CHOICE BASED CREDIT SYSTEM SYLLABUS FOR CHEMISTRY-UG

ANNEXURE-I: Syllabus for Semester III and Semester IV of B.Sc. with Chemistry Programme

ANNEXURE-II: Paper Patterns for all papers Core Courses and Skill Enhancement Courses of Semester III and Semester IV for SEE Semester End Examinations

ANNEXURE-III: Marking Scheme, and Time Duration for practical examinations of Semester III and Semester IV

ANNEXURE-IV: Syllabus for two new Generic Elective Courses as options for Semester I and Semester II

ANNEXURE-V: Paper Patterns for the new optional Generic Elective courses of Semester I and Semester II SEE Semester End Examinations

ANNEXURE-VI: Syllabus, Paper Patterns and Marking Scheme for Laboratory Courses for Semester III and Semester IV of General Industrial Chemistry Courses of B.Sc. with Industrial Chemistry Programme

ANNEXURE-VII: New Course Codes as per OC-66 of Goa University for all papers offered in the subject of Chemistry from Semester I to Semester VI

ANNEXURE-I

Syllabus for

B.Sc. with Chemistry

Programme

SEMESTER-III AND SEMESTER-IV

ANNEXURE-Ia	:Syllabus	for	Semester	III	Core	Course	(CC)	of	Chemistry
		•••••		•••••	•••••			(1 Course)
									CHC 103

ANNEXURE-Ib:	Syllabus f	for S	Semester	III	Skill	Enhancement	Course	(SEC)	of
Chemistry							(1Co	urse)	

CHS101/ CHS106

ANNEXURE-Ic	: Syllabus f	or Semester	IV Core	e Course	(CC) of	f Chemistry (1 Course)
						CHC 104
ANNEXURE-Id: Chemistry	Syllabus for	Semester IV	/ Skill E	Inhancemer	nt Cours	se (SEC) of (1Course)
					CHS 10	2/CHS 107

ANNEXURE-Ia

Syllabus of B.Sc. CHEMISTRY

SEMESTER III

CORE COURSE: CHC103

(06 Credits: Theory-04, Practicals-02)

(PHYSICAL CHEMISTRY AND ORGANIC CHEMISTRY)

Theory: 60 Hours (04 Credits)

Section A: Physical Chemistry-2

(30 Hours; 02 credits)

1. Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Azeotropes.

Partial miscibility of liquids: Critical solution temperature, distillation and fractional distillation.

2. Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium, Phase diagrams of one-component systems (water, sulphur and CO₂) and two component systems involving eutectics, congruent and incongruent melting points (Zn-Mg, NaCl-H₂O).

3. Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Ionic mobility and factors affecting ionic mobility. Transference number and its experimental determination using moving boundary methods. Applications of conductance measurements: solubility and solubility products of sparingly soluble salts, ionic product of water, conductometric titrations (only acid-base).

(8 Hours)

(7 Hours)

(5 Hours)

Goa University, Taleigao Plateau, Goa.

4. Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode.

Section B: Organic Chemistry-3

1. Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters.

Reactions: Hell - Volhard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversions.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky reaction, Perkin condensation (mechanism).

2. Amines and Diazonium Salts

Amines (aliphatic and aromatic): (upto 5 carbons)

Preparation: from alkyl halides, Gabriel's phthalimide synthesis, Hofmann bromamide reaction (Hofmann rearrangement).

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO₂, Schotten – Baumann reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: Preparation from aromatic amines, conversion to benzene, phenol, dyes.

3. Amino Acids and Peptides

Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. *Terms:* Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: Ester of - COOH group, acetylation of -NH2 group, complexation

(10 Hours)

Page 5

(6 Hours)

(6 Hours)

(6 Hours)

(30 Hours; 02 Credits)

with Cu²⁺ ions, ninhydrin test. Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

4. UV – Visible Spectroscopy in Organic Chemistry (8 Hours)

Introduction to spectroscopy :

UV Spectroscopy: Beer-Lambert's law, Types of electronic transitions, λ_{max} , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption. *Visible Spectroscopy:* Effect of conjugation on colour. Application of Woodward - Fieser rules for calculation of λ_{max} for the following systems: α , β unsaturated aldehydes, ketones. Conjugated dienes: alicyclic, homoannular and heteroannular, extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.

5. Carbohydrates:

(4 Hours)

Classification and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, Osazone formation, Killiani Fischer synthesis.

Reference Books:

- 1. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009)
- 3. Undergraduate Physical Chemistry, Vol II, J.N. Gurtu, Pragati Prakashan.
- 4. Advanced Physical Chemistry, Gurtu and Gurtu, Pragati Prakashan
- 5. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
- 6. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 8. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 9. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.

- Berg, J. M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.Kemp, W. *Organic Spectroscopy*, Palgrave.
- 12. Pavia, D. L. et al. Introduction to Spectroscopy 5th Ed. Cengage Learning India
- 13. Silverstein, Bassler and Morill, *Spectrometric Identification of Organic Compounds* Ed. (2015).

SEMESTER III

CHEMISTRY-LAB

CORE COURSE: CHC103

(PHYSICAL CHEMISTRY AND ORGANIC CHEMISTRY)

Practicals: 60 Hours (02 Credits)

Section A: Physical Chemistry-2

(30 Hours: 01 credit)

12 Hours

Phase Equilibria

a)	To draw the phase diagram of the binary system - diphenyl amine and	dα – Naphthol
	and find the eutectic temperature.	(4 Hours)
b)	Study the mutual solubility of phenol and water at various temperate	ures and hence
	determine the critical solution temperature.	(4 Hours)
c)	Study the effect of addition of NaCl on critical solution temperature of	phenol water
	system and study of the effect of impurities on it	(A Hours)

system and study	y of the effect of impurities on it.	(4 110015)

Conductance	10 Hours
a) Determination of cell constant.	(2 Hours)
b) Determination of equivalent conductance, degree of dissociation and	dissociation
constant of a weak acid.	(4 Hours)
c) Conductometric titrations:	(4 Hours)
i. Strong acid vs. strong base	
ii. Weak acid vs. strong base	
Potentiometry	08 Hours
Potentiometric titrations	
i. Strong acid vs. strong base (Quinhydrone method)	(4 Hours)

ii. Potassium dichromate vs. Ferrous Ammonium sulphate (4 Hours)

Reference books:

- **1.** Systematic experimental physical Chemistry by S.W. Rajbhoj, Dr. T. K. Chondhekar, Anjali Publication, Aurangabad.
- 2. Practical Chemistry by O.P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication

 Khosla, B. D., Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Section B: Organic Chemistry - 3 (30 Hours: 1 Credit)

I) Systematic Qualitative Organic Analysis :

Analysis of Organic Compounds possessing monofunctional groups (carboxylic, aldehyde, ketone, amide, nitro, amines) and preparation of one derivative of each group. (Analysis of single compound and its derivative preparation)

II) Organ	(14 Hours)	
Synthesis,	yield, recrystallisation and Melting Point.	
(i) Hippu	ric acid from glycine (Benzoylation-Schotten Baumann reaction)	(4 Hours)
(ii) Osazo	one from Glucose (Nucleophilic addition)	(2 Hours)
(iii) Phtha	(4 Hours)	
(iv) Prepa	aration of Azo dye	(4 Hours)
III) Orga	nic Estimations: (Any 2)	(4 Hours)
(i)	Estimation of glycine by formylation method	(2 Hours)
(ii)	Estimation of Glucose by oxidation	(2 Hours)
(iii)	Estimation of Acetamide by hydrolysis	(2 Hours)

Reference Books:

Organic Chemistry

- 1. 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.
- 2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- 3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

(6x2 = 12 Hours)

ANNEXURE-Ib

SEMESTER III

SKILL ENHANCEMENT COURSE (SEC)

(4 Credits: Theory -03, Practical-01)

SKILL ENHANCEMENT COURSE: CHS101

NATURAL RESOURCES AND ANALYSIS

Theory: 45 Hours (03 Credits)

I. Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. 2 Hours

II. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, Producer gas and Water gas—composition and uses. Fractionation of coal tar, uses of coal tar, requisites of a good metallurgical coke, coal gasification (Hydro gasification and Catalytic gasification), coal liquefaction and solvent refining. **10 Hours**

III. Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its Derivatives. **10 Hours**

IV. Analysis of food products: Nutritional value of foods, idea about food processing and food preservation and adulteration.

a) Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder, pulses etc.

b) Analysis of preservatives and colouring matter. 10 Hours

V. Analysis of soil: Composition of soil, Concept of pH and pH measurement, complexometric titrations, chelation, chelating agents, use of indicators. **7 Hours**

VI. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. **6 Hours**

SEMESTER III

CHEMISTRY-LAB

SKILL ENHANCEMENT COURSE: CHS101

NATURAL RESOURCES AND ANALYSIS

Practicals: 30 Hours (01 Credit)

Instruction: Practicals/ demonstrations

1. Determination of pH of soil samples.	3 Hours
2. Determination of pH of a water samples	3 Hours
3. Estimation of Calcium and Magnesium ions as calcium carbonate by complexome	etric
titration. 4. Determination of dissolved oxygen (DO) in a given water sample.	6 Hours 4 Hours
5. Determination of acidity of a water sample	4 Hours
6. Determination of alkalinity in a given water sample	4 Hours
7. Measurement of dissolved CO ₂ .	4 Hours
8. Percentage of available chlorine in bleaching powder.	2 Hours

Reference Books for Theory and Practicals:

- 1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
 Jain, P.C. & Jain, M. Engineering Chemistry
- 4. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
- 5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- 6. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
- 7. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
- 8. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.

