

NATIONAL UNIVERSITY



Syllabus

Subject: Chemistry

Three Year B.Sc. Pass Course
Effective from the Session: 2013–2014

National University
Syllabus for Three Year B.Sc. Pass Course
Subject: Chemistry
Session: 2013-2014

Course content and marks distribution

Paper Code	Paper	Paper Title	Marks	Credits
First Year				
112801	Paper-I	Physical Chemistry	100	4
112803	Paper-II	Organic Chemistry	100	4
Second Year				
122801	Paper-III	Inorganic Chemistry	100	4
122803	Paper-IV	Synthetic Organic Polymers	100	4
Third Year				
132801	Paper-V	Industrial Chemistry	100	4
132803	Paper-VI	Analytical Chemistry	100	4
132804	Paper- VII	Practical	100	4
		Total =	700	28

**Detailed Syllabus
First Year**

Paper Code	Paper	Paper Title	Marks	Credits
112801	Paper-I	Physical Chemistry	100	4

1. State of aggregation of matter: General discussion.
2. **Gaseous state:** The gas laws. kinetic theory of gases, deviation from ideal behaviour. Amagat's curves. Van der Waals equation. Andrew's isotherms. Iequification of gases. Joule-Thompson effect. critical phenomena. molecular weights from gas density, abnormal molecular weights, thermal dissolution.
3. **The Liquid state:** The vapour pressure of liquids, intermolecular forces, surface tension and viscosity of liquids, molecular structure and its relationship with surface tension, viscosity, optical rotation and dipole moment.
4. **Thermodynamics:** Work, energy and heat; first law of Thermodynamics, internal energy, enthalpy, laws of Thermochemistry. heat of reaction formation etc, heat capacities of substances. Kirchoffs equation.
Reversible and irreversible process, isothermal and adiabatic processes; second law of thermodynamics, Carnot cycle, entropy, free energy, Gibb's-Helmholtz equation, Clausius-Clapyron equation.
5. **Solution properties:** Dalton's law of partial pressure, Henry's law and distribution law and their simple applications (association dissociation and solvent extraction).
6. **Colligative properties:** Raoult's laws of lowering of vapour pressure, elevation of boiling point and depression of freezing point, osmotic pressure, their experimental determination.

- Homogeneous equilibrium:** Law of mass action, its enunciation and mathematical formulation of equilibrium constant and its application to chemical reactions, principle of mobile equilibrium and its application to industrial reactions.
- Phase rule:** Simple one component systems, simple two component system with and without compound formation, partly miscible liquid pairs, principles of fractional distillation.
- Surface chemistry and colloids:** Different types of adsorption: Langmuir adsorption isotherm, classification of colloids, importance of colloids.
- Chemical kinetics:** First and second order reactions and their simple treatment, determination of order of reaction, simple theories of reaction rate (Only outline of Arrhenius). Catalysis (elementary treatment).

Books Recommended:

- Afinolley : *An Introduction to Physical Chemistry*
- Daniels and Alberty : *Physical Chemistry*
- A. R. Chowdhury : *Chemistry Fundamentals*
- M. Haque & Y. A. Mollah : *Principles of Physical Chemistry*
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Paper Code	Paper	Paper Title	Marks	Credits
112803	Paper-II	Organic Chemistry	100	4

- Fundamentals:** Purification and analysis of organic compounds, hybridization, nomenclature and structure of organic compounds.
- Aliphatic compounds:**
 - 2.1 General knowledge of the following terms:** Free radicals, inductive effects, tautomerism, resonance, carbonium ions and carbanion.
 - 2.2 Isomerism:** A general knowledge of isomerism including optical isomerism of substances containing one and two asymmetric carbon atoms and geometrical isomerism of carbon compounds.
 - 2.3. Aliphatic compounds:** A general study, nomenclature, general methods of preparations, physical properties, reactions with special reference to functional groups and characteristic reactions and important uses of alkanes, alkynes, alkenes, alkylhalides, hydroxy compounds, ethers, amines, aldehydes, ketones, carboxylic acids and their esters halides, anhydrides and amides.
- Aromatic compounds:** A general study of the hybridization and structure of benzene; resonance and delocalization. isomerism in benzene substitution, preparation & reactions of benzene, aromatic halides, phenols. aldehydes, ketones, carboxylic acids, nitro, amino and diazonium compounds. polynuclear aromatic hydrocarbons with special reference to the chemistry of naphthalene.
- Important reactions:** General principles and applications of some important reactions: Wurtz-Fitting. Williamson synthesis, Malonic and acetoacetic ester synthesis, Grignard

reaction. Sandmeyer reaction. Friedel-Crafts reaction. Aldol condensation, Cannizzaro reaction. Perkin reaction.

