# CBCS CURRICULM OF UG PROGRAMME

## DEPARTMENT OF CHEMISTRY

**NILAMBER-PITAMBER UNIVERSITY, MEDININAGAR**
**PALAMU, JHARKHAND-822 101**

MODIFIED CBCS CURRICULUM OF

# CHEMISTRY HONOURS PROGRAMME

## SUBJECT CODE = BS52

**FOR UNDER GRADUATE COURSES UNDER NILAMBER-PITAMBER UNIVERSITY**

Implemented from
Academic Session 2018-2021

# Contents

## COURSE STUCTURE FOR UNDERGRADUATE 'HONOURS' PROGRAMME

| Course | Papers | Credits Theory + Practical | Credits Theory + Tutorial |
|---|---|---|---|
| **I. Core Course** | **(CC 1 to 14)** | | |
| Theory | 14 Papers | 14X4=56 | 14X5=70 |
| Practical/Tutorial* | 14 Papers | 14X2=28 | 14X1=14 |
| **II. Elective Course (EC)** | | | |
| A. Discipline Specific Elective | **(DSE 1 to 4)** | | |
| Theory | 4 Papers | 4X4=16 | 4X5=20 |
| Practical/ Tutorial* | 4 Papers | 4X2=8 | 4X1=4 |
| B. Generic Elective/ Interdisciplinary | **(GE 1 to 4)** | | |
| Theory | 4 Papers | 4X4=16 | 4X5=20 |
| Practical/ Tutorial* | 4 papers | 4X2=8 | 4X1=4 |
| **III. Ability Enhancement Compulsory Courses (AECC)** | | | |
| 1. English/ Hindi Communication/ NH+MB/ | 1 Paper | 1X2=2 | 1X2=2 |
| 2. Environmental Science | 1 Paper | 1x2=2 | 1x2=2 |
| 3. Skill Enhancement Course | **(SEC 1 & 2)** | | |
| of the Core Course opted | 2 Papers | 2X2=4 | 2X2=4 |
| | | | = 140 |

**Total Credit = 140**

| Semester | Honours (Core Courses) 14 Papers | Allied (Elective Courses) 8 Papers | Ability Enhancement (Compulsory Courses) 4 Papers | Total Credits |
|---|---|---|---|---|
| Sem-I | C-1, C-2 (6+6=12 Credits) | GE-1 (06 Credits) | Eng Comm./ Hindi/ NH + MB (02 Credits) | 20 Credits |
| Sem-II | C-3, C-4 (6+6=12 Credits) | GE-2 (06 Credits) | EVS (02 Credits) | 20 Credits |
| Sem-III | C-5, C-6, C-7 (6+6+6=18 Credits) | GE-3 (06 Credits) | SEC-1 (02 Credits) | 26 Credits |
| Sem-IV | C-8, C-9, C-10 (6+6+6=18 Credits) | GE-4 (06 Credits) | SEC-2 (02 Credits) | 26 Credits |
| Sem-V | C-11, C-12 (6+6=12 Credits) | DSE-1, DSE-2 (6+6=12 Credits) | | 24 Credits |
| Sem-VI | C-13, C-14 (6+6=12 Credits) | DSE-3, DSE-4 (6+6=12 Credits) | | 24 Credits |
| | | | | Total = 140 Credits |

**Table A-1: Distribution of 140 Credits** [*wherever there is a practical there will be no tutorial and vice _versa.]

## COURSES OF STUDY FOR UNDERGRADUATE 'B. Sc. Hons' PROGRAMME

### Table A-2 Subject Combinations allowed for B. Sc. Hons. Programme (140 Credits)

| Honours/Core Subject CC 14 Papers | Discipline Specific Elective Subject DSES 4 Papers | Skill Enhancement Course SEC 2 Papers | Compulsory Course AECC 1+1=2 Papers |
|---|---|---|---|
| Chemistry | Chemistry Specific | SEC in Chemistry | Language Communication + EVS |

### Table A-2.3 Semester wise Structure for Mid Sem & End Sem Examinations:

| Sem | Core Honours, Allied DSE, Compulsory AECC Courses | | Examination Structure | | |
|---|---|---|---|---|---|
| | Code | Papers | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical/ Viva (F.M.) |
| I | C1 | Atomic Str. & Chemical Bonding +**Lab** | 15 | 60 | 50 |
| | C2 | States of Matter & Ionic Equil.+**Lab** | 15 | 60 | |
| | AECC | Language Communication | | 100 | |
| II | C3 | Basics and Hydrocarbons +**Lab** | 15 | 60 | 50 |
| | C4 | Chem. Thermodynamics & Appl. +**Lab** | 15 | 60 | |
| | AECC | EVS | | 100 | |
| III | C5 | s- and p-Block Elements +**Lab** | 15 | 60 | 75 |
| | C6 | Oxygen Containing Functional Gps. +**Lab** | 15 | 60 | |
| | C7 | Phase Equil. and Chem. Kinetics +**Lab** | 15 | 60 | |
| | SEC 1 | Elementary Computer Application Software +**Lab** | | 75 | 25 |
| IV | C8 | Coordination Chemistry +**Lab** | 15 | 60 | 75 |
| | C9 | Heterocyclic Chemistry +**Lab** | 15 | 60 | |
| | C10 | Electrochemistry +**Lab** | 15 | 60 | |
| | SEC 2 | Fuel Chemistry | | 100 | |
| V | C11 | Biomolecules +**Lab** | 15 | 60 | 100 |
| | C12 | Quantum Chem. & Spectroscopy +**Lab** | 15 | 60 | |
| | DSE 1 | Analytical Methods in Chemistry +**Lab** | 15 | 60 | |
| | DSE 2 | Polymer Chemistry +**Lab** | 15 | 60 | |
| VI | C13 | Organometallic Chemistry +**Lab** | 15 | 60 | 100 |
| | C14 | Spectroscopy +**Lab** | 15 | 60 | |
| | DSE 3 | Green Chemistry +**Lab** | 15 | 60 | |
| | DSE 4 | Industrial Chemicals & Environment +**Lab** | 15 | 60 | |

**Table A-2.2 Generic Subject Papers for B. Sc. Hons. Programme (140 Credits);**

**All Four Papers of Any One Subject** to be opted leaving aside the papers of Hons. Subject:

| Generic Elective Subject GE 4 Papers | Generic Elective Courses for Arts Stream (GE will be other than Core Subject opted | | | |
|---|---|---|---|---|
| | Semester I GE1 | Semester II GE2 | Semester III GE3 | Semester IV GE4 |
| Physics | Mechanics +**Lab** | Electricity and Magnetism +**Lab** | Thermal & Statistical Physics +**Lab** | Waves and Optics +**Lab** |
| Mathematics | Object oriented Programming in C++ +**T** | Econometrics +**T** | Information Security +**T** | Application of Algebra +**T** |
| Zoology | Animal Diversity +**Lab** | Human Physiology +**Lab** | Food, Nutrition & Health +**Lab** | Environment & Public Health +**Lab** |
| Botany | Biodiversity +**Lab** | Plant Ecology & Taxonomy +**Lab** | Plant Anatomy & Embryology +**Lab** | Plant Physiology & Metabolism +**Lab** |
| Geology | Essentials of Geology +**Lab** | Rocks & Minerals +**Lab** | Fossils & their Applications +**Lab** | Earth Resources +**Lab** |

**Table A-2.3 Semester wise Structure for End Sem Examinations of Generic Elective in Chemistry:**

| Sem | Core Honours, Allied DSE, Compulsory AECC Courses | | Examination Structure | | |
|---|---|---|---|---|---|
| | Code | Papers | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical/ Viva (F.M.) |
| I | GE1 | Atomic Structure, Bonding, General Org Chem & Aliphatic Hydrocarbons +**Lab** | | 75 | 25 |
| II | GE2 | Chemical Energetics, Equilibria & Functional Gp Org Chemistry-I +**Lab** | | 75 | 25 |
| III | GE3 | Chem. of s- and p-block elements, States of matter and Chem. Kinetics +**Lab** | | 75 | 25 |
| IV | GE4 | Chem. of d-block elements, Molecules of Life +**Lab** | | 75 | 25 |

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## SEMESTER I                                          4 Papers
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**Total 100 x 4 = 400 Marks**

## I.     ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

(Credits:   Theory-02)

Any One Compulsory Language Communication Prescribed by Nilamber-Pitamber University:

English Communication/ Hindi Communication / NH + MB Communication

**(Refer AECC Curriculum of Nilamber-Pitamber University)**

## II.     GENERIC ELECTIVE (GE 1)                                   (Credits: 06)

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

## III.  <u>CORE COURSE –C 1:</u>                    (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

<u>*Mid Semester Examination (MSE):*</u>

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

<u>*End Semester Examination (ESE):*</u>

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## INORGANIC CHEMISTRY-I                    Theory: 60 Lectures

**Atomic Structure:**
Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of $\psi$ and $\psi^2$. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of $s$, $p$, $d$ and $f$ orbitals. Contour boundary and probability diagrams.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

**(14 Lectures)**

**Periodicity of Elements:**
$s$, $p$, $d$, $f$ block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to $s$ & $p$-block.