SEMESTER III

SKILL ENHANCEMENT COURSE (SEC)

(4 Credits: Theory-03, Practical-01)

SKILL ENHANCEMENT COURSE: CHS106

PHARMACEUTICAL CHEMISTRY AND INTELLECTUAL PROPERTY RIGHTS

Theory: 45 Hours (03 Credits)

Pharmaceutical Chemistry : History and Introduction:

Pharmaceutical Chemistry-Historical background of Drug discovery, design and development. Pharmacophore and Concept of structure-activity relationship. Main Classes of drugs with examples: anti-infective agents, cardiovascular agents, central nervous system agents, analgesics and anti-inflammatory agents, antibiotics and anti-HIV drugs. Basic Retrosynthetic approach with reference to Ibuprofen and Dapsone. (8 Hours)

IUPAC names, Synthesis and uses of representative drugs:

Synthesis of Aspirin, paracetamol, lbuprofen, Chloramphenicol, Sulphanethoxazole, Sulphacetamide,Trimethoprim, Acyclovir, Clotrimazole, Phenobarbital, Diazepam, Glyceryl trinitrate, Dapsone, metronidazole, AZT- Zidovudine. (8 Hours)

Mechanism of Action of representative drugs:

Analgesic and Anti-inflammatory drugs (Ibuprofen), Antilepral agent (Dapsone), Sulphonamides, antiamoebic (metronidazole), Central nervous depressant (Phenobarbital)

(6 Hours)

Structure Activity Relationship of representative drugs:

Analgesic and Anti-inflammatory drugs (Ibuprofen), Antilepral agent (Dapsone),
Sulphonamides (suphacetamide), antiamoebic (metronidazole), Central nervous depressant
(Phenobarbital), Antibiotic (Chloramphenicol), Antimalarial (Trimethoprim) (8 Hours)

Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP. **Copyrights:** Introduction, How to obtain, Differences from Patents.

Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, How to obtain, features, International design registration. Importance for pharmaceutical industry.

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involvedand legal aspects of Trade Secret Protection.(10 Hours)

Different International Agreements

World Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS) (iii) Madrid Protocol (iv) Berne Convention (v) Budapest Treaty. (3 Hours)

Indian Patent Act: Prior Art search for patents with an illustration. (2 Hours)

SEMESTER III

CHEMISTRY-LAB

SKILL ENHANCEMENT COURSE: CHS106

PHARMACEUTICAL CHEMISTRY AND INTELLECTUAL PROPERTY RIGHTS

Practicals: 30 Hours (01 Credit)

Ţ	Preparations (Each practical for four hours)(Any four)	(4x4=16 Hours)
	1)Aspirin 2) Benzimidazole 3) 2,4-diphenyl Quinoxaline	
	4) Benzocaine 5) Sulphacetamide	
Ι	I) Titrimetric Assay (Each practical for three hours)	(3x2=06 Hours)
	1. Assay of Aspirin 2) Assay of Ibuprofen	
2.	Patent filing application procedures with two exercises.	(2x2=4 Hours)
3.	Patent Prior Art search on pharmaceutical patent.	(4 Hours)

Reference Books for Theory and Practicals:

- 1. G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.
- 2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
- 3. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.
- 4. Wilson, Gisvold and Doerge Textbook of Organic, Medicinal and Pharmaceutical Chemistry.
- 5. Lednicer and Meischer, Organic Chemistry of Drug Synthesis. Vol. I to III. John Wiley & Sons, 2005.
- 6. Medicinal Chemistry, D. Shriram, P. Yogeshwari, Pearson Education, 2007.
- 7. Medicinal Chemistry-Burger, John Wiley & Sons N.Y,1997.
- 8. Medicinal Chemistry, Chatwal, Himalaya Publishing house, 2002.
- 9. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
- 10. Manjula Guru & M.B. Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
- 11. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
- 12. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
- 13. Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.
- 14. Indian Pharmacopoiea, latest edition.

ANNEXURE-Ic

Syllabus of B.Sc. CHEMISTRY

SEMESTER IV

CORE COURSE: CHC104

(6 Credits: Theory-04, Practicals-02)

(PHYSICAL CHEMISTRY AND INORGANIC CHEMISTRY)

Theory: 60 Hours (04 Credits)

Section A: Physical Chemistry-3

(30 Hours; 02 credits)

(8 Hours)

1. Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms for CO₂. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation), collision number, collision frequency, collision diameter and mean free path of molecules.

2. Liquids

Surface tension and its determination using stalagmometer. Effect of temperature on surface tension. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer and factors affecting viscosity.

3. Solids

Forms of solids, symmetry elements, unit cells, crystal systems, Bravais lattice. Laws of crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices, X–Ray diffraction by crystals, Bragg's law. Particle size determination using powder method. Structures of NaCl, KCl and CsCl (qualitative treatment only).

(6 Hours)

(8 Hours)

General characteristic properties of 3d series with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties. Ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanides: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Actinides : Electronic configuration and General characteristics.

2. Coordination Chemistry

IUPAC system of nomenclature. Bonding in complexes based on Valence Bond Theory (VBT), Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Different types of structural and stereo-isomerism including optical isomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.

3. Crystal Field Theory

Crystal field splitting in octahedral complexes. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Spectrochemical series. Crystal Field Splitting in Tetrahedral complexes. Calculation of CFSE. Comparison of CFSE for Oh and Td complexes. Factors affecting the magnitude of 10Dq. Merits and Demerits of Crystal Field Theory.

4. Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure and catalyst on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Section B: Inorganic Chemistry-2

1. Transition Elements

(8 Hours)

(10 Hours)

(10 Hours)

(10 Hours)

(30 hour: 02 credits)

Reference Books:

Physical Chemistry

- 1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- 2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- 4. Essentials of Physical Chemistry by A. Bahl and G.D. Tuli, S. Chand Publication,
- 5. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- 6. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- 7. Undergraduate Physical Chemistry, Vol II, J.N. Gurtu, Pragati Prakashan.
- 8. Advanced Physical Chemistry, Gurtu and Gurtu, Pragati Prakashan

Inorganic Chemistry

- 1. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.
- 2. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
- 3. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
- 4. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- 6. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- 7. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
- 8. Principles of Inorganic chemistry by B.R. Puri, S. Sharma and Kalia, Vallabh Publication.
- 9. Inorganic Chemistry Principles of Structure and Reactivity James E Huheey, Ellen A. Keiter, Richard L.Keiter, Okhil K Medhi.

SEMESTER IV

CHEMISTRY-LAB

CORE COURSE: CHC104

(PHYSICAL CHEMISTRY AND INORGANIC CHEMISTRY)

Practicals: 60 Hours (02 Credits)

Section A: Physical Chemistry-3

1. Surface tension measurement

Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

2. Solutions of Solids in Liquids

Determine solubility curve for KCl from 25° C to 50° C.

3. Viscosity measurement

- Determination of the viscosity of a liquid or dilute solution using an Ostwald's a) viscometer.
- b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

4. Chemical Kinetics

- 1. To determine the rate constant and order of reaction between KI and $K_2S_2O_8$.
- 2. Study of saponification of ethyl acetate with sodium hydroxide at equal concentration of ester and alkali.

3. Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate.

Section B: Inorganic Chemistry-2

I. Semi-micro qualitative analysis: not more than four ionic species (two anions and two cations): (4 Mixtures) $(4 \times 3 = 12 \text{ Hours})$

Cations : NH_4^+ , Pb^{2+} , Ag^+ , Bi^{3+} , Cu^{2+} , Cd^{2+} , Sn^{2+} , Fe^{3+} , Al^{3+} , Co^{2+} , Cr^{3+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Zn^{2+} , Ni^{2+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Zn^{2+} , Ni^{2+} , NBa²⁺, Sr²⁺, Ca²⁺, K⁺. **Anions** : CO₃²⁻, S²⁻, SO₂⁻, SO₄²⁻, NO₃⁻, Cl⁻, Br⁻, Γ, NO₂⁻, PO₄³⁻, F⁻

(Spot tests should be carried out wherever feasible)

II. **GRAVIMETRIC/VOLUMETRIC**

1. Estimate the amount of Nickel present in a given solution as bis(dimethylglyoximato) Nickel(II) in a given solution gravimetrically by counterpoise filter paper.

Page 18

(3 HOURS : 01 Credit)

 $(4 \times 3 = 12 \text{ Hours})$

(4 Hours)

(10 Hours)

(12 Hours)

(4 Hours)

(30 HOURS: 01 Credit)

- 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
- 3. To estimate the amount of Bismuth present in the given solution of Bi(NO₃)₂.3H₂O by complexometric titration.
- 4. To estimate the amount of Nitrite present in the given NaNO₂ solution by titrating v/s Ceric ammmonium sulphate / Ceric sulphate.

III.COLORIMETRIC EXPERIMENTS(2x 3 = 06 Hours)

- 1. Draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound (KMnO₄/ CuSO₄) and estimate the concentration of the same in a given solution.
- 2. Determine the composition of the Fe³⁺-salicylic acid complex solution by Job's method.

Reference Books: (Physical Chemistry)

- 1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- 2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.
- 1. Chand & Co.: New Delhi (2011).
- 2. Systematic experimental physical Chemistry by S.W. Rajbhoj, Dr. T. K. Chondhekar, Anjali Publication
- 3. Practical Chemistry by O.P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication
- 4. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg, A. Gulati, R. Chand & Comp, New-Delhi

Reference Books: (Inorganic Chemistry)

- 1. Svehla, G., Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

ANNEXURE - Id SEMESTER IV SKILL ENHANCEMENT COURSE (SEC) (4 Credits: Theory-03, Practical-01)

SKILL ENHANCEMENT COURSE: CHS102 CHEMISTRY OF COSMETICS AND PERFUMES

Theory: 45 Hours (03Credits)

1. Cosmetic Formulation, principles and preparations

Introduction to cosmeticology. Definition of cosmetics as per EU and Indian guidelines. Cleansing and care needs for face, eye lids, lips, hands, feet, nail, scalp, neck, body, and underarms. Examples of marketed products. A general study including preparation and uses of the following: Hair dye, hair spray, sunscreen lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving), Formulation, preparation and packaging of cosmetics for hair - Shampoo and conditioners. Examples from marketed products.

