

AC 7-4-2014
Item No. – 4.7

UNIVERSITY OF MUMBAI



Syllabus for the Interdisciplinary B. Sc.

Module: Chemistry

(Credit Based Semester and Grading System with effect from the academic year 2014–2015)

Preamble

As per the perspective plan of the University which was approved by the Management Council on 11th September 2013 & subsequently by the Academic Council on 19th September 2013, University of Mumbai is going to offer B.Sc. Interdisciplinary programme under the category of Innovative programmes from the academic year 2014-2015. The main objective of this course is to make the learner well versed with all science disciplines as science graduate so that he/she can have scope in schools, banks or any offices as well as they can pursue post graduation in the major subject.

The Rational:

The basic thoughts and understanding in the programme of BSc with interdisciplinary science is, many or around 60 % students after their graduation leave higher education and opt for jobs. These jobs are in Government offices, Municipal Corporations, private companies or, in schools as teachers. They are absorbed as science graduates. Even when the students opt for management carriers they are considered as science graduates at entry level. Thus the specialization or the major subject does not have relevance unless the students want to pursue the carrier in the field of research or higher education. Similarly those who enter in jobs of teachers find it difficult to teach other science subjects as required, than the subject of specialization, because they are not exposed to those branches of science.

With all these requirements of job market University has decided to introduce the graduation course in science as BSc interdisciplinary science. In this a learner can take two subjects from science discipline at first year level, from among these one subject can be selected at Second Year and the same will be continued as major subject along with applied component for final year B. Sc. The learner will earn 70 credits as explained in this subject like the existing system. In first year instead of the third subject the learner can opt any subject from the prescribed modules and as per the availability in the college / institute where admitted. These modules can be called as interdisciplinary modules. At the second year level instead of the second minor subject the learner can opt the modules from the interdisciplinary modules. The foundation course is also modified for interdisciplinary science which includes topics like Law, Economics, Sociology, Political Science etc.

Thus the learner will earn 70 credits in the major subject as obtained by any student in current traditional method. The remaining 50 credits can be earned from the interdisciplinary courses. The modules of interdisciplinary courses can be from science branches or arts / commerce / law / fine arts branches.

Keeping these things in mind the topics included in chemistry modules are experiments with the skill developments which will fulfill the need of the learners. The syllabus includes basic topics in chemistry which will help the learner to know the basic Chemistry & if learner wishes to pursue higher studies same knowledge will be useful.

Interdisciplinary B.Sc Syllabus - Modules in Chemistry
To be implemented from the Academic year 2014-2015

Module I
Theory

Course	Title	Credits	L / Week
USIDCH01		2	3

Practicals

USIDCHP01	Practicals of Course USIDCH01	1	3
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Module II
Theory

Course	Title	Credits	L / Week
USIDCH02		2	3

Practicals

USIDCHP02	Practicals of Course USIDCH02	1	3
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Detailed Syllabus for Interdisciplinary Courses in Chemistry
To be implemented from the Academic year 2014-2015