(a)  Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b)  Atomic radii (van der Waals)   (c) Ionic and crystal radii.
(d)  Covalent radii (octahedral and tetrahedral)
(e)  Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f)  Electron gain enthalpy, trends of electron gain enthalpy.
(g)  Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

**(16 Lectures)**

**Chemical Bonding:**

(i)    *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii)    *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions; HCl, $BeF_2$, $CO_2$, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding ($\sigma$ and $\pi$ bond approach) and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii)    *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv)    *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.
Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

**(26 Lectures)**

**Oxidation-Reduction:**
Redox equations, Standard Electrode Potential and its application to inorganic reactions.
Principles involved in volumetric analysis to be carried out in class.

**(4 Lectures)**

**Reference Books:**
Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

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# CHEMISTRY PRACTICAL- C 1 LAB:                    60 Lectures

**(A) Titrimetric Analysis**
(i)    Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

## (B) Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

## (C) Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

**Reference text:** Vogel, A.I. A Textbook of Quantitative Inorganic

Analysis, ELBS.

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# IV.   CORE COURSE- C 2:                              (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th  (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for  Mid
Semester Examination (MSE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## PHYSICAL CHEMISTRY I                              **Theory: 60 Lectures**

**Gaseous stat**e:
Kinetic molecular model of a gas:  postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their
Temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of $\sigma$ from $\eta$; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees  of freedom and molecular basis of heat capacities.
Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of  other

equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

**(18 Lectures)**

### Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity.

Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Qualitative discussion of structure of water.

**(6 Lectures)**

### Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Defects in crystals. Glasses and liquid crystals.

**(16 Lectures)**

### Ionic equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

**(20 Lectures)**

### Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

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# CHEMISTRY PRACTICAL-C 2 LAB                    60 Lectures

1. **Surface tension measurements.**

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. **Viscosity measurement using Ostwald's viscometer**.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b. Study the variation of viscosity of sucrose solution with the concentration of solute.

3. **Indexing of a given powder diffraction pattern of a cubic crystalline system.**

4. **pH metry**

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH

   i. Sodium acetate-acetic acid

   ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

*Any other experiment carried out in the class.*

**Reference Books**

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

☐  Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGrawHill: New York (2003).

☐  Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

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**SEMESTER II**                                          **4 Papers**
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**Total 100 x 4 = 400 Marks**
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## I.    ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

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(Credits: Theory-02)
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| Marks : 100 (ESE: 3Hrs) =100 | Pass Marks Th ESE = 40 |
|---|---|

***Instruction to Question Setter for***

<u>*End Semester Examination (ESE):*</u>

*There will be **objective type test** consisting of hundred questions of 1 mark each. Examinees are required to mark their answer on **OMR Sheet** provided by the University.*

## AECC – ENVIRONMENT STUDIES                    Theory: 30 Lectures

### Unit 1 : Introduction to environmental studies

   • Multidisciplinary nature of environmental studies;

   • Scope and importance; Concept of sustainability and sustainable development.

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**(2 lectures)**
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### Unit 2 : Ecosystems

   • What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem:

food chains, food webs and ecological succession. Case studies of the following ecosystems :

a.           Forest ecosystem
b.           Grassland ecosystem
c.           Desert ecosystem
d.           Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**(2 lectures)**

## Unit 3 : Natural Resources : Renewable and Non--renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

**(5 lectures) Unit 4 : Biodiversity and Conservation**

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega--biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man--wildlife conflicts, biological invasions; Conservation of biodiversity : In--situ and Ex--situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

**(5 lectures) Unit 5 : Environmental Pollution**

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

**(5 lectures) Unit 6 : Environmental Policies & Practices**

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

**(4 lectures)**

## Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

**(3 lectures)**

**Unit 8 : Field work**

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site--Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems--pond, river, Delhi Ridge, etc.

**(Equal to 4 lectures)**

**Suggested Readings:**

1. Raziuddin, M.., Mishra P.K. 2014, *A Handbook of Environmental Studies*, Akanaksha Publications, Ranchi.
2. Mukherjee, B. 2011: *Fundamentals of Environmental Biology*.Silverline Publications, Allahabad.
3. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
4. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.  Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
5. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
6. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
7. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36---37.  McCully, P. 1996. *Rivers no more: the environmental effects of dams*(pp. 29---64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University

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## II.   <u>GENERIC ELECTIVE (GE 2):</u>                          (Credits: 06)

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

## III. <u>CORE COURSE -C 3:</u>   (Credits: Theory-04, Practicals-02)

**Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100**   **Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10**

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## ORGANIC CHEMISTRY I      **Theory: 60 Lectures**

### Basics of Organic Chemistry

*Organic Compounds:* Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

*Electronic Displacements:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.
Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

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

                  **(6 Lectures)**

### Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: *cis–trans* and, *syn*-anti isomerism *E/Z* notations with C.I.P rules.

*Optical Isomerism:* Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

                  **(18 Lectures)**

### Chemistry of Aliphatic Hydrocarbons

### A. Carbon-Carbon sigma bonds

Chemistry of alkanes:  Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

## B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

*Reactions of alkenes:*  Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic  and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions  in conjugated dienes  and, Diels-Alder reaction;  Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

*Reactions of alkynes:*  Acidity, Electrophilic and Nucleophilic additions. Hydration to form  carbonyl compounds, Alkylation of terminal alkynes.

## C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative  stability:  Energy diagrams  of  cyclohexane:  Chair, Boat  and Twist boat forms; Relative stability with energy diagrams.

**(24 Lectures)**

## Aromatic Hydrocarbons

*Aromaticity:* Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds  with suitable  examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's  alkylation/acylation with their mechanism. Directing effects of the groups.

**(12 Lectures)**

### Reference Books:

1.  Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2.  Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3.  Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4.  Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5.  Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

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## CHEMISTRY PRACTICAL-C 3 LAB                    60 Lectures

1.  Checking the calibration of the thermometer
2.  Purification of organic compounds by crystallization using the following solvents: a. Water
    b.  Alcohol
    c.  Alcohol-Water
3.  Determination of the melting points of above compounds and unknown organic compounds
(Kjeldahl method and electrically heated melting point apparatus)

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds

5. Determination of boiling point of liquid compounds.
   (Boiling point lower than and more than 100 °C by distillation and capillary method)

6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

**Reference Books**

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

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## IV. <u>CORE COURSE -C 4:</u>         (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be* **two** *groups of questions.* **Group A is compulsory** *and will contain five questions of* **very short answer type** *consisting of 1 mark each.* **Group B will contain descriptive type** *three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be* **two** *groups of questions.* **Group A is compulsory** *and will contain two questions.* **Question No.1 will be very short answer type** *consisting of ten questions of 1 mark each.* **Question No.2 will be short answer type** *of 5 marks.* **Group B will contain descriptive type** *five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## PHYSICAL CHEMISTRY II        **Theory: 60 Lectures**

### Chemical Thermodynamics:
Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

*First law:* Concept of heat, $q$, work, $w$, internal energy, $U$, and statement of first law; enthalpy, $H$, relation between heat capacities, calculations of $q$, $w$, $U$ and $H$ for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

*Thermochemistry:* Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

*Second Law:* Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

*Third Law:* Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

*Free Energy Functions:* Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

*Free Energy Functions:* Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

**(36 Lectures)**

**Systems of Variable Composition:**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

**(8 Lectures)**

**Chemical Equilibrium:**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants $Kp$, $Kc$ and $Kx$. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

**(8 Lectures)**

**Solutions and Colligative Properties:**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

**(8 Lectures)**

**Reference Books**

1.  Peter, A. & Paula, J. de. *Physical Chemistry 9ᵗʰ Ed.,* Oxford University Press (2011).
2.  Castellan, G. W. *Physical Chemistry 4ᵗʰ Ed.,* Narosa (2004).
3.  Engel, T. & Reid, P. *Physical Chemistry 3ʳᵈ Ed.,* Prentice-Hall (2012).
4.  McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
5.  Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6.  Levine, I .N. *Physical Chemistry* 6ᵗʰ Ed., Tata Mc Graw Hill (2010).
7.  Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

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# CHEMISTRY PRACTICAL- C 4 LAB              60 Lectures

**Thermochemistry**

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of $\Delta H$.