2. Herbal Cosmetics

Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Classification of herbal cosmetics. Development of Ayurvedic and Herbal formulations and their evaluation by physical methods, chemical methods and microscopical techniques. Herbal cosmetics for skin care (lotions, vanishing cream, foundation creams, anti sunburn preparations, face packs, lipsticks, face powders, soaps). Herbal cosmetics for hair care: Henna and Hibiscus.

3. Perfumes and Flavors

Classification of perfumes. Perfume ingredients listed as allergens. Deodorants, antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone. Volatile Oils : General methods of obtaining volatile oils from plants; Study of volatile oils of Mentha, Lemon peel, Orange peel, Lemon grass, Eucalyptus, Musk, Sandal wood.

15 Hours

15 Hours

15 Hours

SEMESTER IV

CHEMISTRY-LAB

SKILL ENHANCEMENT COURSE: CHS102

CHEMISTRY OF COSMETICS AND PERFUMES

Practicals: 30 HOURS (01 CREDIT)

Demonstration/Practicals (Any Ten)

- 1. Preparation of talcum powder.
- 2. Preparation of shampoo.
- 3. Preparation of enamels.
- 4. Preparation of hair remover.
- 5. Preparation of cold cream.
- 6. Preparation of nail polish and nail polish remover.
- 7. Preparation of vanishing cream.
- 8. Preparation of shaving cream.
- 9. Herbal preparations and evaluations of lotions.
- 10. Herbal preparations and evaluations of face packs.
- 11. Herbal preparations and evaluations of soaps.
- 12. Extraction of volatile oil from lemon peel.
- 13. Extraction of volatile oil from lemon grass.
- 14. Extraction of volatile oil from orange peel.

Reference Books:

- 1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- 2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- 3. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
- 4. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK. 65.
- 5. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
- 6. Keith Wilson and John Walker: Practical Biochemistry.
- 7. Thomas M. Devlin: Textbook of Biochemistry.
- 8. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed.PHI Learning.
- 9. Text book of herbal cosmetics by Vimaladevi M. CBS Publishing 1st Ed. 2015.
- 10. The complete technology book on herbal beauty products with formulation and processes by H. Panda, Asia pacific business press Inc. 2005.
- 11. Essential oils: A practical guide by John Gordon, Aetheric publishing.

3 x 10 = 30 Hours

SEMESTER IV

SKILL ENHANCEMENT COURSE (SEC) (4 Credits: Theory-03, Practical-01)

SKILL ENHANCEMENT COURSE: CHS107

ADVANCES IN ENERGY TECHNOLOGY

Theory: 45 HOURS (03 Credits)

1. INTRODUCTION

1.1 Man and Energy

- 1.2 Chemical Energy System, Electrochemical energy system.
- 1.3 Resources and energy: Natural resources- energy environment triangle, energy problem, World energy resources, Energy conversion, Energy conversion processes.
- 1.4 Future Energy Resources.

2. <u>CHEMICAL ENERGY SOURCES</u>

- 2.1 Petroleum: Origin, nature of sources of material for crude oil, composition of petroleum, refining of petroleum, products derived from petroleum.
- 2.2 Natural gas: Occurrence, natural gas liquid.
- 2.3 Coal: Origin, constitution of coal, coal gasification, and indirect liquification, purification of synthesis gas. Coal combustion, chemical obtained from coal.
- 2.4 Nuclear Fission: Power from nuclear fission, heavy water reactor (HWRs) fast breeder reactors (FBRs)
- 2.5 Nuclear Fusion: Cold fusion

3. <u>ELECTROCHEMICAL ENERGY SYSTEM</u>:

- 3.1 Introduction, fundamentals of batteries, choice of materials, classification of batteries, sizes of batteries.
- 3.2 Some common batteries: Button cells, Portable equipment batteries, SLI batteries, Vehicle traction batteries, Stationary batteries, Battery characteristic power density.
- 3.3 Primary batteries: Combination of materials for a primary battery, alkaline MnO₂ batteries performance and advantages, secondary batteries.
- 3.4 Types and classification, sealed storage batteries, metal hydride electrode.

4. <u>FUEL CELLS</u>:

- 4.1 Introduction, Classification, Choice of electrolyte. Electrodes and requirement of Electrocatalysis.
- 4.2 Use of Carbon in fuel cells, fuel cells using carbon nanomaterials
- 4.3 Biochemical fuel cells, classification ,mechanism and applications

16 Hours

07 Hours

12 Hours

5 Hours

16 Hours

5. <u>SOLAR ENERGY</u>:

- 5.1 Photochemical and photogalvanic conversion.
- 5.2 Hydrogen energy: Merits of hydrogen fuel cell, Hydrogen economy concept, Photo assisted electrolysis of water.
- 5.3 Miscellaneous Sources: Tidal Energy, Geothermal Energy

References:

- 1. R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy Systems, University Press, 1998.
- 2. C. Vincent and B. Scrosati, Modern Batteries, An introduction to Electrochemical Power Sources, Arnold, 1997.
- 3. M. Sharon and M. Sharon, Nano Forms of Carbon and its Application, Monad Nano Tech, Mumbai, 2007.
- 4. R. Probstein and R. Hicks, **Synthetic Fuels**, Mc Graw Hill, 1985.
- 5. International Journal of Hydrogen Energy 16, 35-45 (1991)
- 6. S. Manahan, Fundamentals of Environmental Chemistry, Lewis Publication, New York, 1993.
- 7. S. P. Sukhatme, Solar Energy Principles of Thermal Collection and Storage , Tata McGraw Hill, 2006.

SEMESTER IV

CHEMISTRY-LAB

SKILL ENHANCEMENT COURSE : CHS107

ADVANCES IN ENERGY TECHNOLOGY

Practicals: 30 HOURS (01 Credit)

A. Electrochemical Energy

1. Construct a Daniel cell and determine the voltage of the cell at varying concentrat	ion. (4 Hours)
2. Determination of electrochemical equivalent of copper	(4 Hours)
B. Supports for Electro-catalyst	
1. Preparation of Carbon (from Coconut shell) and determination of surface area usi volumetric method.	ng (4 Hours)
2. Verification of Fruendlich adsorption isotherm of Coconut shell Carbon.	(4 Hours)
C. Photochemical Energy	
1. Extraction of photosynthetic pigments from different parts of the plants and its iden from absorption wavelength (2 samples to be studied)	ntification (4 Hours)
2. Kinetics of photochemical reactions between iodine and oxalate using visible light (Colorimetrically)	(4 Hours)
D. Sources of Chemical Energy	
1. Determination of moisture content in the sample of coal/ charcoal.	(2 Hours)
2. Determination of sulphur and ash content in the sample of Coal/Charcoal.	(4 Hours)

References:

- 1. O. P. Virmani and A.K. Narula, Applied Chemistry theory and Practice, New Age, International Publishers, IInd Edition.
- 2. Robert Bruce Thompson, Illustrated Guide to Home Chemistry Experiments O'Reilly Media. Inc.
- 3. S. W. Rajbhoj and Dr. T. K. Chondhekar, Systemetic Experimental Physical Chemistry, Anjali Publication Aurangabad.

ANNEXURE II

Pattern of Question papers

for

Semester End Examination (SEE)

and

Scheme of marking

ANNEXURE- IIa : Pattern for Semester III and Semester IV Core Course (CC)

SEE Question Papers of B.Sc. With Chemistry Programme

Semester III	CHC103	for 4 credits
Semester IV	СНС104	. for 4 credits

ANNEXURE -IIb: Pattern for Semester III and Semester IV

Skill Enhancement Course (SEC)

Semester III	CHS101 for 3 credits
	OR
	CHS106 for 3 credits
Semester IV	CHS102 for 3 credits
	OR
	CHS107 for 3 credits

ANNEXURE - IIa

SEMESTER III

CORE COURSE: CHC103

(Credits: Theory-04, Practicals-02)

(PHYSICAL CHEMISTRY AND ORGANIC CHEMISTRY)

Time Duration: 2 Hours	Total Marks: 80
Section A: Physical Chemistry-2 Q.1.Answer any five of the following:	<i>Marks: 40</i> (2x5=10 marks)
i) Solutions.	
ii) Phase Equilibria.	
iii) Conductance.	
iv) Electrochemistry.	
v) Solutions.	
vi) Phase Equilibria.	
vii)Electrochemistry.	
Q.2.A. i) Solutions.	4 marks
ii) Phase Equilibria.	3 marks
	OR
Q.2.A. iii) Solutions .	4 marks
iv) Phase Equilibria.	3 marks
Q.2.B. i) Electrochemistry.	4 marks
ii) Electrochemistry	4 marks
Q.3.A.i) Conductance.	4 marks
ii) Electrochemistry.	3 marks
	OR
Q.3.A. iii) Conductance.	4 marks
iv) Electrochemistry.	3 marks
Q.3.B. i) PhaseEquilibria	4 marks
ii)Solutions	4 marks

Section B: Organic Chemistry-3	Marks: 40
Q.4. Answer any five questions of the following .:	(2 x 5=10 marks)
i) Carboxylic Acids and derivatives.	
ii) Amines and Diazonium salts	
iii) Amino acids ,Peptides and Proteins	
iv) Carbohydrates	
v) Amines and Diazonium salts	
vi) UV – Visible Spectroscopy in Organic Chemistry	
vii)Carbohydrates	
Q.5.A. i) UV –Visible Spectroscopy in Organic Chemistry	4 marks
ii) Carboxylic acids and derivatives	3 marks
OR	
iii) Carbohydrates	4 marks
iv) Amino acids, Peptides and Proteins	3 marks
Q.5.B. i) UV-Visible Spectroscopy in Organic Chemistry	4 marks
ii) Carboxylic acids and derivatives	4 marks
Q.6.A. i) Amino acids ,Peptides and Proteins	4 marks
ii) UV-Visible Spectroscopy in Organic Chemistry	3 marks
OR	
iii) Amines and diazonium salts	4 marks
iv) Amino acids ,Peptides and Proteins	3 marks
Q.6.B. i) Amines and Diazonium salts	4 marks
ii) UV-Visible Spectroscopy in Organic Chemistry	4 Marks

