PONDICHERRY UNIVERSITY
(A CENTRAL UNIVERSITY)

B.Sc. Chemistry

(Choice Based Credit System)

Syllabus

2017-18 onwards

Pondicherry University

SCHEME FOR CHOICE BASED CREDIT SYSTEM

B.Sc., Chemistry
(With Effect from 2017-18 onwards)

COURSE	SUBJECT CODE	TITLE OF THE PAPER	Credits	Marks	Contact Hrs. / Week.	Lab Hrs. / Week
SEMESTER-I			**18 Credits**			
MIL – 1	LBEN//LHIN/ LMAL/LSAN/ LTAM/LTEL 111	Bengali/Hindi/Malayalam/ Sanskrit/Tamil/ Telugu	03	100	03	-
ENGLISH – 1	ENGL 112	ENGLISH – 1	03	100	03	-
DSC – 1A	UCHM 111	General Chemistry – I	04	100	04	-
DSC – 2A	UMAT 112 or UZOO 112	Mathematics – I or Zoology - I	03	75	03	-
DSC – 3A	UCHM 116	General Chemistry Practical - I	02	50	-	04
DSC – 4A	UMAT 116 / UZOO 116	Mathematics Lab – I / Zoology Lab - I	01	25	-	02
AECC – 1	PADM 111	Public Administration	02	50	02	-
SEMESTER-II			**18 Credits**			
MIL – 2	LBEN//LHIN/ LMAL/LSAN/ LTAM/LTEL 121	Bengali/Hindi/Malayalam/ Sanskrit/Tamil/ Telugu	03	100	03	-
ENGLISH– 2	ENGL 122	ENGLISH – 2	03	100	03	-
DSC – 1B	UCHM 121	General Chemistry-II	04	100	04	-
DSC – 2B	UMAT 122 or UZOO 122	Mathematics – II or Zoology - II	03	75	03	-
DSC – 3B	UCHM 126	General Chemistry Practical – II	02	50	-	04
DSC – 4B	UMAT 126 / UZOO 126	Mathematics Lab – II / Zoology Lab - II	01	25	-	02
AECC – 2	ENVS 121	Environmental Studies	02	50	02	-
SEMESTER-III			**22 Credits**			
MIL – 3	LBEN//LHIN/ LMAL/LSAN/ LTAM/LTEL 231	Bengali/Hindi/Malayalam/ Sanskrit/Tamil/ Telugu	03	100	03	-
ENGLISH – 3	ENGL 232	ENGLISH – III	03	100	03	-
DSC – 1C	UCHM 231	Physical Chemistry - I	04	100	03	-
DSC – 2C	UCHM 232	Inorganic Chemistry - I	04	100	03	-

DSC – 3C	UPHY 233	Physics - I	03	75	03	-
DSC – 4C	UCHM 236	Physical and Inorganic Chemistry - Practical	02	50	-	04
DSC – 5C	UPHY 238	Physics Practical- I	01	25	-	02
SEC – 1 (Any One to be Selected)	UCHM 234	IT Skills for Chemists	02	50	01	02
	UCHM 235	Basic Analytical Chemistry				
	UCHM 237	Chemical Technology and Society				
SEMESTER-IV			**22 Credits**			
MIL – 4	LBEN//LHIN/ LMAL/LSAN/ LTAM/LTEL 241	Bengali/Hindi/Malayalam/ Sanskrit/Tamil/ Telugu	03	100	03	-
ENGLISH – 4	ENGL 242	ENGLISH – IV	03	100	03	-
DSC – 1D	UCHM 241	Physical Chemistry - II	04	100	03	-
DSC – 2D	UCHM 242	Organic Chemistry - I	04	100	03	-
DSC – 3D	UPHY 243	Physics - II	03	75	03	-
DSC – 4D	UCHM 246	Physical and Organic Chemistry - Practical	02	50	-	04
DSC – 5D	UPHY 248	Physics Practical- II	01	25	-	02
SEC – 2 (Any One to be Selected)	UCHM 244	Analytical and Clinical Biochemistry	02	50	01	02
	UCHM 245	Chemoinformatics				
	UCHM 247	Business Skills for Chemists				
SEMESTER-V			**20 Credits**			
DSC – 1E	UCHM 351	Inorganic Chemistry - II	03	100	03	-
DSE – 1A DSE – 2A (Any Two to be Selected)	UCHM 352	Applications of Computers in Chemistry	04	75	04	-
		Applications of Computers in Chemistry - Practical	01	25	-	02
	UCHM 353	Analytical Methods in Chemistry	04	75	04	-
		Analytical Methods in Chemistry: Practical	01	25	-	02
	UCHM 354	Nano Chemistry	04	75	04	-
		Nano Chemistry: Practical	01	25	-	02
	UCHM 355	Green Chemistry	04	75	04	-
		Green Chemistry: Practical	01	25	-	02