*Any other experiment carried out in the class.*

**Reference Books**

1.  Khosla, B.D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2.  Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001). -----------------------------------------------------------------------------------------------------------

<div align="center">

## SEMESTER III       5 Papers

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## Total 100 x 5 = 500 Marks

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## I.    SKILL ENHANCEMENT COURSE SEC 1:     (Credits: Theory-02)

| **Marks : 100 (ESE: 3Hrs) =100** | **Pass Marks Th ESE = 40** |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **objective type test** consisting of hundred questions of 1 mark each. Students are required to mark their answer on **OMR Sheet** provided by the University.*

## ELEMENTARY COMPUTER APPLICATION SOFTWARES:

A Common Syllabus Prescribed by Nilamber-Pitamber University        **Theory: 30 Lectures**

### Objective of the Course

*The objective of the course is to generate qualified manpower in the area of Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices, whether Govt. or Private or for future entrepreneurs in the field of IT.*

### A. INTRODUCTION TO COMPUTER SYSTEM

**Basic Computer Concept**

Computer Appreciation - Characteristics of Computers, Input, Output, Storage units, CPU, Computer System.        **(1 Lecture)**

**Input and Output Devices**

Input Devices - Keyboard, Mouse, joystick, Scanner, web cam,

Output Devices- Soft copy devices, monitors, projectors, speakers, Hard copy devices, Printers – Dot matrix, inkjet, laser, Plotters.        **(4 lectures)**

**Computer Memory and Processors**

Memory hierarchy, Processor registers, Cache memory, Primary memory- RAM, ROM, Secondary storage devices, Magnetic tapes, Floppy disks, hard disks, Optical Drives- CD-ROM, DVD-ROM, CD-R, CD-RW, USB Flash drive, Mass storage devices: USB thumb drive. Managing disk Partitions, File System. Basic Processor Architecture, Processor speed, Types of processor.

        **(5 lectures)**

**Numbers Systems and Logic Gates**

Decimal number system, Binary number system, Octal number system, Hexadecimal number system, Inter-conversion between the number systems. Basic Logic gates-AND, OR, NOT, Universal logic gates- NAND, NOR

        **(3 lectures)**

**Computer Software**

Computer Software- Relationship between Hardware and Software, System Software, Application Software, Compiler, Names of some high level languages, Free domain software.

(2 **Lectures**)

## Internet & its uses

History of Internet, WWW and Web Browsers: Web Browsing software, Surfing the Internet, Chatting on Internet, Basic of electronic mail, Using Emails, Document handling, Network definition, Common terminologies: LAN, WAN, MAN, Node, Host, Workstation, Bandwidth, Network Components: Severs, Clients, Communication Media. Wireless network

(3 **Lectures**)

## Operating system-Windows

Operating system and basics of Windows, The User Interface, Using Mouse and Moving Icons on the screen, The My Computer Icon, The Recycle Bin, Status Bar, Start and Menu & Menu-selection, Running an Application, Windows Explorer Viewing of File, Folders and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows, Windows Setting, Control Panels, Wall paper and Screen Savers, Setting the date and Sound, Concept of menu Using Help, Advanced Windows, Using right Button of the Mouse, Creating Short cuts, Basics of Window Setup, Notepad, Window Accessories

(2 **Lectures**)

## B. MICROSOFT OFFICE 2007 AND LATEST VERSIONS

### Word Processing

Word processing concepts: saving, closing, Opening an existing document, Selecting text, Editing text, Finding and replacing text, printing documents, Creating and Printing Merged Documents, Character and Paragraph Formatting, Page Design and Layout. Editing and Checking. Correcting spellings. Handling Graphics, Creating Tables and Charts, Document Templates and Wizards, Mail merge and Macros.

(3 **Lectures**)

### Microsoft Excel (Spreadsheet)

Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, entering data in a cell / formula Copying and Moving from selected cells, handling operators in Formulae, Functions: Mathematical, Logical, statistical, text, financial, Date and Time functions, Using Function Wizard. Formatting a Worksheet: Formatting Cells changing data alignment, changing date, number, character or currency format, changing font, adding borders and colors, Printing worksheets, Charts and Graphs – Creating, Previewing, Modifying Charts. Integrating word processor, spread sheets, web pages. Pivot table, goal seek, Data filter and scenario manager

(4 **Lectures**)

### Microsoft Power Point (Presentation Package)

Creating, Opening and Saving Presentations, Creating the Look of Your Presentation, Working in Different Views, Working with Slides, Adding and Formatting Text, Formatting Paragraphs, Drawing and Working with Objects, Adding Clip Art and other pictures, Designing Slide Shows, Running and Controlling a Slide Show, Printing Presentations. Creating photo album, Rehearse timing and record narration. Master slides.

(3 **Lectures**)

### Reference Books

1. Nishit Mathur, Fundamentals of Computer , Aph publishing corporation(2010)
   Misty E. Vermaat,.Microsoft word 2013 1st Edition (2013).
2. Satish Jain, M.Geeta, MS- Office 2010 Training Guide, BPB publication (2010)
3. Joan Preppernau, Microsoft PowerPoint 2016 step by step, Microsoft press(2015)
4. Douglas E Corner, The Internet Book 4th Edition, prentice –Hall(2009)
5. Faithe wempen, word 2016 in depth  1st edition, que publishing(2015)

6. Steven welkler, Office 2016 for beginners, Create Space Independent publishing Plateform (2016)

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# SKILL ENHANCEMENT LAB- SEC 1 LAB                      **30 Lectures**

## A. <u>MS-WORD LAB ASSIGNMENT</u>

**1.** Write down the following Paragraph OR any one provided by your teacher;

Without a doubt, the Internet is one of the most important inventions of modern times. The Internet is a global interconnected computer networks which allow each connected computer to share and exchange information with each other. The origins of the Internet can be traced to the creation of Advanced Research Projects Agency Network (ARPANET) as a network of computers under the auspices of the U.S. Department of Defense in 1969.

Apply following effects on the paragraph:
i    Paragraph **font-size** and **font-type** must be 12 Verdana.
ii   Paragraph **alignment** must be justified and double line spacing.
iii  **Highlight** the "(ARPANET)" with green color.
iv   Make   the "Internet" keywords **Bold and Italic**.
v    Insert any "**WordArt**" and a **symbol** to your document.
vi   Insert a **clipart** to your document.
vii  Add following lines to your document:
viii Internet, Intranet, Extranet, URL, WWW, Networking, Protocols, HTTP, TCP/IP

**2.** Create a Table of following fields:
Name, Surname, Age, Gender, Job and apply the following effects
   i.    Insert 10 records
   ii.   Font size should be 12
   iii.  Title size should be 14
   iv.  Font type should be Times new Roman
   v.   Title color should be blue
   vi.  Text color should be black
   vii. Table border should be 2

**3.** Write a letter on 'Road Safety' and send to 'Multiple Recipients' using mail merge.

**4.** Type the paragraph given below:

Today, the Internet is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (for Transmission Control Protocol/Internet Protocol). Two recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol. Today, the Internet is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (for Transmission Control Protocol/ Internet Protocol). Two

recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol.

Apply the following:
   i.     Change Internet into Internets at a time
   ii.    Highlight TCP/IP in red colour
   iii.   Replace protocol into protocols
   iv.    Find the word "Public"

## B. MICROSOFT EXCEL  LAB ASSİGNMENT

### Basic Formatting and Spreadsheet Manipulation
1. Add rows and columns to an existing spreadsheet
2. Reformat data (center, comma and currency styles, bold, text color)
3. Work with a simple formula (product) and function (sum)

### Assignment
1. Create a workbook as shown below.
2. To enter new rows or columns, simply click on the row or column header to select the whole row or column. Then right click with the mouse and choose insert.
3. Add the new row for S Spade with the data that's shown below (between the original rows 7 and 8).
4. Add a column for gender and the data as shown below (between the original columns A and B). Enter the appropriate gender for yourself in the last row.

| A | B | C | D |
|---|---|---|---|
| **Name** | **Male/Female** | **Genre** | **Number of Songs** |
| J Smith | F | Blues | 50 |
| B Doe | M | Country | 110 |
| S Spade | F | Country | 200 |
| F Zappa | M | Blues | 1400 |
| F Zappa | M | Alternative | 2300 |
| J Smith | F | Alternative | 150 |
| S Spade | F | Blues | 1000 |
| B Doe | M | Blues | 75 |
| yourname | M | Blues | 800 |

5. Center the data in columns B and C. Do this by selecting the whole column and click the center icon on the ribbon.
6. Bold the data in row 1, the column headings (ensure that the data all remains visible within the column boundaries).
7. Change the font color for row 1 to Blue.

8. Change the format of the data in column D to comma style (no decimal places showing).There is an icon on the home tab that sets it to comma style easily.