SEMESTER IV

CORE COURSE: CHC104

(Credits: Theory-04, Practicals-02)

(PHYSICAL CHEMISTRY AND INORGANIC CHEMISTRY)

Time Duration : 2 Hours	Total Marks: 80
Section A: Physical Chemistry-3	Marks: 40
Q.1.Answer any five of the following:	(2x5=10 marks)
 i) Kinetic Theory of Gases. ii) Liquids. iii) Solids. iv) Chemical Kinetics. v) Kinetic Theory of Gases Solutions. vi) Solids. vii) Chemical Kinetics. 	
Q.2.A. i) Kinetic Theory of Gases.	4 marks
ii) Liquids.	3 marks
OR	
Q.2.A. iii) Kinetic Theory of Gases .	4 marks
iv) Liquids .	3 marks
Q.2.B. i) Chemical Kinetics.	4 marks
ii) Solids.	4 marks
Q.3.A.i) Chemical Kinetics.	4 marks
ii) Solids.	3 marks
OR	
Q.3.A. iii) Chemical Kinetics.	4 marks
iv) Solids.	3 marks
Q.3.B. i) Kinetic Theory of Gases	4 marks
ii) Liquids	4 marks

SECTION B : Inorganic Chemistry-2	Marks : 40
Q.1. Answer any five from the following	(2x5 = 10 marks)
i) Transition Elements	
ii) Transition Elements	
iii Transition Elements	
iv) Coordination Chemistry	
v) Coordination Chemistry	
vi) Crystal Field Theory	
vii) Crystal Field Theory	
Q.2. A. Answer the following	
i) Transition Elements	4 marks
ii) Coordination Chemistry	3 marks
OR	
Q.2. A. iii) Transition Elements	4 marks
iv) Coordination Chemistry	3 marks
Q.2.B. i) Crystal Field Theory	4 marks
ii) Coordination Chemistry	4 Marks
Q.3. A. Answer the following	
i) Crystal Field Theory	4 marks
ii) Transition Elements	3 marks
OR	
Q.3. A. iii) Crystal Field Theory	4 marks
iv) Transition Elements	3 marks
Q.3.B i) Coordination Chemistry	4 marks
ii) Crystal Field Theory	4 marks

ANNEXURE – IIb SEMESTER III <u>NATURAL RESOURCES AND ANALYSIS</u> SKILL ENHANCEMENT COURSE: CHS101 (4Credits: Theory-03, Practicals-01)

Time Duration: 2 Hours

Total Marks: 60

Q.1. A	nswer any ten the following:	(2x10= 20 marks)
i)	Review of energy sources	
ii)	Review of energy sources	
iii)	Coal	
iv)	Coal	
v)	Coal	
vi)	Petroleum and petroleum industry	
vii)	Petroleum and petroleum industry	
viii)	Petroleum and petroleum industry	
ix)	Analysis of food products	
x)	Analysis of food products	
xi)	Analysis of soil	
xii)	Analysis of soil	
xiii)	Analysis of water	
xiv)	Analysis of water	
Q.2 A.	i) Coal	3 marks
	ii) Petroleum and petroleum industry	2 marks
	OR	
Q.2 A.	iii) Petroleum and petroleum industry	3 marks
	iv) Coal	2 marks
Q.2 B.	i) Coal	3 marks
	ii) Petroleum and petroleum industry	2 marks
Q.3 A	. i) Analysis of food products	3 marks
	ii) Analysis of water	2 marks
	OR	
Q.3 A	A. iii) Analysis of food products	3 marks

	iv) Analysis of soil	2 marks	
Q.3 B.	i) Analysis of soil	3 marks	
	ii) Analysis of water	2 marks	
Q.4 A.	i) Analysis of water	3 marks	
	ii) Analysis of soil	2 marks	
	OR		
	iii) Analysis of water	3 marks	
	iv) Petroleum and petroleum industry	2 marks	
Q.4 B.	i) Analysis of soil	3 marks	
	ii) Analysis of water	2 marks	
Q.5 A.	i) Analysis of food products	3 marks	
	ii) Analysis of water	2 marks	
	OR		

Q.5 A.	iii) Coal	3 marks
	iv) Petroleum and petroleum industry	2 marks
Q.5 B.	i) Analysis of soil	3 marks
	ii) Analysis of food products	2 marks

SEMESTER III

PHARMACEUTICAL CHEMISTRY AND INTELLECTUAL PROPERTY RIGHTS

SKILL ENHANCEMENT COURSE: CHS106

(4Credits: Theory-03, Practicals-01)

Time Duration: 2 Hours 60

Total Marks:

(2x10=20 marks)

Q.1. Answer **any ten** of the following.

- i) Pharmaceutical Chemistry: History and Introduction
- ii) IUPAC names, Synthesis and uses of representative drugs
- Mechanism of Action of representative drugs iii)
- Structure Activity Relationship of representative drugs iv)
- v) Introduction to Intellectual Property
- vi) Different International Agreements
- vii) Introduction to Intellectual Property
- viii) Pharmaceutical Chemistry: History and Introduction
- ix) IUPAC names, Synthesis and uses of representative drugs
- x) Mechanism of Action of representative drugs
- Structure Activity Relationship of representative drugs xi)
- xii) Pharmaceutical Chemistry: History and Introduction.
- xiii) Introduction to Intellectual Property.
- xiv) IUPAC names, Synthesis and uses of representative drugs

Q2. A) i) IUPAC names, Synthesis and uses of representative drugs	3 marks
ii) Introduction to Intellectual Property	2 marks

ii) Introduction to Intellectual Property

OR

A) iii) Structure Activity Relationship of representative drugs	
iv) Mechanism of Action of representative drugs	2 marks
B) i) Introduction to Intellectual Property	3 marks
ii) Pharmaceutical Chemistry: History and Introduction	2 marks
Q3. A) i) IUPAC names, Synthesis and uses of representative drugs	3 marks

ii) Introduction to Intellectual Property	2 marks	
OR		
A) iii) Structure Activity Relationship of representative drugs.	3 marks	
iv) Pharmaceutical Chemistry: History and Introduction.	2 marks	
B) i) Mechanism of Action of representative drugs.	3 marks	
ii) Indian Patent Act.	2 marks	
Q4. A) i) Introduction to Intellectual Property	3 marks	
ii) Indian Patent Act.	2marks	
OR		
A) iii) Pharmaceutical Chemistry: History and Introduction.	3 marks	
iv) Different International Agreements	2 marks	
B) i) Structure Activity Relationship of representative drugs.	3marks	
ii) IUPAC names, Synthesis and uses of representative drugs	2 marks	
Q5. A) i) Mechanism of Action of representative drugs	3 marks	
ii) Introduction to Intellectual Property	2marks	
OR		
A) iii) Pharmaceutical Chemistry: History and Introduction.	3 marks	
iv) IUPAC names, Synthesis and uses of representative drugs	2 marks	
B) i) Structure Activity Relationship of representative drugs.	3marks	
ii) Different International Agreements	2 marks	

SEMESTER IV

CHEMISTRY OF COSMETICS AND PERFUMES

SKILL ENHANCEMENT COURSE: CHS102

(4 Credits : Theory -03, Practical-01)

Time Duration : 2 Hours

Tim	e Duration : 2 Hours	Total Marks : 60
Q.1)	Answer any ten the following:	(2 x10 =20 marks)
i)	Cosmetic Formulation, principles and preparations.	
ii)	Cosmetic Formulation, principles and preparations.	
iii)	Cosmetic Formulation, principles and preparations.	
iv)	Cosmetic Formulation, principles and preparations.	
v)	Herbal Cosmetics.	
vi)	Herbal Cosmetics.	
vii)	Herbal Cosmetics.	
viii)	Herbal Cosmetics.	
ix)	Perfumes and flavors.	
x)	Perfumes and flavors.	
xi)	Perfumes and flavors.	
xii)	Perfumes and flavors.	
xiii)	Herbal Cosmetics	
xiv)	Perfumes and Flavors	
Q. 2)	A) i) Cosmetics formulation, principles and preparations.	3 marks
	ii) Cosmetics formulation, principles and preparations.	2 marks
	OR	
	iii) Cosmetics formulation, principles and preparations.	3 marks
	iv) Cosmetics formulation, principles and preparations.	2 marks
2	B) i) Herbal cosmetics.	5 marks
Q.3)	A) i) Herbal Cosmetics.	3 marks
	ii) Herbal Cosmetics.	2 marks

iii) Herbal Cosmetics.	3 marks
iv) Herbal Cosmetics.	2 marks
Q.3) B) i) Perfumes and flavors.	5 marks
Q.4) A) i) Perfumes and flavors.	3marks
ii) Perfumes and flavors	2marks
OR	
iii) Perfumes and flavors.	3 marks
iv) Perfumes and flavors.	2 marks
Q. 4) B) i) Cosmetics formulation, principles and preparations.	5 marks
Q. 5) A) i) Cosmetics formulation, principles and preparations.	3 marks
ii) Herbal Cosmetics.	2 marks
OR	
iii) Perfumes and flavors.	3 marks
iv) Cosmetics formulation, principles and preparations.	2 marks
Q.5) B) i) Herbal Cosmetics / Perfumes and flavors.	5 marks

SEMESTER III

ADVANCES IN ENERGY TECHNOLOGY

SKILL ENHANCEMENT COURSE: CHS107

(4 Credits: Theory -03, Practical-01)