Module I (Detailed Syllabus)
Theory

Course	Unit	Topics	Credits	L/Week
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<p>USIDCH 01</p>	<p>I</p>	<p>1.1 CHEMICAL THERMODYNAMICS (4L) Thermodynamic terms: System, Surrounding, Boundaries Sign Conventions, State Functions, Zeroth law- Statement, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) First law of Thermodynamics and its limitations, Second law – Statements and discussion, Mathematical expression.</p> <p>1.2 CHEMICAL KINETICS (2L) Rate of Reaction, rate constant, Measurement of Reaction Rates Order & Molecularity of reaction, Integrated rate equation of first and second order (with equal initial concentration of reactants) reactions. (Derivation not expected). (Numericals expected)</p> <p>1.3 MOLECULAR SPECTROSCOPY-I (2L) Electromagnetic radiation, Electromagnetic Spectrum, Planck’s equation, Interaction of EMR with matter- 2.2</p> <p>1.4 POLYMERS-I (3L) Monomer, Repeat Unit, Polymer, Linear and Branched polymers, Homopolymer, Copolymer, Types of copolymers-Random, Block, Alternate, Graft. Natural Polymers-Source, Structure & Properties of Starch, Cellulose, Protein, Silk, Wool, Rubber.</p> <p>1.5 Scope and Introduction to analytical chemistry (4L) 1.5.1 Analytical chemistry Qualitative and Quantitative analysis ,Chemical analysis –Based on nature of information of the sample sought and based on size of the sample used ,Classification of analytical method-Classical and Instrumental methods – types, advantages and disadvantages</p>	<p>1</p>	<p>1</p>
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	<p>1.5.2 Applications of analytical methods in various fields</p> <p>Organic, Pharmaceuticals, Electronic and Environmental analysis</p>		
II	<p>2.1 Calibration of Glass ware and Chemical calculations (7L)</p> <p>2.1.1 Calibration of pipette, volumetric flask, Burette</p> <p>2.1.2 Measurements in analytical chemistry S.I units -Fundamental Units (Mass, amount of substance, distance, time, temperature, current) Uncertainty of measurements Significant figures- concept, Rules and examples (Numericals expected)</p> <p>2.1.3 Chemical calculations Expressing concentration of solutions –Normality, Molality, Molarity, Formality, Mole fraction, ppb, ppm, millimoles, milliequivalents. (Numericals expected)</p> <p>2.2 Concept of Qualitative Analysis: (8L) (Macro, Semi-Micro, Micro, Ultra Micro, Trace Analysis)</p> <p>2.2.1 Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (With reference to papers impregnated with Starch-Iodide, Potassium Dichromate, Lead acetate, Dimethyl Glyoxime, and Oxine reagents) (balanced Chemical Reactions expected).</p> <p>2.2.2 Precipitation Equilibria: Effect of Common Ions, Uncommon Ions; Oxidation State, Buffer Action, Complexing agents on precipitation of ionic compounds.</p>	1	1

	(Balanced Chemical Equations and Numerical Problems Expected).		
III	<p>3.1 Chemical Bonding(3L)</p> <p>Types of chemical bonds; Comparison between ionic and covalent bonds; polarizability (Fajan's Rules)</p> <p>Shapes of simple molecules: Lewis Dot structures; Sidgwick-Powell theory; Basic VSEPR Theory for AB_n type molecules with and without lone pair of electrons, Isoelectronic Principle.</p> <p>3.2 Bonding and structure of organic compounds (5L)</p> <p>3.2.1 Types of arrows and their significance. (8 types)</p> <p>3.2.2 Electronic effects in organic molecules: Inductive effect (or polarisation), polar covalent bonds and dipole moment. Delocalised bonds and resonance - drawing resonance structures, concept of formal charge, hyperconjugation.</p> <p>3.2.3 Bonds weaker than a covalent bond: Hydrogen bond – intermolecular hydrogen bonding in alcohols - effect on b.p. and solubility; Van der Waal's forces in straight and branched chain alkanes.</p> <p>3.3 Nomenclature of organic compounds (4L)</p> <p>Review of basic rules of IUPAC nomenclature. Nomenclature of mono & bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles & amines; including their cyclic analogues.</p>	1	1

	<p>3.4 Fundamentals of organic reaction mechanisms. (1L) Carbocations(alkyl) , Carbanions : (trichloromethyl)</p> <p>3.5 Reagents: (1L) Electrophiles and nucleophiles.</p> <p>3.6 RECENT TRENDS (1L) Introduction to Premier Indian research Institutes in Chemistry, Shantiswaroop Bhatnagar Awardees in last 5 years in Chemistry. Nobel prize winners in Chemistry in last 5 years.</p>		
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PRACTICAL COURSE IN USIDCH P1