9. Add two new column labels to the right of the current columns; **Unit Price** and **Total Cost**. (They will be in columns E and F.) These two columns of data should be currency type so that the dollar sign is shown. There is an icon to quickly format the selected column as currency type.

10. All tunes are $.99, so enter that value for all rows in Column E. You can copy quickly by using the **Auto Fill** handle and drag that amount down. When you over your mouse over the tiny square in the bottom right hand corner of the active cell, your mouse shape will become a skinny plus sign, and you can click and drag that cell to make a copy.



11. Calculate Total Cost (column F) as *column D times Column E*. You will type in a formula like this into cell F2: **=D2*E2** (Be sure to begin the formula with an equal sign)

12. Use the AutoFill (skinny plus sign) again to copy the formula down column F; down to F10. Double check the picture below to make sure yours has the correct values

13. Add a border to all of the cells (A1-f10) using the Borders tool in the Fonts group on the Home Tab.

14. Change the page layout to landscape. Do this by clicking the Page Layout tab on the ribbon and then to Orientation to Landscape.

15. Save the file.

16. Click in cell F11 and Use the sum function or the shortcut icon that looks like ∑ to get the total of the Total Cost column.

17. Ensure that the data is all visible within the column boundaries. Make the columns wider if needed.

18. Save the workbook. Your final spreadsheet should look like the following when printed.

| Name | Male/Female | Genre | Number of Songs | Unit Price | Total Cost |
|---|---|---|---|---|---|
| J Smith | F | Blues | 50 | $ 0.99 | $ 49.50 |
| B Doe | M | Country | 110 | $ 0.99 | $ 108.90 |
| S Spade | F | Country | 200 | $ 0.99 | $ 198.00 |
| F Zappa | M | Blues | 1,400 | $ 0.99 | $ 1,386.00 |
| F Zappa | M | Alternative | 2,300 | $ 0.99 | $ 2,277.00 |
| S Spade | F | Blues | 1,000 | $ 0.99 | $ 990.00 |
| J Smith | F | Alternative | 150 | $ 0.99 | $ 148.50 |
| B Doe | M | Blues | 75 | $ 0.99 | $ 74.25 |
| yourname | M | Blues | 800 | $ 0.99 | $ 792.00 |
| | | | | | $ 6,024.15 |

### Create a sample table given below in Excel

- ➢ Using formula find Total
- ➢ Find the maximum value using MAX function from the **Units** column ➢ Find minimum value from **Total** column

| Order Date | Region | Rep | Item | Units | Unit Cost | Total |
|---|---|---|---|---|---|---|
| 1/6/2016 | East | Jones | Pencil | 95 | 1.99 | 189.05 |
| 1/23/2016 | Central | Kivell | Binder | 50 | 19.99 | 999.50 |
| 2/9/2016 | Central | Jardine | Pencil | 36 | 4.99 | 179.64 |
| 2/26/2016 | Central | Gill | Pen | 27 | 19.99 | 539.73 |
| 3/15/2016 | West | Sorvino | Pencil | 56 | 2.99 | 167.44 |
| 4/1/2016 | East | Jones | Binder | 60 | 4.99 | 299.40 |
| 4/18/2016 | Central | Andrews | Pencil | 75 | 1.99 | 149.25 |
| 5/5/2016 | Central | Jardine | Pencil | 90 | 4.99 | 449.10 |
| 5/22/2016 | West | Thompson | Pencil | 32 | 1.99 | 63.68 |
| 6/8/2016 | East | Jones | Binder | 60 | 8.99 | 539.40 |
| 6/25/2016 | Central | Morgan | Pencil | 90 | 4.99 | 449.10 |
| 7/12/2016 | East | Howard | Binder | 29 | 1.99 | 57.71 |
| 7/29/2016 | East | Parent | Binder | 81 | 19.99 | 1,619.19 |
| 8/15/2016 | East | Jones | Pencil | 35 | 4.99 | 174.65 |
| 9/1/2016 | Central | Smith | Desk | 2 | 125.00 | 250.00 |
| 9/18/2016 | East | Jones | Pen Set | 16 | 15.99 | 255.84 |
| 10/5/2016 | Central | Morgan | Binder | 28 | 8.99 | 251.72 |
| 10/22/2016 | East | Jones | Pen | 64 | 8.99 | 575.36 |
| 11/8/2016 | East | Parent | Pen | 15 | 19.99 | 299.85 |
| 11/25/2016 | Central | Kivell | Pen Set | 96 | 4.99 | 479.04 |
| 12/12/2016 | Central | Smith | Pencil | 67 | 1.29 | 86.43 |
| 12/29/2016 | East | Parent | Pen Set | 74 | 15.99 | 1,183.26 |

## C. MS-POWERPOINT LAB ASSIGNMENT

### Activity 1 : Using Text & Background/Themes
- i.      Create one new slide and insert any text.
- ii.      To make your slide more attractive, use the themes or background. iii. Make sure it apply for every slide not only one slide.

### Activity 2 : Apply Custom Animation On Text
- i.     Use the custom animation to add effects on your text. Set the text move after  you click the mouse.
- ii.     If you have more than one text, add effects for each of text.

### Activity 3 : Insert Image & WordArt
- i.     Insert one new blank slide.
- ii.     Choose one pictures or clip art from any source and insert in your new slide.
- iii.     Using the WordArt, make a note or title on your picture. iv.     Use     the custom animation again to add effects on your picture and WordArt.

**Activity 4 : Insert Text Box**

    i.      Insert one new blank slide. ii.     Use the text box to insert one paragraph of text and adjust your text.

**Activity 5 : Insert Smart Art**

    i.      Insert one new blank slide. ii.     Insert     the Smart Art and put your text on the Smart Art.

**Activity 6 : Insert Audio**

    i.    Back to your first slide and insert one audio on that slide. The audio must play automatically when you show your slide.

    ii.    Make sure the speaker also not appear when you show your slide. (the icon). iii. The audio must play when you show alls your slide, not only one slide.

**Activity 7 : inserting Video**

    i.    Insert one new slide and insert one short video

**Activity 8 : Save File**

    i.    Save your file

**Activity 9 : Create Photo Album & Hyperlink**

    i.    Insert one new slide and put a text ex: "My Photo Album"

    ii.    Create one photo album and adjust your text and your photos

    iii.    Save your photo album with a new file iv.    Make a hyperlink to your photo using the text "My Photo Album"

**Reference Books:**

1. Faithe wempen, word 2016 in depth 1st edition, que publishing(2015)
2. steven welkler, Office 2016 for bignners, Create Space Independent publishing plateform(2016)
3. Elaine Marmel, office 2016 simplified, 1st Edition, John wiley and sons Inc(2016)
4. Patrice-Anne Rutledge, Easy office 2016 1st edition, Que publishing(2016)

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# II.    <u>**GENERIC ELECTIVE (GE 3)**</u>                    (Credits: 06)

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

## III.　CORE COURSE -C 5:　　　　　　(Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# INORGANIC CHEMISTRY-II　　　　　　　　**Theory: 60 Lectures**

### General Principles of Metallurgy
Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

**(6 Lectures)**

### Acids and Bases
Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

**(8 Lectures)**

### Chemistry of *s* and *p* Block Elements:
Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Hydrides and their classification: Ionic, Covalent and Interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.
Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

**(30 Lectures)**

**Noble Gases:**

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of $XeF_2$, $XeF_4$ and $XeF_6$; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for $XeF_2$). Molecular shapes of noble gas compounds (VSEPR theory).

**(8 Lectures)**

**Inorganic Polymers:**

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

**(8 Lectures)**

**Reference Books:**

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
4. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
   Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

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# CHEMISTRY PRACTICAL-C 5 LAB                    60 Lectures

### (A) Iodo / Iodimetric Titrations

(i)     Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(ii)     Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically

(iii)     Estimation of available chlorine in bleaching powder iodometrically

### (B) Inorganic preparations

(i)     Cuprous Chloride, $Cu_2Cl_2$

(ii)     Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$

(iii)     Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

**Reference Book:**

 Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

## IV.　**CORE COURSE -C 6:**

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## ORGANIC CHEMISTRY-II　　　　　　　　　　**Theory: 60 Lectures**

### Chemistry of Halogenated Hydrocarbons:

*Alkyl halides:* Methods of preparation, nucleophilic substitution reactions – $S_N1$, $S_N2$ and $S_Ni$ mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

*Aryl halides:* Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

**(16 Lectures)**

### Alcohols, Phenols, Ethers and Epoxides:

*Alcohols:* preparation, properties and relative reactivity of $1°$, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

*Phenols:* Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

*Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

**(16 Lectures)**

### Carbonyl Compounds:

Structure, reactivity and preparation:

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, ClaisanSchmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations

and reductions  (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PCC);
Addition reactions of unsaturated carbonyl compounds: Michael addition.
Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

(**14 Lectures**)

**Carboxylic Acids and their Derivatives:**
Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic  acids, hydroxy acids  and unsaturated acids:  succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions  of acid chlorides, anhydrides, esters  and amides;  Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of  esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

(**10 Lectures**)

**Sulphur containing compounds:**
Preparation and reactions of thiols, thioethers and sulphonic acids.

(**4 Lectures**)

Reference Books:
1   Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2   Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3   Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.