Time Duration : 2 Hours	Total marks: 60
Q. 1. Answer <u>any ten of the following</u> :	(2x10 = 20 marks)
 i) Introduction ii) Chemical energies sources iii) Electrochemical energy system iv) Fuel cells v) Solar energy vi) Chemical energies sources vii) Electrochemical energy system viii) Fuel cells ix) Solar energy x) Chemical energies sources xi) Electrochemical energy system xii) Fuel cells 	
xiii) Solar energy	
xiv) IntroductionQ2. A) i) Chemical energies sourcesii) Electrochemical energy system	3marks 2 marks
OR	
iii) Chemical energies sources	3 marks
iv) Electrochemical energy system	2 marks
Q2. B) i) Solar Energy	3 marks
ii) Fuel Cells	2 marks
Q3. A) i) Chemical energies sources	3 marks
ii)Solar Energy	2 marks

OR

iii) Chemical energies sources		3 marks
iv)Solar Energy		2 marks
Q3. B) i) Electrochemical energy system		3 marks
ii) Introduction		2 marks
Q4. A) i) Electrochemical energy system		3 marks
ii)Solar Energy		2 marks
	OR	
iii) Electrochemical energy system		3 marks
iv)Solar Energy		2 marks
Q4 B) i) Chemical energies sources		3 marks
ii) Fuel Cells		2 marks
Q5. A)i) Chemical energies sources		3 marks
ii) Fuel Cells		2 marks
	OR	
iii) Chemical energies sources		3 marks
iv) Fuel Cells		2 marks
Q5. B) i) Electrochemical energy system		3 marks
ii) Solar Energy		2 marks

ANNEXURE III

Laboratory Exercises, Marks distribution and duration of time for Practical Examinations

ANNEXURE- IIIa : For Semester III and Semester IV Core Course (CC)-LAB

of B.Sc. with Chemistry Programme.1 paper per Semester

.....2 credits

ANNEXURE- IIIb: For Semester III and Semester IV Skill Enhancement Course (SEC) - LAB of B.Sc. with Chemistry Programme...... 1 paper per Semester

.....1 credit

ANNEXURE -IIIa SEMESTER III CORE COURSE: CHC103 (PHYSICAL CHEMISTRY AND ORGANIC CHEMISTRY)

Time duration: 6 Hours (02 Credits)

Total Marks: 50

Section A: Physical Chemistry	
Time duration: 3 Hours(01 Credit)	Marks : 25
Experiment: (Any one experiment may be given)	15 marks
Marks allotted to the experiment	
(Systematic work-2 marks, Observation- 6 marks, Calculation and graphs	s- 7 marks)
Journal:	5 marks
Oral :	5 marks

Section B: Organic Chemistry

Time duration: 3 Hours (01 Credit)	Marks: 25
Experiment : Organic spotting to be given for the examination	15 marks
(Preliminary tests- 2 marks, chemical type -2 marks, detection of elements-	2 marks,
functional group tests- 2marks, m.p./b.p- 2 marks, Systematic work-3 marks,	, result-2 marks)
Journal:	5 marks
Oral:	5 marks

NOTE: For <u>Journal marks</u> Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate.

SEMESTER IV

CORE COURSE: CHC104

(PHYSICAL CHEMISTRY AND INORGANIC CHEMISTRY)

Time Duration: 6 Hours (02 Credits)	Total Marks :50	
Section A: Physical Chemistry		
Time duration: 3 Hours (01 Credit) Experiment (Any one experiment may be given).		Marks : 25 15marks
Marks allotted to the experiment		
(Systematic work-2 marks, Observation: 6 marks	, Calculation an	d graphs: 7 marks)
Journal:		5 marks
Oral:		5 marks
Section B : Inorganic Chemistry Time Duration: 3 Hours (01 Credit)		Marks: 25
Any one experiment from the following to be give	en	
Semi-Micro Analysis: One Salt containing one ca	tion and one ani	on15 marks
Probable Radicals	: 3 Marks	
Anion	: 4 Marks	
Cation	: 5 Marks	
Systematic work	: 3 marks	
OR		
Volumetric Analysis		15 marks
Result	: 10 ma	arks
Systematic work	: 3 mai	*KS
Calculations	: 2 mai	KS 5 montra
L Irai		

<u>NOTE</u>: For <u>Journal marks</u>, Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate

ANNEXURE - IIIb

SEMESTER III

SKILL ENHANCEMENT COURSE (SEC)

COURSE: CHS101

NATURAL RESOURCES AND ANALYSIS

Time Duration: 3 Hours (01 Credit)

Total Marks :25

Experiment (Any one experiment may be g	given) 15 marks
Break up : Preliminary test/ arrangements	02 marks
Experimental reading	08 marks
Systematic presentation	02 marks
Results	03 marks
Oral :	5 marks
Journal :	5 marks

<u>NOTE</u>: For <u>Journal marks</u>, Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate

SEMESTER III

SKILL ENHANCEMENT COURSE (SEC)

COURSE: CHS106

PHARMACEUTICAL CHEMISTRY AND INTELLECTUAL PROPERTY RIGHTS

Time Duration:3 Hours(01 Credit)Total Marks: 25

 Experiment: One experiment on Preparation or Assay of drug
 10 marks

 For preparation (Systematic work 2marks , product quality 3marks , % yield-3 marks, m.p -2marks)

 For Assay (Systematic work 2marks, readings 3marks , Calculation-3 marks, result -2marks)

 Patent filing application exercise:

 Journal :
 5 marks

 Oral:
 5 marks

<u>NOTE</u>: For <u>Journal marks</u>, Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate

SEMESTER IV

SKILL ENHANCEMENT COURSE (SEC)

COURSE : CHS102

CHEMISTRY OF COSMETICS AND PERFUMES

Time Duration: 3 Hours (01 Credit)	Marks : 25
1) Experiment No 1: Any one experiment from Preparations/Extraction	n can be given
for examination.	15 marks
2) Preparations : (Product-5 marks, Systematic work-2 marks, Qua	llity-3 marks,
Calculations-3 marks, Results-2 n	narks)
2) Extraction : (Product-5 marks, Systematic work-2 marks, Qualit	y-3 marks,
Boiling points-3 marks, Results-2 marks)	
3) Journal:	5 marks
4) Oral :	5 marks

<u>NOTE</u>: For <u>Journal marks</u>, Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate

SEMESTER IV

SKILL ENHANCEMENT COURSE (SEC)

COURSE : CHS107

ADVANCES IN ENERGY TECHNOLOGY

Time Duration : 3 Hours(01 Credit)

Total marks: 25

Any one experiment could be performed	
Experiment :	15 marks
Experimental Work: 8 marks, observation= 3 marks, calculations = 4 marks	
Journal :	5 marks
Oral :	5 marks

<u>NOTE</u>: For <u>Journal marks</u>, Examiner(s) shall take into account the regularity of the candidate in attending the Laboratory course, completeness of the exercises, presentation and style of writing the journal.

For <u>Oral examination</u>, Examiner(s) shall assess the knowledge of the candidate in the course as well as the experiment(s) performed by the candidate

ANNEXURE IV

ANNEXURE-IVa:	Syllabus	for	Semester	Ι	Generic	Elective	(GE)	of
Chemistry				••••		(1	l Course	e)
							CHG1)3

ANNEXURE-IVb:	Syllabus	for	Semester	II	Generic	Elective	(GE)	of
Chemistry		••••••		•••••			(1 Cour	se)

CHG104

SEMESTER I GENERIC ELECTIVE:CHG103 (Credits: 04)

ANNEXURE-IVa

BASIC CHEMISTRY AND INDIAN SCIENTISTS

Theory: (04 Credits)

1. Importance of science in life.

Towards scientific approach, involvement of science in daily life, Different branches

of science : significance and applications.

(Viz: chemistry, physics, biology, microbiology, medical science etc.)

2. Indian Scientists : Who have made great contributions to science and cemented the way for others to walk on. (9 Hours)

1) Anandibai Joshi - Physician (1865 - 1887).

2) Janaki Ammal - Botanist (1897 - 1984).

3) Kamala Sohonie – Bio-chemist (1912 – 1998).

- 4) Anna Mani Physicist and meteorologist (1918-2001).
- 5) Asmita Chatterjee Chemist and Author (1917 2006).
- 6) Rajeshwari Chatterjee Scientist and Academic (1922-2010).
- 7) Darshan Ranganathan Org. Chemist (1941 2001).
- 8) Prof. C. V. Raman Physcist and Nobel laureate (1888-1970).
- 9) Dr. Jagdish Chandra Bose Physicist (1858-1937).
- 10) Dr. A.P. J. Abdul Kalam Missile Man of India (1931-2015)

3. Basic Organic Chemistry.

Different branches of chemistry, introduction to organic chemistry, classification of Organic compounds and example of each. Importance of organic chemistry in day to day life; toothpastes, soaps, shampoos, cosmetics, drugs, dyes and paints.

Page 46

(9 Hours)

(4 Hours)

60 Hours

4. Hydrogen and Water:

Hydrogen: chemistry of hydrogen, the hydrogen economy.

Water: water cycle, domestic and industrial water supplies. Water as a solvent, chemical and physical test of water. Hard and Soft water.

5. Oxygen and Sulphur:

Air as a resource, properties of oxygen, fire triangle, combustion and respiration. Sources of sulphur: Volcanic regions, oil, gas and minerals. Allotropes of sulphur, oxides of sulphur, use of sulphuric acid.

6. Carbon and Nitrogen:

Carbon in air, carbon cycle, removal of carbon dioxide, production of carbon dioxide, oxides of carbon, carbon monoxide, applications of carbon. Nitrogen cycle, properties of nitrogen, manufacture of ammonia and nitric acid,

Uses of ammonia.

7. Halogens and Noble gases:

Halogens: Similarities and applications. Noble gases; Properties and Uses.

8. Chemistry & Industry :

Minerals and ores: General Awareness

Chemical plants: Cost, Environmental impact and recycling.

References:

1) Chemistry by Richard Harwood ,Cambridge University press.published 1998

- 2) First lady doctor of India. The Telegraph . Retrieved 2016-05-01.
- 3) Lilavati's Daughter's by Indian Academy of Sciences (Bangalore) 2008.
- 4) Organic Chemistry. Morrison, Boyd, Bhattacharjee. Seventh Edition. Pearson.
- 5) Wings of fire: An Autobiography by A. P. J. Abdul Kalam. Orient blackswan.
- 6) Jagdish Chandra Bose by Sanjay Goyal.
- 7) Prof. C. V. Raman: A biography by Uma Parameswaran. Ed.2011, Penguin.