7. **Heterocyclic compounds:** Furan, pyrrole, thiophene and pyridine- their preparation and properties.
8. **Study of Carbohydrates:** With special reference to glucose, fructose, mutarotation, Kiliani reaction and Ruff's degradation.

Books Recommended:

1. I. L. Finar : *Organic Chemistry (Vol.I)*
2. J. Conant : *The Text Book of Organic Chemistry*
3. Ahmad & Miah : *Organic Chemistry*
4. English & Cassidy : *Principles of Organic Chemistry*
5. A. Khaleque : *Organic Chemistry*
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Second Year

Paper Code	Paper	Paper Title	Marks	Credits
122801	Paper-III	Inorganic Chemistry	100	4

1. Atomic structure: General study of the modern concept of the structure of atom. Rutherford atom model, Bohr's atom model; quantum numbers, Pauli's exclusion principle, electronic configurations of elements; elementary ideas about the wave nature of electrons; atomic orbitals.

2. Periodic classification: General survey of the classification of elements; periodic nature as related to the atomic structure. modern periodic table: its constitution; s-block, p-block, d-block & f-block elements, change of properties of elements in periods & groups.

3. Sizes of atoms and ions: Atomic and ionic radii-ionization potential, electron affinity, electronegativity and their influences on the properties of molecules.

4. Bonding: Elementary ideas about the electronic theory of bonding, different bonds; hybridization of orbital, bond length, bond strength and bond angles, shapes of molecules.

5. Transition metals: General chemistry of transition elements with reference to the elements of the first transition series (3d elements).

6. Acids and bases: Modern views about acids and bases, theories and their applications and limitations. strength of acids.

7. Group chemistry: Brief general study of the following groups of elements in the periodic table with reference to properties and uses of elements and their important compounds with special emphasis to comparative chemistry.

i) Inert gases ii) Alkali and coinage metals iii) Alkaline earth metals iv) Group-III v) Group-IV vi) Group-V vii) Group-VI viii) Group-VII. Elements.

8. Radio-activity: Discovery of radioactivity, concepts of half life, and disintegration constant of radioelements, uses of radioisotopes. Typical examples and elementary idea about artificial radio-activity and nuclear reactions.

9. Co-ordination compounds: Classification; Werner's theory and electronic interpretation of the structure and isomerism in 6-coordinated complexes (elementary treatment only).

10. Principles of analytical chemistry: Theoretical principles of qualitative and quantitative analysis.

Books Recommended:

1. S. Z. Haider : *Introduction to Modern Inorganic Chemistry*
2. G. S. Gilreath : *Fundamental Concept of Inorganic Chemistry*
3. T. Moellar : *Inorganic Chemistry*
4. G. T. K. Gm. Avng : *A%Re imvqb*
5. mvqg G. jwZd : *A%Re imvqb*
6. byi"j nK l gwni Dwlb : *%Re imvqb cwiwPwZ*
7. iex>`abv_ tNvl : *A%Re imvqb*

Paper Code	Paper	Paper Title	Marks	Credits
122803	Paper-IV	Synthetic Organic Polymers	100	4