	UCHM-356	Organometallics, Bioinorganic Chemistry & Polynuclear hydrocarbons	04	75	04	-
		Organometallics, Bioinorganic Chemistry & Polynuclear hydrocarbons: Practical	01	25	-	02
	UCHM-357	Research Methodology	05	100	05	02 (Tutorial)
DSC– 2E	UCHM 350	Inorganic Chemistry Practical - II	02	50	-	04
GE – 1	XXXX XXX	A course from other department	03	100	03	-
SEC – 3 (Any One to be Selected)	UCHM 358	Green Methods in Chemistry	02	50	01	02
	UCHM 359	Pharmaceutical Chemistry				
SEMESTER-VI			**20 Credits**			
DSC– 1F	UCHM 361	Organic Chemistry - II	03	100	03	-
DSE – 1B DSE – 2B (Any 2 DSE Courses to be selected)	UCHM 362	Analytical Chemistry	04	75	04	02
		Analytical Chemistry: Practical	01	25	-	02
	UCHM 363	Polymer Chemistry	04	75	04	02
		Polymer Chemistry: Practical	01	25	-	02
	UCHM 364	Molecular Modelling & Drug Design	04	75	04	-
		Molecular Modelling & Drug Design:Practical	01	25	-	02
	UCHM 365	Industrial Chemicals & Environment	04	75	04	-
		Industrial Chemicals & Environment: Practical	01	25	-	04
	UCHM 366	Dissertation	05	100	-	10
DSC – 2F	UCHM 360	Organic Chemistry Practical -II	02	50	-	04
GE – 2	XXXX XXX	A course from other department	03	100	03	-
SEC – 4 (Any One to be Selected)	UCHM 367	Forensic Chemistry	02	50	01	02
	UCHM 368	Fuel Chemistry				

Total Number of Credits: 120

Pondicherry University

Syllabus for B. Sc., (Chemistry)

Choice Based Credit System

I Year – Semester-I

DSC – IA: UCHM 111: GENERAL CHEMISTRY – I

Objective: **4-1-0-4**

- To Study Atomic Structure, Chemical Bonding and Molecular Structure
- To Study the Fundamentals of Organic Chemistry and Stereochemistry
- To Study the Gaseous state

Unit – I: Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydronic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum quantum numbers m_l and m_s. Shapes of s, p and d atomic orbitals, nodal planes. Spin quantum number (s) and magnetic spin quantum number (ms).

(12 Lectures)

Unit II: Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with the following examples – $BeCl_2$, BF_3, NH_3, SF_4, PCl_5, SF_6.

Concept of resonance and resonating structures in various inorganic compounds. MO Approach: Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of O_2 and N_2 and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

(12 Lectures)

Unit III: Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

(12 Lectures)

Unit IV: Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

(12 Lectures)

Unit V: Gaseous State:

Kinetic molecular model of a gas: Postulates and derivation of the kinetic gas equation - collision frequency - collision diameter - mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degree of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(12 Lectures)

Reference Books:

• Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.

• Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley.

• Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in

Inorganic Chemistry, John Wiley & Sons.

• Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:

Principles of Structure and Reactivity, Pearson Education India, 2006.

• Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry,

John Wiley &Sons (2014).

• McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

• Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman,

New Delhi (1988).

• Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.

• Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.

• Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

• Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

• Puri B.R., Sharma L.R. and Kalia K.C. Principles of Inorganic Chemistry, Milestone.

• Arun Bahl, Bahl, B.S. and Tuli G.D. *Essentials of Physical Chemistry*, S. Chand & Co, 2012.

• Peter Atkins and Julio de Paula, *Atkin's Physical Chemistry* 9th Ed., Oxford University Press.

• Puri B.R., Sharma L.R. and Pathania M.S. *Principles ofof Physical Chemistr*, Vishal Publishing Co., 2008.

DSC-3A: UCHM 116: GENERAL CHEMISTRY PRACTICAL – I

(60 Lectures) **0-1-4-2**

Volumetric Analysis & Chromatography

1. Preparation of standard solutions of different Molarities and Normalities.

2. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

3. Estimation of oxalic acid by preparing standard FAS and titrating it with $KMnO_4$.

4. Estimation of Fe^{2+} by preparing standard FAS and using $KMnO_4$ link solution.

5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

7. Estimation of $K_2Cr_2O_7$ iodometrically by preparing standard $K_2Cr_2O_7$ and link $Na_2S_2O_3$.

8. Estimation of Cu (II) ions iodometrically by preparing standard $CuSO_4$ and link $Na_2S_2O_3$.

9. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

10. Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

11. Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

• Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

• Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

• Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. &Smith, P.W.G.,

Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

• Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Scheme of Valuation: (Max marks: 50)

1.	Internal Marks	--------	10 marks
2.	Writing Principle and brief procedure	--------	5 marks
3.	Record	--------	5 marks
4.	Viva-voce	--------	5 marks
5.	Experiment (based on error %)	--------	25 marks (see below)
	Up to 2% error	--------	25 marks
	2% to 3%	--------	20 marks
	3% to 4%	--------	15 marks
	4% to 5%	--------	10 marks
	More than 5% error or expt. is incomplete	--------	5 marks

For calculation mistake: 2 marks to be deducted; for no calculation: 5 marks to be deducted.