(8 Hours)

(8 Hours)

(10 Hours)

(6 Hours)

(6 Hours)

Goa University, Taleigao Plateau, Goa.

ANNEXURE - IVb

SEMESTER II

GENERIC ELECTIVE: CHG104

(Credits: 04)

CHEMISTRY IN DAILY LIFE

Theory: (04 Credits)

1. Different techniques in Chemistry

Introduction: Discoveries of different techniques and their applications, viz. purification techniques: distillation, recrystallization, chromatography. X-ray and radioactivity.

2. Organic Chemistry in medical sciences.

Introduction to Pharmaceutical chemistry, Classification of Drugs, names and uses of the following drugs with one example each: Antibiotics, Analgesics, Antihistamines, Anticonvulsant, Hypnotics and Sedatives.

3. Medicinal plants.

Introduction: Importance of plant kingdom in general and medicinal plants in particular. Viz. Tulsi, Aloevera, Turmeric, Vinca rosea, Cinchona, Datura etc. Compounds obtained from them, their uses and applications.

4. Cellulose and starch.

Cellulose: General properties. Various compounds obtained from Starch: General properties. Isolation method. Different types and uses.

5. Acids, Bases, Salts

Introduction- acids, alkalies and salts, litmus, pH scale, Ionic nature of acids and alkalies, importance of water, the chemical reaction of acids and bases- acid reactions in everyday life, alkalies and bases, characteristic reactions of acids, Salts and their preparations: The importance of salts, their solubility, water of crystallisation, preparation of soluble salts.

6. Corrosion:

Definition, types, reactions, EMF series, method for prevention of metal corrosion, environmental modifications, metal selection and surface conditions, Cathodic protection. Corrosion Inhibitors, Coating and Plating. Applications.

7. Nanomaterials:

Overview of nanostructures, nanomaterials and nanotechnology.

Classification: 1, 2, and 3 dimensional nanomaterials, nanomaterials in nature,

examples: Nanotubes, fullerenes, nanowires, applications of nanostrucutres,

8. Macro and micro nutrients in Health Sciences:

Macronutrients: Carbohydrates, Fats and Proteins w.r.t. Classification, Functions,

(4 Hours)

(10 Hours)

(5 Hours)

(5 Hours)

ns,

(10 Hours)

<u>60 Hours</u> (5 Hours)

(6 Hours)

(5 Hours)

Health and Diseases, Food Sources, Deficiencies and Excess.

Micronutrients

Vitamins : Introduction and Classification with respect to Fat soluble Vitamins :Vitamin A, Vitamin D, Vitamin E, Vitamin K.

Water soluble Vitamins : Thiamine, Riboflavin, Niacin, Pantothenic acid, Vitamin B_{6} , Biotin, Folate, Cyanocobalamin, Ascorbic Acid.

9. Environmental Pollution

(10 Hours)

Air Pollution: Definition of pollutant, pollution. Different sectors of atmosphere, Green house effect, Green House effect, Global warming, ozone layer depletion.

Different types of pollutant. Photochemical smog. Effect of CO on human system.

Control Measures.

Water Pollution Sources, Effects, different types of water pollutants,

Entry into the food chain. Harmful effects, Control measures.

References:

- 1. Chemistry, Richard Harwood, Cambridge University Press, 1st ed., (Topic 1)
- 2. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit, 18th revised edition, Himalaya Publishing House.(Topic 2)
- 3. Food Science, Nutrition and Safety, Sukhneet Suri and Anita Malhotra, Pearsons.
- 4. B. K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut
- 5. B. S. Baliga and A. Zaveri, College Analytical Chemistry, 15th edition,Himalaya Publishing House, 2004.
- 6. Goth's medical pharmacology, by W. G. Clark, D. C Brater, A. R. Johnson . Galgotia Publications.
- 7. Medicinal Chemistry by A. Kar. Wiley Eastern Limited, New Delhi.
- 8. Sharma O. P. Economic botany. Tata McGraw Hill publishing Com.Ltd.
- 9. Sambamurthy A.V.S.S & Subramanyam N.S. 1989. A text book of Economic Botany. Wiley Eastern Limited, New Delhi.
- 10. An Introduction to Medical Botany & pharma cognosy by N. C. Kumar. Emkay publications, Delhi.
- 11. Study Material for Vocational Subject by Dr. B. G. Mhatre, Dr .V. S. Narkar, and Prof. R. K. Pathak.
- 12. Pharmaceutical Chemistry Organic Volume II, by G. R. Chatwal, Himalaya Publishing House.

ANNEXURE V

Pattern of Question papers

for

Semester End Examination (SEE)

and

Scheme of marking

ANNEXUR	E-Va : Paper Pattern for Semester I Generic Elective (GE)
SEE Questio	on paper of B.Sc. With Chemistry programme
Semester I	CHG103 for 4 credits
ANNEXUR	E – Vb : Paper Pattern for Semester II Generic Elective (GE)

	vo . i aper i allerii foi beniester ii Generie i	
SEE Question	n paper of B.Sc. With Chemistry programme	
Semester II	CHG104	for 4 credits

ANNEXURE - Va

SEMESTER I

GENERIC ELECTIVE: CHG103

BASIC CHEMISTRY AND INDIAN SCIENTISTS

(4 Credits: Theory 04)

Time Duration : 2 Hours	Marks: 80
Q.1) Answer any ten of the following:	(2 x10 =20 marks)
i) Importance of Science in life.	
ii) Indian Scientists.	
iii) Indian Scientists.	
iv) Basic Organic Chemistry.	
v)Basic Organic Chemistry.	
iv) Hydrogen and Water	
vii) Oxygen and Sulphur	
viii)Oxygen and Sulphur	
ix) Carbon and Nitrogen	
x) Carbon and Nitrogen	
xi) Halogens and Nobel Gases.	
xii) Chemistry and Industry.	
xiii) Indian Scientists	
xiv) Hydrogen and Water	
Q. 2) A) i) Indian Scientists.	4 marks
ii) Importance of Science in life.	3 marks
	OR
iii) Indian Scientists.	4 marks
iv) Importance of Science in life.	3 marks
2 B) i)Basic Organic Chemistry	4 marks

ii)Basic Organic Chemistry	4 marks
Q.3) A) i) Hydrogen and Water	4 marks
ii) Basic Organic Chemistry	3 marks
OR	
iii) Basic Organic Chemistry	4 marks
iv) Oxygen and Sulphur	3 marks
Q.3) B)i) Oxygen and Sulphur	4 marks
ii) Oxygen and Sulphur	4 marks
Q.4) A) i) Carbon and Nitrogen	4 marks
ii) Hydrogen and water	3 marks
OR	
iii) Carbon and Nitrogen	4 marks
iv) Indian scientists	3 marks
Q. 4) B)i) Carbon and Nitrogen	4 marks
ii) Carbon and Nitrogen	4 marks
Q. 5) A) i) Hydrogen and water	4 marks
ii) Halogens and Nobel Gases	3 marks
OR	
iii) Halogens and Nobel Gases	4 marks
iv) Chemistry and Industry	3 marks
Q.5) B) i)Halogens and Nobel Gases / Chemistry and Industry	4 marks
ii) Halogens and Nobel Gases / Chemistry and Industry	4 marks

ANNEXURE - Vb

SEMESTER II

GENERIC ELECTIVE: CHG104

CHEMISTRY IN DAILY LIFE

(4 Credits: Theory 04)

Time Duration: 2 Hours	Marks : 80
Q.1 Answer any ten of the following:	(2x10=20 Marks)
i) Different techniques in chemistry.	
ii) Organic chemistry in medical sciences.	
iii) Medicinal Plants	
iv) Cellulose and Starch	
v) Acids, bases, salts.	
vi) Acids, bases and salts	
vii) Corrosion	
viii) Nanomaterials	
ix) Macro and Micro nutrients in health sciences	
x) Macro and Micro nutrients in health sciences	
xi) Environmental Pollution	
xii)Environmental Pollution	
xiii) Organic Chemistry in medical sciences	
xiv) Acids, Bases, Salts/Macro and micro nutrients in health sciences.	
Q2. A) i)) Different techniques in chemistry	4 marks
ii)Organic Chemistry in medical sciences	3 marks
OR	
iii)Medicinal Plants	4 marks
iv)Different techniques in Chemistry	3 marks

B) i) Cellulose and starch	4 marks
ii) Acids, bases and salts	4 marks
(\mathbf{A}, \mathbf{A}) i) A gide bases and salts	1 montra
	4 mai ks
ii) Organic Chemistry in medical sciences	3 marks
OR	
iii) Acids ,bases and salts	4 marks
iv) Organic Chemistry in medical sciences	3 marks
B) i) Corrosion	4 marks
ii) Nanomaterials	4 marks
(A, A) i) Equipmental Dallution	4
Q4. A) I) Environmental Ponution	4 marks
ii) Medicinal Plants	3 marks
OR	
iii) Environmental Pollution	4 marks
iv) Cellulose and starch	3 marks
B) i) Environmental Pollution	4 marks
ii) a) Acids, bases and salts	2 marks
b) Macro and micro nutrients in health sciences	2 marks
Q5. A)i) Macro and micro nutrients in health sciences	4 marks
ii) Corrosion	3 marks
OR	
iii) Macro and micro nutrients in health sciences	4 marks
iv) Environmental pollution	3 marks
B) i) Macro and micro nutrients in health sciences	4 marks
ii) Nanomaterial	4 marks

ANNEXURE VI

Syllabus for B.Sc. Industrial Chemistry Programme

And

Paper Patterns and Marking Scheme for(SEE) Examination and Time

Duration and Marking Scheme for Laboratory Courses

ANNEXURE VIa Semester III Core Course of Industrial Chemistry......(1 course) CHC153 (4+2) credits

ANNEXURE VIb Semester IV Core Course of Industrial Chemistry......(1 course) CHC154 (4+2) credits

ANNEXURE VIc Pattern of Semester III SEE Question paper of B.Sc Industrial Chemistry CHC153......for 4 credits

ANNEXURE VId Pattern of Semester IV SEE Question paper of B.Sc Industrial Chemistry CHC154......for 4 credits

ANNEXURE VIe Laboratory exercises, marks distribution and duration of time for practical examination for Semester III of B.Sc. Industrial Chemistry CHC153for 2 credits

ANNEXURE VIf Laboratory exercises, marks distribution and duration of time for practical examination for Semester IV of B.Sc. Industrial Chemistry CHC154for 2 credits

ANNEXURE VIa B.Sc. WITH INDUSTRIAL CHEMISTRY

CHOICE BASED CREDIT SYSTEM

SEMESTER-III

CORE COURSE CHC153

GENERAL INDUSTRIAL CHEMISTRY

(6Credits: Theory-04, Practicals-02)

Theory: 60 Hours(04 Credits)

Section A: Material Science

I) Mechanical properties of materials and change with respect to temperature.