# CHEMISTRY PRACTICAL- C 6 LAB                    60 Lectures

1.  Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2.  Organic preparations:
   i. Acetylation of  one  of  the  following compounds: amines (aniline, *o*-, *m*-, *p*- toluidines  and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
            a. Using conventional method.                b.    Using green approach
   ii. Benzolyation of one of the following  amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-,
            a.   *m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, p-
            b.   cresol) by Schotten-Baumann reaction.
  iii.   Oxidation of ethanol/ isopropanol (Iodoform reaction).
  iv.    Bromination of any one of the following:
            a.   Acetanilide by conventional methods
            b.   Acetanilide using green approach (Bromate-bromide method)
   v.    Nitration of any one of the following:
            a.   Acetanilide/nitrobenzene by conventional method
            b.   Salicylic acid by green approach (using ceric ammonium nitrate).
      vi.    Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.   vii. Reduction of *p*-nitrobenzaldehyde  by  sodium  borohydride.   viii. Hydrolysis of amides and esters.   ix. Semicarbazone  of  any one  of  the  following compounds:   acetone,  ethyl  methyl ketone, cyclohexanone, benzaldehyde.

   x.    *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

   xi.    Aldol condensation using either conventional or green method. xii.       Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

**Reference Books**

1   Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)

2   Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

3   Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).

4   Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

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## V.    CORE COURSE -C 7:         (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# PHYSICAL CHEMISTRY-III         Theory: 60 Lectures

### Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots.

*Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.
Nernst distribution law: its derivation and applications.

**(28 Lectures)**

### Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

**(18 Lectures)**

**Catalysis:**

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

**(8 Lectures)**

**Surface chemistry:**

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

**(6 Lectures)**

**Reference Books:**

1  Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press (2010).
2  Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3  McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4  Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5  Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
6  *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
7  Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
   Ball, D. W. *Physical Chemistry* Cengage India (2012).
8  Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9  Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
   Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

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# CHEMISTRY PRACTICAL-C 7 LAB                    **60 Lectures**

I.   Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II.  Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
     a. simple eutectic and
        b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV.  Study the equilibrium of at least one of the following reactions by the distribution method:

     (i)  $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

     (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V.   Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction   2.

Integrated rate method:

     a.   Acid hydrolysis of methyl acetate with hydrochloric acid.
     b.   Saponification of ethyl acetate.

3. Compare the strengths of HCl and $H_2SO_4$ by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

   1. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

**Reference Books:**

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

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## SEMESTER IV         5 Papers

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## Total 100 x 5 = 500 Marks

## I.    SKILL ENHANCEMENT COURSE SEC 2:       (Credits: Theory-02)

| Marks : 100 (ESE 3Hrs) =100 | Pass Marks Th ESE = 40 |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of 20 marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## FUEL CHEMISTRY                         30 Lectures

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

*Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of
Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

*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 Xylene.

*Lubricants:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

### Reference Books:
1  Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2  P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3  B.K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.

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## II.    GENERIC ELECTIVE (GE 4)                (Credits: 06)

All Four Papers (One paper to be studied in each semester) of any One Subject to be opted other than the Honours Subject. Refer Content from the Syllabus of Opted Generic Elective Subject.

## III.   CORE COURSE -C 8:                          (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# INORGANIC CHEMISTRY-III                          **Theory: 60 Lectures**

### Coordination Chemistry:
Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq ($\Delta o$), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq ($\Delta o$, $\Delta t$). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

**(26 Lectures)**

### Transition Elements:
General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

**(18 Lectures)**

### Lanthanoids and Actinoids:
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

**(6 Lectures)**

### Bioinorganic Chemistry:
Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium/ K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals.

Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

**(10 Lectures)**

### Reference Books:

1   Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
2   Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
3   Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
4   Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
5   Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6   Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann,1997.

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## CHEMISTRY PRACTICAL -C 8 LAB                    60 Lectures

### Gravimetric Analysis:

i.      Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii.     Estimation of copper as CuSCN
iii.    Estimation of iron as $Fe_2O_3$ by precipitating iron as $Fe(OH)_3$.
iv.     Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxiMe)_3$ (aluminium oxinate).

### Inorganic Preparations:

i.      Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii.     *Cis* and *trans* $K[Cr(C_2O_4)_2. (H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii.    Tetraamminecarbonatocobalt (III) ion
iv.     Potassium tris(oxalate)ferrate(III)

### Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i.      Ni (II) and Co (II)
ii.     Fe (III) and Al (III)

### Reference Book:

☐   Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

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## IV.   CORE COURSE -C 9:          (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# ORGANIC CHEMISTRY-III          Theory: 60 Lectures

### Nitrogen Containing Functional Groups
Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

**(18 Lectures)**

### Polynuclear Hydrocarbons
Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

**(8 Lectures)**

### Heterocyclic Compounds
Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine
(Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and furoic acid.

**(22 Lectures)**

**Alkaloids**

Natural occurrence, General structural features, Isolation and their physiological action.

Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

**(6 Lectures)**

**Terpenes**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

**(6 Lectures)**

**Reference Books:**

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976). Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
5. Kalsi, P. S. *Textbook of Organic Chemistry 1$^{st}$ Ed.*, New Age International (P) Ltd. Pub.
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).

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# CHEMISTRY PRACTICAL -C 9 LAB     60 Lectures

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional 4. groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

**Reference Books**

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic*
3. *Chemistry, 5$^{th}$ Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:*
5. *Preparation and Quantitative Analysis,* University Press (2000).
6. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

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# V.    CORE COURSE -C 10:                    (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*
*Mid Semester Examination (MSE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# PHYSICAL CHEMISTRY-IV                        Theory: 60 Lectures

## Conductance

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.
Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

**(20 Lectures)**

## Electrochemistry

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.
Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.
Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $SbO/Sb_2O_3$ electrodes.
Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).                        **(28 Lectures)**

## Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements.

Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

**(12 Lectures)**

### Reference Books:

1. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
3. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry 5th Ed.,* Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).   Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).   Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.,* John Wiley & Sons, Inc. (2005).

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# CHEMISTRY PRACTICAL-C 10 LAB             60 Lectures

### Conductometry

i.      Determination of cell constant
ii.     Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
iii.    Perform the following conductometric titrations:
       a. Strong acid vs. strong base
       b. Weak acid vs. strong base
       c. Mixture of strong acid and weak acid vs. strong base
       d. Strong acid vs. weak base

### Potentiometry

I. Perform the following potentiometric titrations:
       a. Strong acid vs. strong base
       b. Weak acid vs. strong base
       c. Dibasic acid vs.  strong base
       d. Potassium dichromate vs. Mohr's salt

### Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGrawHill: New York (2003).
3. Halpern, A. M. &  McBane, G. C. Experimental Physical Chemistry 3rd Ed.;  W.H. Freeman & Co.: New York (2003).

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**SEMESTER V**                                                    **4 Papers**

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**Total 100 x 4 = 400 Marks**

**I.    CHEMISTRY SPECIFIC (DSE 1):**            (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer. **Note:** There may be subdivisions in each question asked in Theory Examinations.*

# ANALYTICAL METHODS IN CHEMISTRY            Theory: 60 Lectures

### Qualitative and quantitative aspects of analysis:
Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

**(5 Lectures)**

### Optical methods of analysis:
Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

*UV-Visible Spectrometry:* Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

*Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

*Infrared Spectrometry:* Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

*Flame Atomic Absorption and Emission Spectrometry:* Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and

their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.                                                            **(25 Lectures)**

**Thermal methods of analysis:**

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

**(5 Lectures)**

**Electroanalytical methods:**

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.
Techniques used for the determination of pKa values.

**(10 Lectures)**

**Separation techniques:**

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

**(15 Lectures)**

**Reference Books:**

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

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## CHEMISTRY PRACTICAL-DSE 1 LAB:           **60 Lectures**

### I. Separation Techniques

1. Chromatography:

(a) Separation of mixtures

    (i) Paper chromatographic separation of $Fe^{3+}$, $Al^{3+}$, and $Cr^{3+}$.