I Year - Semester - II

DSC- 1B: UCHM 121: GENERAL CHEMISTRY-II

(60 Lectures) **4-1-0-4**

Objective:

- To Study Chemical Energetics
- To Study the Chemical Equilibrium, Ionic Equilibria
- To Study the Hydrogen, Hydrides, and S-block elements
- To Study the Aliphatic Hydrocarbons, Aromatic Hydrocarbons

Unit I: Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Third law of thermodynamics:

Statement of third law; concept of residual entropy; Nernst heat theorem; Evaluation of absolute entropy from heat capacity data.

(12 Lectures)

Unit II: Chemical Equilibrium & Ionic Equilibria:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(12 Lectures)

Unit III: Hydrogen, Hydrides, and S-block elements

Hydrogen-Isotopes, ortho- and para-hydrogens. Hydrides: ionic, covalent, metallic and interstitial hydrides, Hydrogen bonding.
Alkali metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, aqueous solution chemistry, complexes and organometallic compounds.
Alkaline Earth metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, aqueous solution chemistry, complexes and organometallic compounds.

(12 Lectures)

Unit IV: Aliphatic Hydrocarbons

Alkanes: Preparation – Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Cycloalkanes: Preparation by Dieckman condensation & Baeyer's strain theory. Conformational analysis of mono- and di-substituted cyclohexanes.

Alkenes: Preparation – Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis*-alkenes (Partial catalytic hydrogenation) and *trans*-alkenes (Birch reduction). *Reactions: cis*-addition (alkaline $KMnO_4$) and *trans*-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration-oxidation.

Alkynes: Preparation of acetylene from CaC_2 and conversion into higher alkynes by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

(12 Lectures)

Unit V: Aromatic Hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Activating and deactivating substituents. Orientation and ortho-para ratio. Addition reactions of benzene - Birch reduction.

(12 Lectures)

Reference Books:

- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Lee, J.D. Concise Inorganic Chemistry, John Wiley & Sons.
- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Arun Bahl and Bahl, B.S. Advanced Organic Chemistry, S. Chand & Co. Ltd., 2012.
- Arun Bahl, Bahl, B.S. and Tuli G.D. Essentials of Physical Chemistry, S. Chand & Co, 2012.
- Peter Atkins and Julio de Paula, Atkin's Physical Chemistry 9th Ed., Oxford University Press.
- Puri B.R., Sharma L.R. and Pathania M.S. Principles of of Physical Chemistr, Vishal Publishing Co., 2008.
- Hari Jeevan Arnikar, Essentials of Nuclear Chemistry, Revised 4th Ed., New Age International Publishing, 1995.

DSC - 3B: UCHM 126: GENERAL CHEMISTRY PRACTICAL – II

(60 Lectures) **0-1-4-2**

Physical Chemistry Experiments

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.
7. Determination of molecular mass by Rast's macro method.
8. Determination of transition temperature of the given substance by thermometric method ($Na_2S_2O_3.5H_2O$; $SrCl_2.6H_2O$; $CH_3COONa.3H_2O$; $MnCl_2.4H_2O$)
9. Distribution coefficient of iodine between water and carbon tetrachloride.
10. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
11. Determination of the critical solution temperature (CST) and composition of the phenol water system.
12. Effect of added electrolytes on the miscibility temperature of phenol-water system.

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. &Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry. Pearson Education (2009).
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).

<u>Scheme of Valuation:</u> (Max marks: 50)

1. Internal Marks -------- 10 marks
2. Writing principle, formula/graph, etc. -------- 5 marks
3. Record -------- 5 marks
4. Viva-voce -------- 5 marks
5. Experiment (based on error % with theoretical value) ----- 25 marks (see below)
   - Up to 2% error -------- 25 marks
   - 2% to 3% -------- 20 marks
   - 3% to 4% -------- 15 marks
   - 4% to 5% -------- 10 marks
   - More than 5% error or expt. is incomplete -------- 5 marks (grace mark)

   For calculation mistake: 2 marks to be deduced; For no calculation: 5 marks to be deduced.