(3Hours)

(30 Hours:02 Credits)

- II) Polymeric materials: Industrial Polymers their constitution, chemical and physical properties. Industrial applications (5 Hours)
- III) Metals and alloys important metals and alloys: iron, copper, nickel, and their alloys Mechanical and chemical properties and their application. (8 Hours)
- IV) Cement Composition, Manufacturing processes (Dry and Wet), Types of cement, setting and hardening of cement. (4 Hours)
- V) Ceramics Introduction , Types (Conventional) , Manufacturing processes,
 Applications, Refractories (5 Hours)
- VI) Glass –Manufacture (Tank and Pot Furnaces), Distinction between Tank And Pot Furnaces, physical and chemical properties, types of glasses, composition and applications. (5 Hours)

Section B : Chemical Unit processes

VII) Nitration: Introduction – Nitrating agents. Kinetics and mechanism of nitration
 Processes such as nitration of (i) Paraffinic Hydrocarbons (ii) Benzene to

nitrobenzene and m- dinitrobenzene (iii) Chlorobenzene to o - and p - nitrochlorobenzene (iv) Acetanilide to p- nitroacetanilide. (9 Hours)

VIII) Halogenation : Reagents for halogenation. Halogenation of aromatics – side chain and nuclear halogenations. Commercial manufacture – Chlorobenzenes, monochloroacetic acid, Chloromethanes and dichlorofluromethane chloral.

```
(7 Hours)
```

- IX) Sulphonation : Introduction Sulphonating agents, chemical and physical factors in sulphonation, Kinetics and mechanism of sulphonation reaction. Commercial sulphonation of benzene, naphthalene, alkyl benzene, Batch vs continuous sulphonation. (7 Hours)
- X) Hydrolysis Introduction, hydrolyzing agents, mechanism of ester hydrolysis (Acid and Alkaline)
 (2 Hours)
- XI) Temperature measuring instruments:
 Principle, construction and working of following measuring instruments
 Temperature glass thermometers, bimetallic thermometer, vapor filled thermometer resistance thermometer radiation pyrometers. (5 Hours)

SEMESTER III

GENERAL INDUSTRIAL CHEMISTRY - LAB

CORE COURSE: CHC153

Practicals: 60 Hours (02 Credits)

Instruction: There will be two practicals each of three hours duration from **Section A** and **Section B** respectively for the examination.

SE	CTION A	(30 Hours: 01 Credit)
1.	Measurement of dissolved CO ₂ .	(3 Hours)
2.	Estimation of Aluminum gravimetrically from Bauxite Or	re (3Hours)
3.	Analysis of Brass (Volumetrically)	(4Hours)
4.	Estimation of chromium colorimetry or spectrophotometr	ry (4Hours)
5.	Estimation of Iron (Volumetrically) (2 experiments)	(4Hours)
6.	Rate of Corrosion with respect to Al and Fe plates	(6Hours)
7.	Dissociation constant of acetic acid – conductometry	(4Hours)
8.	Percentage of available chlorine in bleaching powder.	(2Hours)

SECTION B	(30 Hours: 01 Credit)
-----------	-----------------------

1. Analysis of oils and fats (iodine value, saponification value, acid value).

	(4Hours)
2. Nitration - i)Nitration of acetanilide	(4Hours)
ii)Nitration of nitrobenzene	(4Hours)
3. Halogenation i) Preparation of p-bromoacetanilide	(4Hours)
ii) Preparation of 2, 4, 6- tribromophenol	(3Hours)
4. Hydrolysis i) Hydrolysis of benzamide	(4Hours)
ii) Hydrolysis of ethylbenzoate	(4Hours)
5. Preparation of methyl orange.	(3Hours)

Note: In addition to the above laboratory exercises, each student as a part of teaching curriculum, shall be required to visit at least two industrial units, one in each semester and submit individual report

Reference Books for Theory:

- 1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
- 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
- 3. UGC course material as prescribed by UGC
- 4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- 5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- 6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

Reference Books for Practicals

- 1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- 3. S.W. Rajbhoj and T. K. Chondhekar, Systematic Experimental Physical Chemistry, Anjali Publication ,Second Edition 2000.

4. Sunita Rattan , Experiments in Applied Chemistry, S.K. Kataria & Sons ,Second edition ,2008

5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.

Chand & Co.: New Delhi (2011).

6. UGC practical manual for experimental analysis.

ANNEXURE - VIb

B.Sc. WITH INDUSTRIAL CHEMISTRY

CHOICE BASED CREDIT SYSTEM

SEMESTER- IV

CORE COURSE CHC154

GENERAL INDUSTRIAL CHEMISTRY

(Credits: Theory-04, Practicals-02)

Theory: (60 Hours :04 Credits)

Section A: Material Science

(30 Hours: 02 Credits)

(5Hours)

I) Segments of environment

Air, Oxygen, nitrogen cycle, water, Biosphere, Flora and Fauna, Energy, Soil (5Hours)

- II) Types of Pollution:
 - (i) Various pollutants
 - (ii) Air Pollution Green House Effect.
 - (iii) Water pollution Organic /Inorganic pollutants Sewage analysis
 - (iv) Pesticide pollution
 - (v) Radiation pollution,
 - (vi) Noise pollution
- III) Effluent treatment

Waste water treatment methods,

Physical: i) Sedimentation,(Clarification), Filtration etc.

Chemical: i) Disinfection: Chlorination, UV-radiation, Ozonation

ii) Coagulation iii) adsorption iv) Oxidation

Biological: i) Aerobic treatment and its mechanism

- ii) Anaerobic treatment and its mechanism (5Hours)
- IV) Bag filters, electrostatic precipitators, mist eliminators, wet scrubbers (6Hours) Absorbers
- V) Solid Waste Management(4Hours)VI) Industrial safety with respect to Chemical hazards(3Hours)

VI) Pollutants and their statutory limits. Pollution evaluation methods (2Hours)

Section B : Chemical Unit processes and instrumentation (30 Hours: 02 Credits)

- VII) Alkylation : Introduction ; types of alkylation , Alkylating agents, Thermodynamics and mechanism of alkylation reactions. Manufacture of alkyl benzenes (for detergents), ethyl benzene. (3Hours)
- VIII) Esterification: Introduction, Hydrodynamics and Kinetics of esterification reactions, Esterification by organic acids, by addition of unsaturated compounds, esterification of carboxyl acid derivatives, commercial manufacture of ethyl acetate, cellulose acetate.
 (3Hours)

IX) Amination:

- a. By reduction: Introduction, Methods of reduction metal and acid catalytic, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal, concentrated caustic oxidation, reduction, Commercial manufacture of aniline , m nitoaniline
- b. By aminolysis : Introduction, ammoniating agents, factors affecting aminolysis, manufacture of monomethylaniline (6 Hours)
- X) Hydrogenation : Introduction Kinetics and thermodynamics of hydrogenation reactions, catalysts for hydrogenation reactions, Hydrogenation of vegetable oil, Manufacture of methanol from carbon monoxide and hydrogen, hydrogenation of acids and esters to alcohol, catalytic reforming. (6Hours)
- XI) Oxidation: Introduction Types of oxidation reactions, oxidizing agents, Liquid phase oxidation, vapor phase oxidation. Commercial manufacture of benzoic acid, maleic anhydride, phthalic anhydride, acrolein, acetaldehyde and acetic acid. (6Hours)
- XII) Pressure measuring instruments Manometers , barometers, bourdon pressure gauge : bellow type, diaphragm type pressure gauges, Macleod gauges, Pirani gauges, etc.

Liquids level measuring instrument: direct – indirect liquid level measurement, Float type liquid level gauge, ultrasonic level gauges; viscosity measurement **(6Hours)**

SEMESTER-IV

GENERAL INDUSTRIAL CHEMISTRY – LAB

CORE COURSE: CHC154

Practicals: 60 Hours (02 credits)

Instruction: There will be two practicals each of three hours duration from Section A and Section B respectively for the examination.

