

**NATIONAL UNIVERSITY**



**Second Year Syllabus  
Department of Chemistry**

**Four Year B.Sc. Honours Course  
Effective from the Session : 2013-2014**

**National University**  
**Subject: Chemistry**  
**Syllabus for Four Year B.Sc. Honours Course**  
**Effective from the Session: 2013-2014**

**Year wise Paper, Marks and Credit distribution**

**SECOND YEAR**

<b>Paper Code</b>	<b>Paper Title</b>	<b>Marks</b>	<b>Credits</b>
222801	Physical Chemistry-II	100	4
222803	Organic Chemistry	100	4
222805	Chemistry of the Representative Elements	100	4
222806	Quantitative Inorganic Analysis (Practical)	100	4
222707	Physics-III (Electricity and Modern Physics)	100	4
222708	Physics-IV (Physics Practical)	50	2
223707	Calculus-II	100	4
223708	Math Lab (Practical)	50	2
	<b>Total =</b>	<b>700</b>	<b>28</b>
221109	English (Compulsory)	100	Non-Credit

## Detailed Syllabus

<b>Paper Code</b>	222801	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Physical Chemistry-II</b>			Exam Duration: 4 hours

**1. Thermodynamics:** Scope and limitations of thermodynamics, the direction of spontaneous changes: degradation of energy: carnot cycle; second law of thermodynamics; entropy; Clasius-Clapyron equation; changes in  $u$ ,  $h$  and  $s$ . with temperature and pressure; Gibb's- Helmholtz equation; heat engines; third law of thermodynamics; nernst's heat theorem; absolute entropy: maxwell's relations; temperature and pressure dependence of Gibbs function: chemical potential and fugacity, partial molar quantities; Gibbs-Duhem equation: thermodynamic derivation of colligative properties.

### 2. Electrochemistry:

**2.1 Electrolytes:** Electrolyte, nonelectrolyte, polyelectrolyte, electrolysis and Farady's laws; conductance; specific conductance, molar conductance; Kohlrausch's law.

**2.2 Conductance:** Conductance measurement, conductometric titration; ionic mobility, ion transport number and its determination. theories of strong electrolytes; Debye-Huckel limiting law.

**2.3 Electrochemical Cells and Cell Potentials:** Cells: concept, electrolytic and Galvanic cells; half cells; different types of electrodes and half cells, half cell reactions & cell reactions, standard hydrogen electrode, subsidiary and reference electrodes, electrode potentials, Nernst's equation, measurement of e.m.f of a cell, compensation method of measurement of electrode potential, thermodynamic functions from e.m.f. standard free energy changes, equilibrium constant. standard Weston cadmium cell. dry cell, alkaline cell, lead accumulator. polarization: over voltage and polarization. fuel cell.

**3. pH, Buffer and Indicators:** Definition of pH, buffer and indicator,  $K_w$  of water, buffer mechanism, preparation of buffer of definite pH, Acid-base PH titration curves, determination  $K_a$  from titration curve, theories of indicator, pH range of indicator, selection of indicator.

### Books Recommended:

1. Physical Chemistry, P.W, Atkins, W.H. Freeman & Co.
2. Physical Chemistry, G.W. Castellan, Narosa Publishing House
3. Chemical Thermodynamics, Basic Concepts and Methods, I.Fqotz, I.M. Klotz and R.M. Rosenberg, John Wiley & Sons.
4. Electrochemistry, S. Glasstone, East-West Press Pvt. Ltd.
5. The Principles of Electrochemistry, D.A. Maclinnes, Reinhold Publishing Corporation.
6. Modern Electrochemistry, J.O. Bockris and A.K.N. Reddy, Springes
7. Physical Chemistry, W.J. Moore, Longmans Green & Co.

8. Colloidal Science – A.E. Alexander and Johnson.
9. Colloidal Chemistry – B. Jigensons and M.E. Straumanis
10. Text of Colloidal Chemistry – A.B Weiser
11. Solid State Chemistry. N.B. Hannay
12. Solid State Chemistry. A.K. Galwey

<b>Paper Code</b>	222803	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Organic Chemistry</b>			Exam Duration: 4 Hours