1. To determine the rate constant for the hydrolysis of ester using HCl as catalyst.
2. To determine the rate constant for the hydrolysis of ester using H₂SO₄ as catalyst, using scientific calculator by Regression analysis.
3. Determination of amount of NaHCO₃ + Na₂CO₃ in the given solid mixture titrimetrically.
4. Determination of % composition of BaSO₄ and NH₄Cl in the given mixture gravimetrically.
5. Semi-Micro Inorganic Qualitative Analysis of a sample containing Two Cations and Two Anions. Cations: (from amongst) Pb²⁺, Ba²⁺, Ca²⁺, Sr²⁺, Cu²⁺, Cd²⁺, Fe³⁺, Ni²⁺, Mn²⁺, Mg²⁺, Al³⁺, Cr³⁺, K⁺, NH₄⁺
Anions : (from amongst) CO₃²⁻, SO₃²⁻, S²⁻, NO₂⁻, NO₃⁻, Cl⁻, Br⁻, I⁻, SO₄²⁻, PO₄³⁻
(Scheme of analysis should avoid use of sulphide ion in any form for precipitation /separation of cations). (Two mixtures)
6. **Crystallization**
Acetanilide / salicylic acid from hot water using fluted filter paper.
7. **Characterization organic compounds containing only C, H, (O) elements:**
Compounds belonging to the following classes: carboxylic acid, phenol, aldehyde/ ketone, ester, alcohol (Minimum any 3 compounds)

Detailed Syllabus for Interdisciplinary Courses in Chemistry
To be implemented from the Academic year 2014-2015

Module II (Detailed Syllabus)
Theory

Course	Unit	Topics	Credits	L/Week
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USIDCH 01	I	1.1 GASEOUS STATE (4L) Ideal Gas laws, Ideal gases, real gases, compressibility factor. Deviation from ideal gas laws, reasons for deviation from ideal gas laws, van der Waals equation of state, Joule-Thomson effect –qualitative discussion and experimentation,. 1.2 NUCLEAR CHEMISTRY-I (4L) Natural Radioactivity – Introduction, Types of radiation (α , β , γ) & their properties. Isobars, Isotopes & Isotones. Decay constant and half life period (Numericals expected). 1.3 BUFFERS (3L) – Introduction, Types of buffers, Buffer action, Buffer capacity. Hendersons equation (Numericals expected.) 1.4 Introduction to Gravimetric Analysis (4L) 1.4.1 Solubility product and Precipitation. 1.4.2 Factors affecting solubility of precipitate. 1.4.3 Conditions of precipitation, nucleation, particle size, crystal growth, colloidal state, ageing of precipitate/ digestion of precipitate.	1	1
	II	2.1 Titrimetric Analysis –I (7L) 2.1.1 Terms – Titration ,Titrant , titrand, End point, Equivalence point, Titration Error ,Indicator 2.1.2 Primary and Secondary standards- characteristics and examples 2.1.3 Types of Titration –Acid –Base, Redox. Precipitation, Complexometric titration. 2.2 Comparative Chemistry of Main Group Elements: Metallic and Non-Metallic Nature, Oxidation States, Electronegativity, Anamolous behavior of Second Period elements, allotropy. Catenation, Diagonal relationship.	1	1

	<p>(4 L)</p> <p>2.2.1 Comparative Chemistry of Some important compounds: a) Na_2CO_3; b) NaOH; c) NaCl; d) NaHCO_3; e) CaO; CaCO_3 (2L)</p> <p>2.2.2 Oxides of Nitrogen with respect to Environmental aspects. (2L)</p>		
III	<p>3.1 Acid-Base Theories (3L)</p> <p>Arrhenius ; Lowry-Bronsted ; Lewis ; Solvent Solute; Lux-Flood; Hard and Soft Acids and Bases-HSAB; Usanovich Definition.</p> <p>3.2 Stereochemistry of organic Compounds (4L)</p> <p>3.2.1 Isomerism – Types of isomerism: constitutional isomerism (chain, position and functional) and stereoisomerism.</p> <p>3.2.2 Chirality: Configuration, asymmetric carbon atom, stereogenic/ chiral centers, chirality,</p> <p>3.2.3. Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms; enantiomers, diastereomers, and racemic mixtures threo, erythro and meso isomers.</p> <p>3.3 Mechanism of organic reactions:(4L)</p> <p>3.3.1 Classification of organic reactions based on mechanism.</p> <p>3.3.2 Substitution: Nucleophilic substitution in alkyl halides ($\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$), electrophilic substitution in benzene (Friedel Crafts alkylation).</p> <p>3.3.3 Addition: Electrophilic addition (Markovnikov addition of HX to alkenes); Radical addition (AntiMarkovnikov addition of HBr to alkenes in presence of peroxide);</p> <p>3.4 Functional group interconversion based on the</p>	1	1