    (ii)   Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the $R_f$ values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

### II. Solvent Extractions:

(i)    To separate a mixture of $Ni^{2+}$ & $Fe^{2+}$ by complexation with DMG and extracting the $Ni^{2+}$-DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii)    Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:
(i)   Determination of pH of soil.
(ii)  Total soluble salt
(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:
(i)   Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii)  Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

### III Spectrophotometry

1. Determination of $pK_a$ values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method

**Reference Books:**

1.  Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. By G. H. Jeffery and others) 5$^{th}$ Ed. The English Language Book Society of Longman.
2.  Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3.  Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4.  Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5.  Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6.  Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7.  Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles
8.  Harwood Ltd. London.
9.  Ditts, R.V. Analytical Chemistry – Methods of separation.

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## II.    CHEMISTRY SPECIFIC (DSE 2):           (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

***Instruction to Question Setter for***

*Mid Semester Examination (MSE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# POLYMER CHEMISTRY                        Theory: 60 Lectures

**Introduction and history of polymeric materials:**
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

**(4 Lectures) Functionality and its importance:**
Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi- functional systems, Poly-functional systems.

**(8 Lectures) Kinetics of Polymerization:**

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

**(8 lectures)**

## Crystallization and crystallinity:
Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

**(4 Lectures)**

**Nature and structure of polymers**-Structure Property relationships.

**(2 Lectures)**

**Determination of molecular weight of polymers** ($M_n$, $M_w$, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

**(8 Lectures)**

**Glass transition temperature (Tg) and determination of Tg**, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

**(8 Lectures)**

**Polymer Solution** – Criteria for polymer solubility, Solubility parameter, Thermodynamics

of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**(8 Lectures)**

**Properties of Polymer**s (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

**(10 Lectures)**

**Reference Books:**

1. *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

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# CHEMISTRY PRACTICAL-DSE 2 LAB          **60 Lectures**

### Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
2. Purification of monomer
3. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
4. Preparation of nylon 66/6
5. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
6. a. Preparation of IPC    b. Purification of IPC    c. Interfacial polymerization
7. Redox polymerization of acrylamide
8. Precipitation polymerization of acrylonitrile
9. Preparation of urea-formaldehyde resin
10. Preparations of novalac resin/resold resin.
11. Microscale Emulsion Polymerization of Poly(methylacrylate).

### Polymer characterization

1. Determination of molecular weight by viscometry:   (a) Polyacrylamide-aq.$NaNO_2$ solution
         (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

### Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques        3. IR studies of polymers
4. DSC analysis of polymers     5. Preparation of polyacrylamide and its electrophoresis  *at least 7 experiments to be carried out.

### Reference Books:

1  Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2  Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
3  Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4  Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
5  Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6  L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)

    Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)

7  Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

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## III.     CORE COURSE -C 11:               (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

<u>*Mid Semester Examination (MSE):*</u>

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

<u>*End Semester Examination (ESE):*</u>

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# ORGANIC CHEMISTRY-IV               Theory: 60 Lectures

### Nucleic Acids
Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

**(9 Lectures)**

### Amino Acids, Peptides and Proteins
Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p$K_a$ values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

**(16 Lectures)**

### Enzymes
Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

**(8 Lectures)**

### Lipids
Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

**(8 Lectures)**

### Concept of Energy in Biosystems
Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: $NAD^+$, FAD.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.

Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

**(7 Lectures)**

**Pharmaceutical Compounds: Structure and Importance**

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

**(12 Lectures)**

**Reference Books:**

1  Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
2  Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry XXVIII edition. Lange Medical Books/ McGraw-Hill.

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# CHEMISTRY PRACTICAL-C 11 LAB                    60 Lectures

1.  Estimation of glycine by Sorenson's formalin method.
2.  Study of the titration curve of glycine.
3.  Estimation of proteins by Lowry's method.
4.  Study of the action of salivary amylase on starch at optimum conditions.
5.  Effect of temperature on the action of salivary amylase.
6.  Saponification value of an oil or a fat.
7.  Determination of Iodine number of an oil/ fat.
8.  Isolation and characterization of DNA from onion/ cauliflower/peas.

**Reference Books:**

1  Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi. Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

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## IV.  <u>CORE COURSE -C 12:</u>                    (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

<u>*Mid Semester Examination (MSE):*</u>

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

<u>*End Semester Examination (ESE):*</u>

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# PHYSICAL CHEMISTRY V                    Theory: 60 Lectures

### Quantum Chemistry
Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free  particle  and "particle-in-a-box" (rigorous  treatment), quantization of  energy levels, zero-point  energy and Heisenberg Uncertainty principle;  wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and zcomponent.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of chrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of  Schrödinger equation for many-electron atoms  (He, Li).  Need for approximation methods. Statement  of  variation theorem  and application to simple  systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital  approaches, LCAO-MO treatment of $H_2^+$. Bonding and antibonding orbitals. Qualitative extension to $H_2$. Comparison of LCAO-MO and VB treatments of $H_2$ (only wavefunctions, detailed solution not  required) and their limitations. Refinements  of  the  two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH$_2$, H$_2$O) molecules. Qualitative MO theory and its application to AH$_2$ type molecules.

**(24 Lectures)**

**Molecular Spectroscopy:**

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

**(24 Lectures)**

**Photochemistry**

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

**(12 Lectures)**

**Reference Books:**

1. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGrawHill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005). Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

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# CHEMISTRY PRACTICAL-C 12 LAB         **60 Lectures**

### UV/Visible spectroscopy

I.    Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M $H_2SO_4$) and determine the $\lambda_{max}$ values. Calculate the energies of the two transitions in different units (J molecule$^{-1}$, kJ mol$^{-1}$, cm$^{-1}$, eV).

II.   Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

### Colourimetry

I.    Verify Lambert-Beer's law and determine the concentration of $CuSO_4/KMnO_4/K_2Cr_2O_7$ in a solution of unknown concentration

II.   Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline. V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analysis of the given vibration-rotation spectrum of HCl (g)

### Reference Books

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

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8$^{th}$ Ed.;* McGraw-Hill: New York (2003).

3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3$^{rd}$ Ed.;* W.H. Freeman & Co.: New York (2003).

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## SEMESTER VI                    4 Papers

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## Total 100 x 4 = 400 Marks

## I.    CHEMISTRY SPECIFIC (DSE 3):               (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# GREEN CHEMISTRY                          Theory: 60 Lectures

### Introduction to Green Chemistry
What is Green Chemistry?  Need for Green Chemistry. Goals of Green Chemistry.
Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

**(4 Lectures)**

### Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

**(24 Lectures)**

### Examples of Green Synthesis/ Reactions
1.    Green Synthesis of the following compounds:  adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.
2.    Microwave assisted reactions in water:  Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate  to benzole  acid), Oxidation (of   toluene,

alcohols).   Microwave assisted reactions in organic solvents:  Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

Microwave assisted solid state reactions:  Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

3.    Ultrasound assisted reactions:    Esterification,  saponification,  substitution  reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

4.    Selective methylation of active methylene group using dimethylcarbonate:   Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

**(24 Lectures)  Future Trends in Green Chemistry**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

**(8 Lectures)**

**Reference Books**:
1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

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# CHEMISTRY PRACTICAL-DSE 3 LAB                    60 Lectures

### 1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

i.        Effect of concentration on clock reaction

ii.       Effect of temperature on clock reaction. (if possible)

### 2. Using renewable resources
Preparation of biodiesel from vegetable oil.

### 3. Avoiding waste
Principle of atom economy.  Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

I.      Triethylamine ion +  OH$^-$ → Propene  +  trimethylpropene  + water

$$H_2SO_4/\Delta$$
II.     1-Propanol          →          Propene  +  water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

**4.  Use of enzymes as catalysts**
Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

**Alternative Green solvents**

**5.  Diels Alder reaction in water**
Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

**6.** Extraction of D-limonene from orange peel using liquid $CO_2$ prepared form dry ice.

**7.** Mechanochemical solvent free synthesis of azomethines

**8.** Co-crystal controlled solid state synthesis ($C^2S^3$) of  N-organophthalimide   using phthalic anhydride and 3-aminobenzoic acid.

**Alternative sources of energy**

**9.** Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of Copper(II).

**10.** Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

**Reference Books:**
1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory  and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate  chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand;   (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C.  & Connelly, M. E. *Real  world cases  in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).
7. Pavia, D. L. Lamponan, G. H. &Kriz, G.S. *W B Introduction to organic laboratory*.

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## II.   **CHEMISTRY SPECIFIC (DSE 4):**     (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** group of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# INDUSTRIAL CHEMICALS AND ENVIRONMENT
## Theory: 60 Lectures
### Industrial Gases and Inorganic Chemicals

*Industrial Gases:* Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

*Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

**(10 Lectures)**

### Industrial Metallurgy
Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

**(4 Lectures)**

### Environment and its segments
Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by $SO_2$, $CO_2$, $CO$, $NOx$, $H_2S$ and other foul smelling gases. Methods of estimation of $CO$, $NO_x$, $SO_x$ and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

*Water Pollution:* Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Industrial effluents from the following industries and their treatment: electroplating, textile, annery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

**(30 Lectures)**

## Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

**(10 Lectures)**

## Bio-catalysis

Introduction to bio catalysis: Importance in "Green Chemistry" and Chemical Industry.

