chand and Company LTD
3. Advanced Organic Chemistry by Michael B. Smith, Jerry March. 2014
4. Banwell.,(2017). Fundamentals of Molecular Spectroscopy (IV Edition), McGraw-Hill Education (India) Pvt. Limited 2018
5. Practical Organic Chemistry by F.G. Mann, B.C. Saunders, Orient Longman.
6. Comparative Practical Organic Chemistry (Qualitative Analysis) by V.K. Ahluwalia and Sunita Dhingra, Orient Longman.
7. Comprehensive Practical Organic Chemistry (Preparation and Qualitative Analysis) by V.K. Ahluwalia and Renu Agrawal, Orient Longman.
8. Practical Physical Chemistry: Palit and De.
9. Practical Physical Chemistry: Yadao.
10. Practical Physical Chemistry: Khosla.
11. Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Pulishing House, Meerut.

Distribution of Marks for Practical Examination

Time: 04 hours (One Day Examination)

Total Practical Marks 50, Duration of Exam 04 Hours	
Internal Practical Exam (25 Marks)	**External Practical Exam* (25 Marks)**
Attendance, Students' Performance, Activity, Practical Record Book / Laboratory Manual/Journal Report : 20 Internal Viva/Assignment/Quiz/Test : 05	Experiment 1 Performance / Demonstration : 10 Experiment 2 Performance / Demonstration : 10 External Viva (by External and Internal Examiner: 05
Total : 25	**Total : 25**

*Note: One practical from respective exercise

Syllabus Prescribed for Three Year UG/PG Programme

Programme: B.Sc. with Chemistry

Semester 6

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE (6S) T DSE-Ib	**Chemistry 6S (DSE-Ib)**	**84**

After successful completion of this unit, you will be able to

1. Apply the different separation techniques
2. Explain the extraction process and factors favouring it.
3. Understand the basic principle of spectroscopy
4. Explain the Stark effect, Zeeman effect, Beer- Lambert law
5. Predict and explain the type of transition in the molecule.
6. Predict approximate wavelength regions for different types of transitions.
7. Identify the IR-active and IR-inactive.
8. Justify the bands in IR Spectroscopy.
9. Elucidate structure using NMR and Mass spectrometric data
10. Explain the fragmentation rule in mass spectrometry.

Unit	**Content**
Unit I	**A) Separation Technique:** Introduction to Analytical separations and its important in analysis, Types of separation methods: (i)Based on solubility- Precipitation, Filtration, Crystallization (ii) Based on Gravity- Centrifugation (iii)Based on Volatility- Distillation (iv)Based on retention capacity of stationary phase-Chromatography. **B) Solvent Extraction:** Introduction to Solvent Extraction, Nernst Distribution law, Distribution Ratio, Distribution Coefficient, Factors favoring Solvent extraction, Single step and multiple step extraction, Condition of extraction: Equilibrium time, Solvent volume, temperature, pH, percentage extraction for single step and multiple step extraction, Batch extraction and Continue extraction. **Periods: 14**
Unit II	**A) Paper Chromatography:** Definition and introduction of Chromatography, Classification of chromatography, Advantage and disadvantage of chromatography, Retention Factor (R_f) - Definition of R_f, Calculation of R_f value, factors affecting R_f values, Principle of paper chromatography, Technique of paper chromatography, Development of chromatogram, Ascending technique, Descending technique, Application of Paper Chromatography. **B) Thin layer Chromatography (TLC):**Introduction of TLC, Principle ofTLC, Technique of TLC, Stationary phase, Mobile Phase, Solvent used in TLC (Polar and Non polar solvent), Preparation of TCL plate, Development of Chromatogram, Application Of TLC. **Periods: 14**
Unit III	**A) Principles of Spectroscopy:** Electromagnetic spectrum, Interaction of emr with matter, Natural line width and Broadening- Intensity of spectral transitions. Electronic transitions, Franck-Condon principle, Fluorescence and phosphorescence. Stark effect, Zeeman effect. **B) Ultraviolet and visible spectroscopy :** Introduction to UV Spectroscopy, UV spectral range and Theory of UV Spectroscopy, Laws of photochemistry-Basic law of absorption- Beer-Lambert law, Instrumentation: Light sources: deuterium lamps, tungsten-halogen lamps**,** Monochromors**,** Detectors: photomultiplier tubes, photodiodes**,** Sample Preparation, Selection of solvents, Concentrations; Handling of solid and liquid samples, Calibration curves, λmax **Periods: 14**
Unit IV	**IR Spectroscopy:** Overview of electromagnetic radiation and the IR spectrum range, the vibrating diatomic molecules-the simple harmonic oscillator and anharmonic oscillator, diatomic rotor- Formula for vibrational frequency, problems. Interaction of infrared radiation with matter, Theory of IR Spectroscopy, Vibrational transitions: stretching, bending, and combination, Types of Bands in IR: overtones; combination bands and Fermi resonance, Selection rules for IR-active and IR-inactive, Degree of vibrations in a molecules (examples- H_2O, CO_2, HCN etc) **Periods: 14**
Unit V	**Introduction to Mass spectrometry:** Basic principles of mass spectrometry Overview of ionization techniques: Electron Impact Ionization (EI), Chemical Ionization (CI), Field desorption (FD), Fast Atom Bombardment(FAB) **Instrumentation:** Component of mass spectrometer-Mass ionizers, mass analyzers, and detectors, mass spectra and it's presentation, molecular ion, meta stable ions and peaks, fragmentation processes: Fragmentation pathways and rules. **Periods: 14**