1. **Organic Acids and Bases:** Concepts, inductive, mesomeric and structural effects affecting the acidity and basicity; acid and base catalysis.
2. **Aromatic Hydrocarbons:** Source; structure and bonding in benzene; concept of aromaticity; Huckel's rule, nomenclature and their preparations, disubstitution in benzene ring; orientation in benzene ring and its derivatives, activation and deactivation in aromatic disubstitution, mechanism of electrophilic substitution in aromatic rings: halogenation, nitration, sulfonation, Friedel-Crafts alkylation and acylation. Benzene derivatives.
3. **Polynuclear Aromatic Hydrocarbons:** General methods of synthesis, reactions of naphthalene, anthracene, phenanthrene and their derivatives.
4. **Amines:** Aliphatic and aromatic, nomenclature, preparation and reaction of amines, Hofmann amine degradation, separation of amines, nomenclature, preparation and reactions of diazonium salt, coupling reaction.
5. **Heterocyclic Compounds Containing One Hetero atoms:** Aromatic character, chemistry and structure of heterocyclic compounds-furan, pyrrole, thiophene and pyridine.
6. **Stereochemistry:** A brief concept of stereoisomerism, geometric and optical isomerism, polarimetry, optical activity, molecular asymmetry, optical isomerism due to asymmetric carbon atoms, compounds with one and two or more asymmetric carbon atoms, racemic modification and their formation, resolution of racemic modifications.
7. **Bifunctional Compounds:** Chemistry of 1, 3-dienes,  $\alpha$ - $\beta$  unsaturated carbonyl compounds, hydroxy ketones, 1, 2- and 1, 3 – diketones, keto-enol tautomerism.

#### Books Recommended:

1. Organic Chemistry, I. L. Finar, Vol I & II, Longmans.
2. Advanced Organic Chemistry, B. S. Bahl and A. Bahl, S. Chand & Co. Ltd.
3. Organic Chemistry, T.W.G. Solomons, Wiley.
4. Organic Chemistry, W.H. Brown, C.S. Foote and B.L. Iverson Brooks Cole.

<b>Paper Code</b>	222805	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Chemistry of the Representative Elements</b>			Exam Duration: 4 Hours

- Hydrogen:** Introduction, resemblance with alkali metals and with halogens, various forms of hydrogen (nascent hydrogen, occluded hydrogen, atomic hydrogen, and ortho and para hydrogen molecules), isotopes of hydrogen, binary hydrides and their classification.
- The Alkali Metals:** Occurrence and extraction, comparative properties, hardness, ionization energies, cation sizes and polarization, flame coloration, solubility and hydration, hydration radii, reducing strength, anomalous behavior of Li, diagonal relationship of Li with Mg, compounds of Na.
- The Alkaline Earth Metals:** Occurrence and extraction, comparative properties, ionization energies, cation sizes and polarization, flame coloration, solubility and lattice energy, reducing character, anomalous behavior of Be, diagonal relationship between Be and Al, compounds of beryllium and calcium, hardness of water, biological role of magnesium and calcium ions.
- The Boron Family:** General properties, occurrence and abundance, extraction of aluminium, electron deficient compounds, chemistry of boron hydrides, borax and boric acid, borazine and its similarity and dissimilarity with benzene, Lewis acid character of  $BX_3$  compounds.
- Carbon and Its Congeners:** Introduction, structure and allotropy of the elements, catenation, structure of graphite and diamond, inert pair effect, carbides, oxides of carbon and carbonic acid, physiological aspects of CO, multiple bonding in carbon and silicon, silicates, classification of silicates, structure of silicates, lead and its toxicity, carbon dating.
- The Nitrogen Family:** General properties, catenation, anomalous nature of nitrogen, nitrogen fixation, nitrogen hydrides,  $NH_3$  as a nonaqueous solvent, hydroxylamine, azides, oxides and oxo-acids of nitrogen, allotropes of phosphorus, oxides and oxo-acids of phosphorus, phosphazenes and cyclophosphazenes, arsenic as a water pollutant.
- The Chalcogens:** General properties, anomalous nature of oxygen, allotropes of oxygen, uses of dioxygen, ozone - its production and importance in atmosphere, ionic and covalent oxides, peroxides and superoxides, occurrence and allotropes of sulfur, oxides and oxo-acids of sulfur, acid rain and  $SO_2$ .
- The Halogens:** Occurrence, comparative properties, colors and physical states of dihalogens, trends in bond dissociation energies, electrolytic production of  $F_2$  and  $Cl_2$  and their uses, hydrogen halides, bridging halides, interhalogen compounds.
- The Inert Gases:** Occurrence, isolation, chemistry and uses, xenon compounds: fluorides, oxides and oxo - acids and their structures, complexes of xenon, clathrate compounds of noble gases.