**(6 Lectures)**

### Reference Books:

1. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

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# CHEMISTRY PRACTICAL-DSE 4 LAB:            60 Lectures

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples ($CO_3^{2-}$, $HCO_3^-$) using double titration method.
7. Measurement of dissolved $CO_2$.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

### Reference Books:

1. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

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## III.  <u>CORE COURSE -C 13:</u>          (Credits: Theory-04, Practicals-02)

| | |
|---|---|
| **Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100** | **Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10** |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.*

*End Semester Examination (ESE):*

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# INORGANIC CHEMISTRY-IV            **Theory: 60 Lectures**

## Theoretical Principles in Qualitative Analysis ($H_2S$ Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

**(10 Lectures)**

## Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

**(22 Lectures)**

**Reaction Kinetics and Mechanism**

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar omplexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

**(18 Lectures)  Catalysis by Organometallic Compounds**

Study of the following industrial processes and their mechanism:
1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

**(10 Lectures)**

**Reference Books:**

1   Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972 Svehla, G.
2   *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, 1996-03-07.
3   Cotton, F.A. G.;  Wilkinson &  Gaus, P.L. *Basic Inorganic Chemistry 3$^{rd}$  Ed.;* Wiley India,
4   Huheey, J. E.;  Keiter, E.A. &  Keiter, R.L. *Inorganic  Chemistry, Principles  of  Structure and Reactivity 4$^{th}$ Ed.,* Harper Collins 1993, Pearson,2006.
5   Sharpe, A.G. *Inorganic Chemistry*, 4$^{th}$ Indian Reprint (Pearson Education) 2005
6   Douglas, B. E.;  McDaniel, D.H. &  Alexander, J.J. *Concepts   and Models   in Inorganic Chemistry3$^{rd}$ Ed.,* John Wiley and Sons, NY, 1994.
7   Greenwood, N.N. &  Earnshaw, A. *Chemistry  of  the  Elements*, *Elsevier 2$^{nd}$  Ed*, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
8   Lee, J.D. *Concise Inorganic Chemistry 5$^{th}$ Ed.,* John Wiley and sons 2008.
9   Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
10  Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2$^{nd}$ Ed.,* Oxford University Press, 1994.
11  Basolo, F. &  Person, R. *Mechanisms  of  Inorganic  Reactions: Study  of  Metal Complexes in Solution 2$^{nd}$ Ed.,* John Wiley & Sons Inc; NY.
12  Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
13  Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4$^{th}$ Ed.,* Pearson, 2010.
14  Collman, James  P. et  al. *Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
15  Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals*. *J* New York, NY: John Wiley, 2000.
16  Spessard, Gary  O., &Gary  L. Miessler. *Organometallic Chemistry*. Upper Saddle  River, NJ: Prentice-Hall, 1996.

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# CHEMISTRY PRACTICAL-C 13 LAB                    **60 Lectures**

Qualitative  semimicro analysis  of  mixtures  containing 3 anions  and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

$CO_3^{2-}$, $NO_2^-$, $S^{2-}$, $SO_3^{2-}$, $S_2O_3^{2-}$, $CH_3COO^-$, $F^-$, $Cl^-$, $Br^-$, $I^-$, $NO_3^-$, $BO_3^{3-}$, $C_2O_4^{2-}$, $PO_4^{3-}$, $NH_4^+$, $K^+$, $Pb^{2+}$, $Cu^{2+}$, $Cd^{2+}$, $Bi^{3+}$, $Sn^{2+}$, $Sb^{3+}$, $Fe^{3+}$, $Al^{3+}$, $Cr^{3+}$, $Zn^{2+}$, $Mn^{2+}$, $Co^{2+}$, $Ni^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $Mg^{2+}$

Mixtures  should preferably contain:

i.      one  interfering anion, **or**

ii.     iinsoluble  component  ($BaSO_4$, $SrSO_4$, $PbSO_4$, $CaF_2$ or $Al_2O_3$) **or**

iii.    combination of anions e.g. $CO_3^{2-}$and $SO_3^{2-}$,   $NO_2^-$ and $NO_3^-$,  $Cl^-$ and $Br^-$,   $Cl^-$ and $I^-$, $Br^-$ and  $I^-$, $NO_3^-$ and  $Br^-$, $NO_3^-$ and $I^-$.

 Spot tests should be done whenever possible.

i.      Measurement of 10 Dq by spectrophotometric method

ii.     Verification of spectrochemical series.

iii.    Controlled synthesis  of  two copper oxalate  hydrate  complexes: kinetic  vs thermodynamic factors.

iv.     Preparation of acetylacetanato complexes of $Cu^{2+}$/$Fe^{3+}$. Find the $\lambda_{max}$ of the complex.

v.      Synthesis  of  ammine  complexes  of  Ni(II) and  its  ligand exchange  reactions  (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

### Reference Books

1.  Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla.
2.  Marr & Rockett *Inorganic Preparations.*

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## IV.   CORE COURSE -C 14:                    (Credits: Theory-04, Practicals-02)

| Marks : 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th (MSE +ESE) = 30 + Pr ESE =10 |
| --- | --- |

*Instruction to Question Setter for*

*Mid Semester Examination (MSE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** three questions of five marks each, out of which any two are to answer.

*End Semester Examination (ESE):*

There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## ORGANIC CHEMISTRY-IV                    Theory: 60 Lectures

### Organic Spectroscopy

General principles Introduction to absorption and emission spectroscopy.

*UV Spectroscopy:* Types  of  electronic  transitions, $\lambda_{max}$, Chromophores  and Auxochromes, Bathochromic  and Hypsochromic  shifts, Intensity of  absorption; Application of  Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids  and esters; Conjugated dienes:  alicyclic, homoannular and heteroannular; Extended conjugated systems  (aldehydes, ketones  and dienes);  distinction between cis  and trans isomers.

*IR Spectroscopy:* Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

*NMR Spectroscopy:* Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.  Applications of IR, UV and NMR for identification of simple organic molecules.

**(24 Lectures)**

**Carbohydrates**
Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers  and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation;

Disaccharides – Structure elucidation of maltose, lactose and sucrose.
Polysaccharides – Elementary treatment of starch, cellulose and glycogen.          **(16   Lectures)**

**Dyes**
Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet;
Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

**(8 Lectures)**

**Polymers**
Introduction and classification including di-block, tri-block and amphiphilic polymers;
Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

 Polymerisation reactions  -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes;
Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);
Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives;
Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

**(12 Lectures)**

**Reference Books:**

1.  Kalsi, P. S. *Textbook of Organic Chemistry 1ˢᵗ Ed.*, New Age International (P) Ltd. Pub.
2.  Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3.  Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.

4. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.

5. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

6. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.

7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan (2010). Kemp, W. *Organic Spectroscopy*, Palgrave

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## CHEMISTRY PRACTICAL-C XIV LAB                                         **60 Lectures**

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

**Reference Books:**
1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

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COURSES OF STUDY FOR **GENERIC ELECTIVE 'B. Sc. Hons'** PROGRAMME IN

**"CHEMISTRY"**

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**SEMESTER I**              **GENERIC ELECTIVE**               **1 Paper**

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**Total 100 x 1 = 100 Marks**

**I.**      <u>**GENERIC ELECTIVE (GE 1)**</u>       (Credits: Theory-04, Practicals-02)

➢ All Four Generic Papers (One paper to be studied in each semester) of Chemistry to be studied by the Students of **Other than Chemistry Honours.**

➢ Students of **Chemistry Honours** must Refer Content from the **Syllabus of Opted Generic Elective Subject**.

| Marks : 75 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th ESE = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

## ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

**Theory: 60 Lectures**

*Section A: Inorganic Chemistry-1* **(30 Periods)**

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

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

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of halffilled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

**(14 Lectures)**

## Chemical Bonding and Molecular Structure

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

*Covalent bonding:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and $NO^+$. Comparison of VB and MO approaches.

**(16 Lectures)**

*Section B: Organic Chemistry-1* **(30 Periods)**

## Fundamentals of Organic Chemistry

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

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

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

**(8 Lectures)**

## Stereochemistry

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

**(10 Lectures)**

### Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Alkanes:** (Upto 5 Carbons).

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

**Alkenes:** (Upto 5 Carbons)

*Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecurationdemercuration, Hydroboration-oxidation.