Unit VI	**Introduction to NMR Spectroscopy:** Principle of NMR spectroscopy – Overview of nuclear spin, magnetic resonance, and energy levels in nuclei, Nuclear spin and magnetic moment, Larmor frequency and chemical shift Relaxation processes: T1 (spin-lattice relaxation) and T2 (spin-spin relaxation **Description of the NMR instrument:** Components of an NMR spectrometer: magnet, radiofrequency (RF) transmitter/receiver, sample holder, Solvent for NMR, Reference for NMR, NMR spectra and its analysis. **Periods: 14**
SEM :	• Numerical associated with molecular spectroscopy • Chart preparations of molecular spectroscopy • Comparative chart preparations of chromatography • Comparative spectral analysis of different compounds
	COs: By the end of this module, the students will be able to: 1. Create models associated with spectroscopy 2. Solve numerical problem associated with molecular spectroscopy.
Activities	Model creation, poster, chart preparation, memory maps, class tests, assignments, project, survey, group discussion, industrial visit, or any other innovative pedagogical method. Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.

Reference Books:

1. Solvent Extraction in Analytical Chemistry, G. H. Morrison and H. Freiser, John Wiley & Sons
2. Basic concept of Analytical Chemistry, S. M. Khopkar, 3rd edn., Age International Publisher
3. High Performance Liquid Chromatography, Analytical Chemistry by open learning, John Wiley & Sons
4. Chromatography and Separation Science, Satinder Ahuja, Volume 4, Academic Press.
5. Solid phase Extraction- Principles, Techniques and Applications, N. J. K. Simpson, Marcel Dekker.
6. Instrumental Methods of Analysis H. H. Willard, L. L. Merritt Jr, J.A. Dean, F.A.Settle (CBS publisher)7the edn.
7. Analytical Chemistry: G. D. Christian, Wiley, 6th edn.
8. Sharma, Y. R. (2013). Elementary Organic Spectroscopy: Principles and Chemical Applications (Revised V Edition). New Delhi: S. Chand and Company LTD
9. Advanced Organic Chemistry by Michael B. Smith, Jerry March. 2014
10. Banwell.,(2017). Fundamentals of Molecular Spectroscopy (IV Edition), McGraw-Hill Education (India) Pvt. Limited 2018

Weblink to Equivalent MOOC on SWAYAM if relevant:
https://onlinecourses.nptel.ac.in/noc20_cy08/preview
https://onlinecourses.nptel.ac.in/noc24_cy16/preview

Weblink to Equivalent Virtual Lab if relevant:

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:
https://www.youtube.com/watch?v=gaBXQW9rCDA

Part B

Syllabus Prescribed for Three Year UG/PG Programme

Programme: B.Sc. with Chemistry

Semester 6

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CHE(6S) PR DSE-Ib	**Chemistry 6S (DSE-I) Practical (LAB on DSE-Ib)**	**21 Sessions**

COs:

By the end of this course, the students will be able to

1. Use different purifications techniques
2. Utilize chromatographic techniques for separation
3. Efficiently use different glassware and instruments for identification and purification of compounds
4. Compare the behaviour of different compounds with different solvent systems
5. Analyze the given spectral data for a compound
6. Interpret the given spectral data of a compound
7. Deduce the structure of compound from the given spectral data

*** List of Practical/Laboratory Experiments/Activities etc.**

Exercise-1: Analytical Practical:

1. Purify the unknown components using techniques like recrystallization, filtration, or distillation, depending on their physical properties.
2. Chromatographic separation of active ingredients of plant leaves, flower and identify the compounds present in each mixture based on the R_f (retention factor) values
3. Paper Chromatography: Separation of cations like Fe(III), Ni(II) and Cu (II) in sample.
4. To Separate mixture of Ni^{2+} and Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in Chloroform.
5. Separation and identification of monosaccharides present in given mixture (glucose & fructose) by paper chromatography and report the R_f value.
6. Separation of a mixture of methyl orange and methylene blue by thin layer chromatography (using benzene).
7. Separation of a mixture of 2,4-dinitro phenyls of acetaldehyde and benzaldehyde by thin layer chromatography(using benzene : petroleum ether = 3:1).
8 Separation of a mixture of dyes by thin layer chromatography (using cyclohexane:ethyl acetate = 8.5:1.5).
9. Separation of a mixture of 2,4-dinitro phenyls of acetaldehyde and benzaldehyde by thin layer chromatography (using toluene: petroleum ether).

Exercise-2: Spectral Problems:

1. Interpretation of given IR spectra: characteristic peaks and their assignments. (Four different molecules with different functional groups)
2. Draw the UV, FT-IR and ^{1}H-NMR & Mass spectrum of the compound from the given data. (Two different molecules with different functional groups)

Reference Books:

1. Analytical Chemistry: An Introduction, D. A. Skoog, D.A. West, F. J. Holler and S. R. Crouch.
2. Analytical Chemistry Method of Separation: R.V. Dilts

Distribution of Marks for Practical Examination

Time : 04 hours (One Day Examination)

Total Practical Marks 50, Duration of Exam 04 Hours	
Internal Practical Exam (25 Marks)	**External Practical Exam* (25 Marks)**
Attendance, Students' Performance, Activity, Practical Record Book / Laboratory Manual/Journal Report : 20 Internal Viva/Assignment/Quiz/Test : 05	Experiment 1 Performance / Demonstration : 10 Experiment 2 Performance / Demonstration : 10 External Viva (by External and Internal Examiner): 05
Total : 25	**Total : 25**

*Note: One practical from respective exercise