#### **Books Recommended:**

- Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, Pergamon Press.
- Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, and P. L. Gaus, John Wiley & Sons.
- Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, John Wiley & Sons, Inc.
- Modern Inorganic Chemistry, R. D. Madan, S. Chand & Co. Ltd.
- Advanced Inorganic Chemistry, S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, S. Chand & Co. Ltd.
- Introduction to Modern Inorganic Chemistry, S. Z. Haider, Friends International.

<b>Paper Code</b>	222806	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Quantitative Inorganic Analysis (Practical)</b>			Exam Duration: 4 Hours

- Data Collection and Processing:** Introduction to analytical balance, volumetric glasswares, reagents and standard solutions, calibration of weights and glasswares, uncertainty in measurements, accuracy and precision, standard deviation, systematic error, random error, rounding off, significant figures, primary and secondary standard substances.
- Volumetric Analysis:** The principle of volumetric analysis, preparation of standard solutions, classifications of methods of volumetric analysis,
  - Neutralization Method:* Standardization of sodium hydroxide solution using oxalic acid solution as a primary standard titrant, standardization of hydrochloric acid using standard sodium hydroxide solution, determination of acetic acid content in vinegar, determination of carbonate in washing soda.
  - Oxidation-Reduction Method:* Standardization potassium permanganate using standard oxalic acid solution, determination of Fe(II) using standard permanganate solution, determination of Fe(II) using potassium dichromate solution as primary standard titrant, determination of Fe(II) and Fe(III) in a Fe(II)-Fe(III) mixture.
  - Iodometric Method:* Standardization of sodium thiosulphate solution using dichromate solution, iodometric determination of copper(II), iodometric determination of Fe(III) using  $\text{Cu}_2\text{I}_2$  as catalyst, iodometric determination of sulfite.
  - Precipitation Method:* Preparation of standard silver nitrate solution, standardization of ammonium or potassium thiocyanate solution, determination of chloride by Volhard's method.
  - Complexometric Method:* Preparation of standard EDTA solution, complexometric determination of copper using Fast sulphon Black as indicator, zinc using Eriochrome Black T as indicator, nickel using murexide as indicator, determination of hardness of water.
- Gravimetric Analysis:** Determination of calcium as oxalate, aluminium as 8-hydroxyquinolate, sulfate as barium sulfate.
- Analysis of Mixtures:** Separation and quantitative determination of copper (II) and nickel (II), copper (II) and zinc (II) from the respective binary admixtures using suitable methods.

#### **Books Recommended:**

- A Textbook of Quantitative Inorganic Analysis, A. I. Vogel, 3<sup>rd</sup>/4<sup>th</sup> edition, ELBS/Longman.
- Elementary Quantitative Analysis – Theory and Practice, W. J. Blaedel and V. W. Meloche, Harper & Row.
- Quantitative Chemical Analysis, R. B. Fischer and D. G. Peters, W. B. Saunders Co.
- Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Thomson Asia Pvt. Ltd.
- Analytical Chemistry, G. D. Christian, John Wiley & Sons, Inc.

<b>Paper Code</b>	222707	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Physics-III (Electricity and Modern Physics)</b>			Exam Duration: 4 Hours

1. **Change and Matter:** Concept of charge, Conservation of charge. Coulomb's law.
2. **The Electrostatic Field:** The Electric field strength due to a point charge, a dipole, Group of charged and uniformly distributed charged bodies.
3. **The electrostatic potential:** Potential due to a point charge, a dipole, a group of charged and a continuous distribution of charged bodies. Notion of gradient: Relation between potential and electric field strength. Electric potential energy. Van de Graff generator.
4. **Flux of electrostatic field:** Gauss's law. Concept of solid angle. Flux due to a point charge, group of charge. Conservation of flux. Application of Gauss's law.
5. **Capacitor and Dielectrics:** Capacitance, Parallel plate and cylindrical capacitor. Dielectrics and Gauss's law. Energy storage in an electric field.
6. **Electric Current (D.C):** Electromotive force, Current and current density. Resistance, Resistivity and conductivity, Ohm's law, Atomic view of resistivity, Energy transfer in an electric circuit, Kirchhoff's laws and their applications. Potentiometer. Meter bridge and Post office box.
7. **The Magnetic field:** Magnetic Induction B. Motion of a charge field. Magnetic force on a current, Torque on a current loop, the Hall effect, Circulating charges. Dead beat and ballistic galvanometers, Thomson's experiment, Ampere's law, B near a long wire, Ampere's circuital law, B due to a solenoid, the Biot-Savart law and its applications.
8. **Electromagnetic induction:** Faraday's law of induction, Lenz's law, Self and mutual inductance. Time-varying magnetic fields, Energy density in a magnetic field.
9. **Magnetic Properties of matter:** Magnetic dipole, Gauss's Law for magnetism, Paramagnetism, Diamagnetism and ferromagnetism, Nuclear magnetism, Energy in a magnetic field, Hysteresis.
10. **Varying current:** Growth and decay of currents in LR, CR and LCR circuits.
11. **Alternating Currents:** AC generator, Concept of r.m.s and average values of current and voltage, Resistive circuit, CR, LR and LCR circuits in series and parallel, Resonance, Phase and Power transformer.
12. **Electronics:** Vacuum diodes and triodes, P-type, n-type semiconductors, p-n junctions, Transistors, Transistor biasing, Transistor amplifiers, Transmitters and Receivers.
13. **Special Theory of Relativity:** Inertial frame, Galilean transformation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformation equations space contraction, Time dilation, Relativity of mass, Mass and energy.
14. **Light and Quantum Physics:** Planck's radiation formula, Photoelectric effect, Einstein's Photon theory, The Compton effect, The hydrogen atom and The correspondence principle.
15. **Waves and particles:** Matter waves, atomic structure and standing waves, Mechanics, Uncertainty principle.
16. **The atomic nucleus:** The nuclear constituents, The nuclear force, Nuclear radius, Stable nuclei, The binding energy of stable nuclei mass defect and Packing fraction.
17. **Radioactivity:** Meaning of radioactivity, Unstable nuclei, Exponential decay law, Half life, Mean life and units of radioactivity, Basic ideas of nuclear reactor, Nuclear fission and Nuclear fusion.