- 1. Classification of Polymers & Polymerization Process:** Addition (chain reaction) and condensation (step reaction) polymerizations
- 2. Fundamental concept of the Following Polymer:** Homopolymers and heteropolymers. low density and high density polymers and their properties. Copolymers, alternating, random, block and graft copolymers. elastomer, thermoplastic and thermosetting polymers and their properties. fiber and elastomer.
- 3. Mechanism of polymerization:** Radical, cationic and anionic polymerization, and their kinetics, chain termination, chain transfer, chain retardation and chain inhibition.
- 4. Co-ordination polymerization:** Fluid-bed process, Ziegler-Natta catalysis, mechanism of co-ordination polymerization and its kinetics, metal oxide catalyzed and olefin polymerizations. ring opening polymerization.
- 5. Configuration of polymers:** Syndiotactic, isotactic, atactic polymers.
- 6. Some important polymers:** Production of monomer unit, physical properties and important uses of polythene, polyvinylchloride (PVC), polystyrene, polybutylene, polybutadiene-styrene, neoprene, polymethylmethacrylate, polyacrylonitrile, polyvinylacetate, polyamides: Nylon 6, Nylon 66, Nylon 11 and Nylon 12, silk and wool.
- 8. Thermosetting resins:** Phenol-formaldehyde, phenol-urea, melamine-formaldehyde polymers, their preparation and uses. Epoxy resins and polyurethanes.

Books Recommended:

1. R.T. Morrison and R.N. Boyd Fifth edition : *Organic Chemistry*
2. F.W. Billmeyer, JR : *Text book of polymer science*

Third Year

Paper Code	Paper	Paper Title	Marks	Credits
132801	Paper-V	Industrial Chemistry	100	4

- Fundamentals to the development of a chemical industry:** Future prospect of different types of chemical industries in Bangladesh. general ideas regarding unit processes and unit operations.
- Natural gas and urea fertilizer industries:** Composition of natural gas and its survey in Bangladesh, Purification of natural gas, manufacture of ammonia and urea from natural gas.
- Phosphoric and sulfuric acids:** Manufacture of phosphoric and sulfuric acids, triple super phosphate, calcium phosphate.
- Cement industry:** Raw materials, composition, methods of manufacture of portland cement, types of cement, setting and hardening of cement.
- Glass industry:** Basic raw materials and manufacturing processes of glass, their composition and users.
- Oils, fats, waxes, soap, and detergent:** Manufacturing of soap and detergent. concept of soap and detergents and their action.
- Pulp and paper industry:** Concept of cellulose structure. natural sources of cellulose and their composition. different processes for the manufacturing of paper from pulp.
- Synthetic fibres:** Rayon, nylon and cellulose acetate.

Books recommended:

- R. N. Shreve and J. A. Brink, Jr., McGraw-Hill Inc. : Chemical Process Industries
- B. K. Sharma, Geol Publishing House. : Industrial Chemistry
- J. A. Kent edited, Van Nostrand. : Reagent's Hand Book of Industrial Chemistry
- G. T. Austin edited, McGraw-Hill. : Chemical Process Industries
- W. D. Callister, Jr., John Wiley & Sons, Inc. : Materials Science and Engineering – An Introduction
- J. H. Block and E. B. Roche, Lea and Febiger Pub. : Inorganic Medicinal and Pharmaceutical Chemistry
- H. J. M. Bowen, The Royal Society of Chemistry. : Environmental Chemistry Vol. I - III

Paper Code	Paper	Paper Title	Marks	Credits
132803	Paper-VI	Analytical Chemistry	100	4

- Basic concepts in analytical chemistry and statistical treatment of data:** Analytical detection and quantification, sensitivity, selectivity, specificity, concentration limit, dilution limit etc. of chemical reactions, sample containers, sample preservation, sampling, sample dissolution, wet ashing and dry ashing, reagents and reactions, population and sample mean, standard deviation, relative standard deviation, coefficient of variation, variance, confidence limit, Gaussian distribution, statistical tests – the F test, the T test, the Q test, regression lines, least square method, coefficient of correlation.
- Volumetric analysis:** Principle, apparatus, end point, indicator, general factors influencing volumetric method, advantages, acid-base titrations, redox titrations, complexometric titrations – complexing agents, influence of $[H^+]$ on complexation.

3. **Gravimetric analysis:** Introduction, general requirements of a gravimetric method, precipitation from homogeneous solution.
4. **Spectrophotometric analysis:** Ultraviolet and visible radiation, absorbance, transmittance, absorptivity, the Beer-Lambert's law, limitations of Beer-Lambert's law, basic components of a spectrophotometer, qualitative and quantitative analysis.
5. **Thermal analysis:** Thermogravimetry (TG), types of TG, instrumentation, application of TG, differential thermal analysis (DTA): working principle, instrumentation, factors affecting DTA, applications, differential scanning calorimetry (DSC): working principle, instrumentation and applications.
6. **Atomic spectrometric methods:** Atomic absorption and atomic emission, absorption line width, choice of absorption line, flame emission spectrometry: instrumentation, flame emission analysis, atomic absorption spectrophotometry: principles, instrumentation and interferences, hydride vapour generation technique, cold vapour technique, advantages and disadvantages of AAS.
7. **Voltammetric analysis:** Diffusion current, half wave potential, oxygen interference, cyclic voltammetry(Cv), quantitative applications.