	<p>following reactions: (3L)</p> <p>3.4.1 Alkanes: Methods of formation: Kolbe reaction, Wurtz reaction, decarboxylation of carboxylic acids; hydrolysis of Grignard reagent.</p> <p>3.4.2 Alkenes: Methods of formation: hydrohalogenation of alkyl halides; Reactions: Addition of hydrogen, halogen, HX; oxidation using KMnO_4.</p> <p>3.4.3 Alkynes: Methods of formation: Dehydrohalogenation of alkyl dihalides, Reactions: Addition of hydrogen, HX.</p> <p>3.5 RECENT TRENDS (1L)</p> <p>Introduction to Premier Indian research Institutes in Chemistry, Shantiswaroop Bhatnagar Awardees in last 5 years in Chemistry. Nobel prize winners in Chemistry in last 5 years.</p>		
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PRACTICAL COURSE: USIDCHP2

1. To standardize commercial sample of NaOH using KHP and to write material safety data of the chemicals involved.
2. To standardize commercial sample of HCl using Borax and to write material safety data of the chemicals involved.
3. Determination of acetic acid in Vinegar by titrimetric method.
4. Determination of the amount of Mg(II) present in the given solution complexometrically

5. Inorganic Preparations: Copper Sulfate from Copper(II) Oxide;
6. Volumetric Analysis:- Determination of the strength of sodium carbonate and sodium bicarbonate by titration with standard acid solution using phenolphthalein and methyl orange as indicators;
7. **Characterization of organic compounds containing C, H, (O), N, S and halogen elements.** (Element tests to be done). (Minimum 3 compounds)
Compounds belonging to the following classes: amine, amide, nitro compound,

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Vishal Publish Co. Jalandhar. 45th ed.
3. **Chemistry For Degree Students Bsc First Year**, Dr. R. L. Madan , S. Chand &
Company Ltd, 1st Ed, 2010
4. **Physical Chemistry** , Vol I & II , N.B. Singh Shiv Saran Das . A.K.Singh
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company ,Rensed ed 2009, Reprint 2010.
6. **Chemistry John E. Mc Murray & Robest Fay**, 5th ed Pearsan 2011.
7. **Essentials Of Nuclear Chemistry**, H.J Arnika Fourth Revised ed. 2011
reprint 2012 new age international (P) limited publish
8. **Elements Of Physical Chemistry** by Atkins , 4th. Ed.

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Publication
2. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
3. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated
East-West Press.
4. Quality in the Analytical Chemistry laboratory –Neil T.Crosby,Florence Elizabeth
Prichard, Ernest.J Newman – John Wiley&Sons Ltd

5. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science
6. Analytical Chemistry, Christain, WSE / Wiley
7. Basic concepts of Analytical Chemistry, S.M.Khopkar, New Age International(P) Ltd.
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4. James E.Huheey, ‘Inorganic Chemistry’, 3rd edition, Harper & Row, Publishers, Asia, Pte Ltd., (1983).
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6. J. Barrett, ‘Inorganic Chemistry in Aqueous Solutions’; The Royal Society of Chemistry (2003).
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- 12.Asmik Das, *Fundamental Concepts of Inorganic Chemistry*,(Volumes-I,II and III)CBS Pub.(2000).
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