#### Books Recommended:

1. Halliday, D, Resnick, R and Walker, J : Fundamentals of Physics
2. Halliday, D and Resnick, R. : Physics
3. Husain, A & Islam. S : Parmanabik Bijnan
4. Emran, M, Ishaque, M & Islam, A.M.Z. : A Text Book of Magnetism, Electricity

5. Besier, A. & Modern Physics.  
: Concepts of Modern Physics  
6. Semat, H. : Introduction to Atomic and Nuclear Physics.

<b>Paper Code</b>	222708	<b>Marks: 50</b>	<b>Credits: 2</b>	<b>Class Hours: 30</b>
<b>Paper Title:</b>	<b>Physics-IV (Physics Practical)</b>			Exam Duration: 6 Hours

To perform two experiments (one from each group) each of three hours duration.

i) Experiments (3 hours each)	2 x 20 =	40
ii) Laboratory note book		05
iii) Experimental Viva-voce		<u>05</u>

Total marks= 50 Marks for each experiment

shall be distributed as follows:

a) Theory		3
b) Data collection and Tabulation		8
c) Calculation, graphs and result		6
d) Discussion		<u>3</u>
Total marks =		20

#### Group – A

- Determination of 'g' by compound pendulum.
- Determination of Young's and rigidity moduli by Searle's dynamic method.
- Rigidity modulus by static method.
- Surface tension of water by capillary tube method.
- To determine the spring constant and effective mass of a given spiral spring and hence to calculate the rigidity modulus of the material of the spring.
- To determine the Young's modulus by the flexure of a beam (bending method).
- To determine the moment of inertia of a fly-wheel about its axis of rotation.
- Determination of surface tension of mercury by Quincke's method.
- To determine the specific heat of solid by method of mixture, with radiation correction.
- To determine the specific heat of a liquid by the method of cooling.
- To determine the thermal conductivity of a bad conductor by Lee's method.
- To determine 'J' with radiation correction.
- To verify the laws of transverse vibration of a stretched string with a sonometer (n-1, and n-T curves only)
- To find the frequency of a tuning fork by Melde's experiment.

#### Group – B

- Comparison of e.m.f.s of two cells by potentiometer.
- Determination of galvanometer resistance by half deflection method.
- Determination of low resistance by fall of potential method.
- Determination of figure of merit of a galvanometer.
- To determine ECE of copper/silver.
- Determination of the refractive index of a glass prism by a spectrometer.
- Determination of Cauchy's constant and the resolving power of a prism using a spectrometer.



8. Determination of wavelength of light by Newton's rings.
9. Determination of wavelength of light using a bi-prism.
10. Specific rotation of plane of Polarization in sugar solution by polarimeter.