Books Recommended:

1. D. A. Skoog, D. M. West, F. J. Holler : Fundamentals of Analytical Chemistry and S. R. Crouch, Saunders College Publishing.
2. G. D. Christian, John Wiley & Sons. : Analytical Chemistry
3. D. Harvey, McGraw-Hill Higher Education : Modern Analytical Chemistry
4. A. I. Vogel, Longman, Green and Co. Ltd : A Text Book of Quantitative

Paper Code	Paper	Paper Title	Marks	Credits
132804	Paper- VII	Practical	100	4

For B.Sc (Pass) Course (Two days of 6 hours duration each day)

Marks distribution:

1. Inorganic qualitative analysis 30 Marks
2. Organic qualitative analysis 25 Marks
3. Inorganic quantitative/Physical chemistry 20 Marks
4. Lab note book 10 Marks
5. Viva-voce 15 Marks

Total = 100 Marks

Experiments:

- A. **Inorganic Qualitative Analysis:** Qualitative analysis of mixture of inorganic compounds containing three radicals, two basic and one acid (including interfering radicals by classical or semi-micro methods).
- B. **Inorganic qualitative Analysis:**
 - i) Acidimetry and Alkalimetry: Preparation of N/10 HCl, H₂SO₄ and CH₃, COOH solutions and their standardisation.

- ii) Determination of Na_2CO_3 content in washing soda.
- iii) Determination of mixture of carbonate and caustic soda
- iv) Oxidation-reduction titration's involving.
 - a) Preparation and standardization of N/10 KMnO_4 sodium oxalate solution.
 - b) Determination of ferrous iron using standard KMnO_4 solution.
 - c) Determination of Ca in CaCO_3 by standard KMnO_4 solution.
 - d) Preparation of standard N/10 $\text{K}_2\text{Cr}_2\text{O}_7$ solution and determination of ferrous iron by using internal indicators.
 - e) Determination of Cu iodometrically.

Physical Chemistry:

1. Determination of molecular weight by
 - a) Vapour density method
 - b) Depression of freezing point or elevation of boiling point.
 2. Thermochemical measurements; heat of neutralization and heat of solution calorimetrically.
 3. Rate of inversion of sucrose to be followed by a polarimeter.
 4. Experiment involving distribution law: Determination of partition co-efficient, molecular association and equilibrium constant.
 5. Measurements of electrolytic conductance and two typical conductometric titrations of strong acid-strong base and weak acid-strong base.
 6. Determination of solubility of a solid at various temperatures and calculation of its heat of solution.
- C. Organic qualitative analysis: analysis of organic compounds, such as amine (primary, secondary and tertiary), aldehydes, ketones, carboxylic acids, phenols and nitrocompounds (containing only one functional group).

The analysis should include the following:

- i) Elemental analysis (N.S. and halogen).
- ii) Solubility tests with the following solvents.
 - a) Water
 - b) 5% Solution of sodium bicarbonate, sodium hydroxide and hydrochloric acid
 - c) Concentrated sulphuric acid
- iii) Functional group analysis

Book Recommended:

1. A. I. Vogel : *A. Text Book of Quantitative Inorganic Analysis*
2. A. I. Vogel : *A. Text Book of Qualitative Inorganic Analysis*
3. Jabbar & Haque : *Practical Chemistry*
4. Shriner & Fuson : *Systematic Identification of Organic compounds*
5. $\text{bi}^{\text{q}} \text{nK} \text{I} \text{gwni} \text{Dw}^{\text{b}}$: $\text{e}^{\text{envwiK}} \text{imvqb}$
6. $\text{nvRvix}, \text{ }_{\beta} \text{I} \text{ }^{\text{t}}$: $\text{m}^{\text{ævZK}} \% \text{Re} \text{imvqb}$