SECTION A	(30 Hours: 01 Credit)
One experiment each on following in a given water sample.	(3×10 =30Hours)
1. Determination of solids content.	
2. Determination of Hardness.	
3. Determination of acidity.	
4. Determination of Alkalinity.	
5. Determination of dissolved oxygen	
6. Determination of BOD.	
7. Determination of COD.	
8. Determination of mixture of halide potentiometrically.	
9. Estimation of Available Oxygen in Hydrogen Peroxide.	
10. Determination of alkali in water samples and soaps.	
SECTION B	(30 Hours: 01 Credit)
1. Esterification : benzocaine	(4Hours)
2. Oxidation; p-nitrobenzoic acid,,benzyl,anthraquinone.(2ex	(periments)
	$(2 \times 4 = 8 \text{Hours})$
3. Reduction: p- aminobenzoic acid, m-nitroaniline.	(3Hours)
4. Preparation of o-chlorobenzoic acid	(3Hours)
4. Preparation of o – chlorobenzoic acid5. Preparation of o –benzoyl benzoic acid	(3Hours) (4Hours)
 4. Preparation of o – chlorobenzoic acid 5. Preparation of o –benzoyl benzoic acid 6. Estimation of glucose in food samples. 	(3Hours) (4Hours) (4Hours)
 4. Preparation of o – chlorobenzoic acid 5. Preparation of o –benzoyl benzoic acid 6. Estimation of glucose in food samples. 7. Preparation of soap. 	(3Hours) (4Hours) (4Hours) (4Hours)

Note: In addition to the above laboratory exercises, each student as a part of teaching curriculum, shall be required to visit at least two industrial units, one in each semester and submit individual report.

Reference Books for Theory

- 1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
- 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
- 3. UGC course material as prescribed by UGC
- 4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- 5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- 6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

Reference Books for Practicals

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

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

3. S.W. Rajbhoj and T. K. Chondhekar, Systematic Experimental Physical Chemistry, Anjali Publication, Second Edition 2000.

4. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons ,Second edition ,2008

5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.

Chand & Co.: New Delhi (2011).

6. UGC practical manual for experimental analysis

ANNEXURE - VIc

B.Sc. WITH INDUSTRIAL CHEMISTRY

CHOICE BASED CREDIT SYSTEM

SEMESTER-III

CORE COURSE: CHC153

GENERAL INDUSTRIAL CHEMISTRY

_____ **Time Duration: 2 Hours Total Marks: 80** Note : All questions are compulsory **Section A: Material Science** (40 marks) Q.1. Answer ANY FIVE from the following $(2 \times 5 = 10 \text{ Marks})$ i) Mechanical properties ii) Polymeric materials iii) Metals and alloys iv) Cement v) Ceramics vi) Glass vii) Metals and alloys Q.2 A) i) Mechanical properties 4 Marks ii) Metal and alloys 3 Marks OR Q.2 A) iii) Polymeric materials 4 Marks iv) Cement **3 Marks** 4 Marks Q.2 B) i) Metals and alloys ii) Ceramics 4 Marks Q.3 A) i) Ceramics 4 Marks 3 Marks ii) Glass

Q.3 A) iii) Glass	4 Marks
iv) Cements	3 Marks
Q.3 B) i) Metals and alloys	4 Marks
ii) Polymeric material	4 Marks
Section B : Chemical Unit processes	(40 Marks)
Q.4. Answer ANY FIVE from the following	(2 x 5 = 10 Marks)
i) Nitration	
ii) Halogenation	
iii) Sulphonation	
iv) Hydrolysis	
v) Temperature measuring instruments	
vi) Nitration	
vii) Halogenation	
Q.5. A) i) Nitration	4 Marks
ii) Halogenation	3 Marks
OR	
Q.5. A.) iii) Sulphonation	4 Marks
iv) Halogenation.	3 Marks
Q.5.B) i) Sulphonation	4 Marks
ii) Temperature measuring instruments	4 Marks
Q.6.A) i) Nitration	4 Marks
ii) Hydrolysis	3 Marks
OR	
Q6. A)i) Halogenation	4 Marks
ii) Sulphonation	3 Marks
Q.6.B. i) Nitration	4 Marks
ii) Temperature measuring instruments	4 Marks

ANNEXURE - VId

B.Sc. WITH INDUSTRIAL CHEMISTRY

SEMESTER- IV

CORE COURSE: CHC154

GENERAL INDUSTRIAL CHEMISTRY

Time Duration: 2 Hours	Total Marks: 80
Section A: Material Science	(40 marks)
Q.1. Answer ANY FIVE from the following	(2 x 5 = 10 Marks)
i) Segments of environment	
ii) Types of pollution	
iii) Effluent analysis	
iv) Bag filters	
v) Solid waste management	
vi) Industrial safety	
vii) Pollutants and statutory limits	
Q.2.A.i) Segments of environment	4 marks
ii) Types of pollution	3 Marks
OR	
Q.2.A.iii) Segments of environment	4 Marks
iv) Pollutants and statutory limits	3 marks
Q. 2.B. i) Bag filters	4 Marks
ii) Industrial safety	4 Marks
Q. 3.A. i) Effluent analysis	4 marks
ii) Solid waste management	3 marks

Q. 3.A. iii) Bag filters 4 M	arks
iv) Solid waste management 3 ma	arks
Q. 3.B. i) Types of pollution 4 M	arks
ii) Effluent analysis 4 ma	arks
Section B : Chemical Unit processes and instrumentation (40 M	larks)
Q.4. Answer ANY FIVE from the following $(2 \times 5 = 10 \text{ M})$	arks)
i) Alkylation	
ii) Esterification	
iii) Amination	
iv) Hydrogenation	
v) Oxidation	
vi) Pressure measuring instruments	
vii) Amination	
O_{5} A i) Allephation A	orka
i) Hydrogenetion 2 M	arks
	arks
OS A iii) Dressure measuring instruments	anlea
(U.S. A III) Pressure measuring instruments 4 M	arks
1V) Hydrogenation 5 M	arks
Q.5. B 1) Oxidation 4 M	arks
11) Esterification 4 M	arks
O.6. A. ii) Amination 4 M	arks
iii) Oxidation 3 M	arks
OR	
Q.6.A. iii) Hydrogenation 4 M	arks
iv) Oxidation 3 M	arks
Q.6. A. i) Amination 4 M	arks
ii) Pressure measuring instruments 4 M	arks

ANNEXURE VIe

SEMESTER III

CORE COURSE: CHC153

GENERAL INDUSTRIAL CHEMISTRY-LAB

Time Duration:6 Hours

Total Marks:50

SECTION A

(3 Hours)

Each Practical of three hours duration.		(25 marks)
Experiment:		15 marks
Break up : Preliminary test/ arrangements	02 marks	
Experimental reading	08 marks	
Systematic presentation	02 marks	
Results	03 marks	
Oral (Viva)		05 marks
Journal		05 marks
SECTION B		(3 Hours)
Each Practical of three hours duration.		(25 marks)
Experiment:		15 marks
Break up : Preliminary test/ arrangements	02 marks	
Experimental reading	08 marks	
Systematic presentation	02 marks	
Results	03 marks	
Oral (Viva)		03 marks
Journal		02 marks
On- Job – Training		05 marks

ANNEXURE - VIf

SEMESTER IV

CORE COURSE: CHC154

GENERAL INDUSTRIAL CHEMISTRY- LAB

Time Duration: 6 Hours

Total Marks: 50

(Marking Scheme)

SECTION A		(03 Hours)
Each Practical of three hours duration.		(25 marks)
Experiment:		15 marks
Break up : Preliminary test/ arrangements	02 marks	
Experimental reading	08 marks	
Systematic presentation	02 marks	
Results	03 marks	
Oral (Viva)		05 marks
Journal		05 marks
SECTION B		(3 Hours)
Each Practical of three hours duration.		(25 marks)
Experiment:		15 marks
Break up : Preliminary test/ arrangements	02 marks	
Experimental reading	08 marks	
Systematic presentation	02 marks	
Results	03 marks	
Oral (Viva)		03 marks
Journal		02 marks
On- Job – Training		05 marks

ANNEXURE VII

Course Codes of Chemistry - UG

Course codes in the subject of CHEMISTRY under CBCS as per OC-66 for

Bachelor of Science Programme & Bachelor of Science (Honours) Programme

Class & Semester	Initial code	New code as per OC-66	Credits
FYBSc SEM I	DSC 2A	CHC101	6 Credits
	GE 1	CHG 101/CHG103	4 Credits
FYBSc SEM II	DSC 2B	CHC102	6 Credits
	GE 2	CHG 102/CHG104	4 Credits
SYBSc SEM III	DSC 2C	CHC103	6 Credits
	SEC 1	CHS 101/CHS106	4 Credits
SYBSc SEM IV	DSC 2D	CHC104	6 Credits
	SEC 2	CHS 102/CHS107	4 Credits
TYBSc (Seme	ester V & VI) for Bacl	helor of Science (Honours progra	mme)
	DSC 5	CHC105	6 Credits
		PHYSICAL CHEMISTRY	
	DSC 6	CHC106	6 Credits
		INORGANIC CHEMISTRY	
	DSC 7	CHC107	6 Credits
TYBSc		ORGANIC CHEMISTRY	
SEM V	DSE 1	CHD101	4 Credits
	DSE 2	CHD102/CHD 105	4 Credits
	DSC 8	CHC108	6 Credits
		PHYSICAL CHEMISTRY	
	DSC 9	CHC109	6 Credits
TYBSc		INORGANIC CHEMISTRY	
SEM VI	DSC 10	CHC110	6 Credits
		ORGANIC CHEMISTRY	
	DSE 3	CHD103/CHD106	4 Credits
	DSE 4 (DSP)	CHP 101	4 Credits
TYBSc ((Semester V & VI) fo	r Bachelor of Science programme	
	SEC 3	CHS103	4 credits
TYBSc SEM V	SEC 4	CHS104	4 credits
	DSE 2A	CHD101	4 credits
TYBSc SEM VI	SEC 5	CHS105	4 credits
	DSE 2B(DSP)	CHP101 or CHD 104/CHD107	4 credits

CHG103	New Alternative GE 1 for Semester I
CHG104	New Alternative GE 2 for Semester II

CHD101	Same paper for Semester V of the two programmes i.e. DSE 1 & DSE 2A
CHD105	Alternative for CHD 102
CHD106	Alternative for CHD 103
CHD107	Alternative for CHD 104

COURSE CODES FOR B.Sc WITH INDUSTRIAL CHEMISTRY

SEM I	CHC151(Industrial Chemistry)
SEM II	CHC152(Industrial Chemistry)
SEM III	CHC153(Industrial Chemistry)
SEM IV	CHC154(Industrial Chemistry)