**Books Recommended:**

- |                                     |   |                            |
|-------------------------------------|---|----------------------------|
| 1. Ahmed, G.U. and Uddin, M.S.      | : | Practical Physics          |
| 2. Chawdhury, S.A. and Bashak, A.K. | : | Advanced Practical Physics |
| 3. Din, K. and Matin, M.A.          | : | Advanced Practical Physics |
| 4. Worsnop and Flint                | : | Advanced Practical Physics |

<b>Paper Code</b>	223707	<b>Marks: 100</b>	<b>Credits: 4</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	<b>Calculus- II</b>			Exam Duration: 4 Hours

1. **Vector valued functions of a single variable:** Limits. Derivatives and integrals. Tangent lines to graphs of such functions. Arc length from vector viewpoint. Arc length parametrization .
2. **Curvature of space curves:** Definition. Curves of zero curvature. Curves of constant non-zero curvature. Cartesian equations and parametric equations. Radius of curvature. Centre of curvature.
3. **Functions of several variables:** Limits and continuity. Partial derivatives. Differentiability, linearization and differentials. The chain rule. Partial derivatives with constrained variables. Directional derivatives, gradient vectors and tangent planes. Extreme values and saddle points of functions of several variables. Lagrange multipliers. Taylor's formula.
4. **Multiple Integration:** Double integrals and iterated integrals. Double integrals over nonrectangular regions. Double integrals in polar coordinates. Area by double integrals. Triple integrals and iterated integrals. Volume as a triple integral. Triple integral in cylindrical and spherical coordinates. General multiple integrals. Jacobians.
5. **Topics in Vector Calculus:** Scalar and vector fields, Gradient, divergence and curl, and their properties. Line integrals, Independence of paths. Green's theorem. Surface integrals. Stokes' theorem. The divergence theorem.

**Books Recommended :**

1. Howard Anton-*Calculus 5/E (and forward edition)*

<b>Paper Code</b>	223708	<b>Marks: 50</b>	<b>Credits: 2</b>	<b>Class Hours: 30</b>
<b>Paper Title:</b>	<b>Math. Lab.</b>			<b>Exam Duration: 6 Hours</b>

Getting started. Problem solving using Mathematica /Maple (Problems will be selected from Papers studied in the first and second years of their studies).

Students are required to work on their assignments in MMT 201 in the lab sessions.

<b>Paper Code</b>	221109	<b>Marks: 100</b>	<b>Non-Credit</b>	<b>Class Hours: 60</b>
<b>Paper Title:</b>	English (Compulsory)			<b>Exam Duration: 4 Hours</b>

**Aims and objectives of this Paper:**

To develop students' English language skills, to enable them to benefit personally and professionally. The four skills ~ listening, speaking, reading and writing will be integrated to encourage better language use.

**1. Reading and understanding**

5×4=20

Students will be expected to read passages they might come across in their everyday life, such as newspapers, magazines, general books etc. Simple stories will also be included to give students a familiarity with different uses of the language.

[N.B. : 5 Questions are to be answered. Each question will carry 4 marks. There may be division in each question]

- Understanding different purposes and types of readings
- Guessing word-meaning in context.
- Understanding long sentences
- Recognizing main ideas and supporting ideas.
- Answering comprehension questions.
- Writing summaries.

**2. Writing**

40

- Writing correct sentences, completing sentences and combining sentences. 5
- Situational writing : Posters, notices, slogans, memos, advertisements etc. 4
- Paragraph writing : Structure of a paragraph; topic sentences; developing ideas; writing a conclusion; types of paragraphs (narrative, descriptive, expository, persuasive); techniques of paragraph development (such as listing, cause and effect, comparison and contrast). 8

**Or,**

- Newspaper writing : Reports, press releases dialogues etc.
- Writing resumes. **Or,** 8
- Writing letters : Formal and informal letters, letters to the editor, request letters, job applications, complaint letters etc.
- Essay : Generating ideas; outlining; writing a thesis sentence; writing the essay: writing introductions, developing ideas, writing conclusions; revising and editing. 15

**3. Grammar**

25

- Word order of sentences.
- Framing questions.
- Tenses, articles, subject-verb agreement, noun-pronoun agreement, verbs, phrasal verbs, conditionals, prepositions and prepositional phrases, infinitives, participles, gerunds. (Knowledge of grammar will be tested through contextualised passages).
- Punctuation.

**4. Developing vocabulary :** Using the dictionary, suffixes, prefixes, synonyms, antonyms, changing word forms (from verb to noun etc.) and using them in sentences. 10

**5. Translation from Bengali to English :**

1x 5=5

**6. Speaking skills :** Speaking skills should be integrated with writing and reading in classroom activities.

The English sound system; pronunciation skills; the IPA system; problem sounds, vowels, consonants and diphthongs; lexical and syntactic stress.

(Writing dialogue and practising it orally students can develop their speaking skill. Dialogue writing can be an item in writing test.)