**Alkynes**: (Upto 5 Carbons)

*Preparation:* Acetylene from $CaC_2$ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

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

**(12 Lectures)**

**Reference Books:**

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

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# CHEMISTRY PRACTICAL-GE1 LAB:                    60 Lectures

*Section A: Inorganic Chemistry - Volumetric Analysis*

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

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

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

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

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

### *Section B: Organic Chemistry*

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

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

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

**Reference Books:**
1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

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## SEMESTER II                       GENERIC ELECTIVE                              1 Paper
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**Total 100 x 1 = 100 Marks**

## II.      GENERIC ELECTIVE (GE 2)                    (Credits: Theory-04, Practicals-02)

| Marks : 75 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th ESE = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP; ORGANIC CHEMISTRY-I Theory: 60 Lectures

*Section A: Physical Chemistry-1* (30 Lectures)

## Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

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

**(10 Lectures)**

## Chemical Equilibrium:

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

**(8 Lectures)**

## Ionic Equilibria:

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

**(12 Lectures)**

*Section B: Organic Chemistry-2* (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

## Aromatic hydrocarbons

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

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

**(8 Lectures)**

## Alkyl and Aryl Halides

## Alkyl Halides (Upto 5 Carbons)

Types of Nucleophilic Substitution ($S_N1$, $S_N2$ and $S_Ni$) reactions. *Preparation:*
from alkenes *and* alcohols.

*Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

**Aryl Halides** *Preparation:*

(Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: $KNH_2/NH_3$ (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

**(8 Lectures)**

**Alcohols, Phenols and Ethers** (Up to 5 Carbons)

**Alcohols:**

*Preparation:* Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

*Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO4$, acidic dichromate, conc. $HNO3$). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. PinacolPinacolone rearrangement.

**Phenols:** (Phenol case)

*Preparation:* Cumene hydroperoxide method, from diazonium salts.

*Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

**Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

**Aldehydes and ketones (aliphatic and aromatic):**

(Formaldehye, acetaldehyde, acetone and benzaldehyde)

*Preparation:* from acid chlorides and from nitriles.

*Reactions* – Reaction with HCN, ROH, $NaHSO_3$, $NH_2$-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

**(14 Lectures)**

**Reference Books:**

1. T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
   I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
3. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
4. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
   G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
5. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
6. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
7. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
8. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

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# CHEMISTRY PRACTICAL-GE2  LAB                    **60 Lectures**

*Section A: Physical Chemistry*
**Thermochemistry**
1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts ($KNO_3$, $NH_4Cl$).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of $\Delta H$.

**Ionic equilibria** pH measurements
a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.  b) Preparation of buffer solutions:
    i.     Sodium acetate-acetic acid
    ii.    Ammonium chloride-ammonium hydroxide
Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

*Section B: Organic Chemistry*
1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
4. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
    (a) Bromination of Phenol/Aniline
    (b) Benzoylation of amines/phenols
    (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

**Reference Books**

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
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**SEMESTER III**             **GENERIC ELECTIVE**            **1 Paper**

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**Total 100 x 1 = 100 Marks**

**III.   GENERIC ELECTIVE (GE 3) )**     (Credits: Theory-04, Practicals-02)

| Marks : 75 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th ESE = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# CHEMISTRY OF *S-* AND *P*-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS

**Theory: 60 Lectures**

### General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

**(4 Lectures)**

### *s*- and *p*-Block Elements

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

### Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.

Concept of multicentre bonding (diborane). Structure, bonding and their important properties

like oxidation/reduction, acidic/basic nature of the following compounds and their applications

in industrial, organic and environmental chemistry. Hydrides of nitrogen ($NH_3$, $N_2H_4$, $N_3H$,

$NH_2OH$)  Oxoacids of P, S and Cl.

Halides and oxohalides: $PCl_3$, $PCl_5$, $SOCl_2$ and $SO_2Cl_2$

**(26 Lectures)**

## *Section B: Physical Chemistry-3* (**30 Lectures**)

### Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

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 of $CO_2$.

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 cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

### Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

### Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

### Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors 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. Comparison of the two theories (qualitative treatment only).

### Reference Books:
1. G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
5. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
8. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
   Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.

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# CHEMISTRY PRACTICAL-GE3  LAB          **60 Lectures**

### Section A: Inorganic Chemistry

Semi-micro qualitative analysis using $H_2S$ of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations :

$NH_4^+$, $Pb^{2+}$, $Ag^+$, $Bi^{3+}$, $Cu^{2+}$, $Cd^{2+}$, $Sn^{2+}$, $Fe^{3+}$, $Al^{3+}$, $Co^{2+}$, $Cr^{3+}$, $Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $K^+$

Anions :

$CO_3^{2-}$ , $S^{2-}$, $SO_2^-$, $S_2O_3^{2-}$, $NO_3^-$, $CH_3COO^-$, $Cl^-$, $Br^-$, $I^-$, $NO_3^-$, $SO_4^{2-}$, $PO_4^{3-}$, $BO_3^{3-}$, $C_2O_4^{2-}$, $F^-$

*(Spot tests should be carried out wherever feasible)*

### Section B: Physical Chemistry

(I)   Surface tension measurement (use of organic solvents excluded).

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

     b) Study of the variation of surface tension of a detergent solution with concentration.

(II)  Viscosity measurement (use of organic solvents excluded).

     a)    Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

     b)    Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

     a.    Initial rate method: Iodide-persulphate reaction
     b.    Integrated rate method:
     c.    Acid hydrolysis of methyl acetate with hydrochloric acid.
     d.    Saponification of ethyl acetate.
     e.    Compare the strengths of HCl and $H_2SO_4$ by studying kinetics of hydrolysis of methyl acetate

#### Reference Books:

1.  A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2.  A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3.  B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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**SEMESTER IV**          **GENERIC ELECTIVE**                    **1 Paper**

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**Total 100 x 1 = 100 Marks**

**IV.    GENERIC ELECTIVE (GE 4) )**                    (Credits: Theory-04, Practicals-02)

| Marks : 75 (ESE: 3Hrs) + 25 (Pr 3Hrs)=100 | Pass Marks: Th ESE = 30 + Pr ESE =10 |
|---|---|

*Instruction to Question Setter for*

*End Semester Examination (ESE):*

*There will be **two** group of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in Theory Examinations.*

# CHEMISTRY OF *d*-BLOCK ELEMENTS, MOLECULES OF LIFE
## Theory: 60 Lectures
*Section A: Inorganic Chemistry-3* (30 Lectures)

**Transition Elements (3d series)**
General group trends 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.

**(8 Lectures)**

**Coordination Chemistry**
Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.
Drawbacks of VBT. IUPAC system of nomenclature.

**(8 Lectures)**

**Crystal Field Theory**
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Dq. Spectrochemical series. Comparison of CFSE for $O_h$ and $T_d$ complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

**(8 Lectures)**

*Section B: Organic Chemistry*

**Unit 1: Carbohydrates**
Classification of carbohydrates, reducing and non reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

**(10 Periods)**

## Unit 2: Amino Acids, Peptides and Proteins

Classification of Amino Acids, Zwitterion structure and Isoelectric point

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (upto dipeptides) by N-protection (t- butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

**(10 Periods)**

## Unit 3: Enzymes and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecifity).

Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibtion).

Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, -NH$_2$ group, double bond and aromatic ring,

**(8 Periods)**

## Unit 5: Lipids

Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

**(8 Periods)**

### Reference Books:

1. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
2. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
3. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
4. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
5. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
6. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
7. 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).
10. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7$^{th}$ Ed.,* W. H. Freeman.

    Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7$^{th}$ Ed.,* W. H. Freeman.

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# CHEMISTRY PRACTICAL-GE4 LAB                    60 Lectures

### Section A: Inorganic Chemistry

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) $Mg^{2+}$ or (ii) $Zn^{2+}$ by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.
5. Determination of the composition of the $Fe^{3+}$salicylic acid complex/ $Fe^{2+}$phenanthroline complex in solution by Job's method.
6. Determination of concentration of Na+ and K+ using Flame Photometry.

### Section B: Organic Chemistry

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. To determine the saponification value of an oil/fat.
5. To determine the iodine value of an oil/fat
6. Differentiate between a reducing/ non-reducing sugar.
7. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

**Reference Books:**

1. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
4. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R.
5. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

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SAMPLE CALCULATION FOR SGPA & CGPA FOR UNDERGRADUATE 'B.Sc./B.A./B.Com

Honours & General' PROGRAMME

# Distribution of Credits Semester wise for Undergraduate Honours Courses

## Table B-1: UG (B.A./ B.Sc./B.Com. Hons. Programme)

### Semester wise distribution of 140 Credits

|  | C.C | AECC | GE | SEC | DSE | Total credits |
|---|---|---|---|---|---|---|
| Semester I | 12 | 02 | 06 |  |  | 20 |
| Semester II | 12 | 02 | 06 |  |  | 20 |
| Semester III | 18 |  | 06 | 02 |  | 26 |
| Semester IV | 18 |  | 06 | 02 |  | 26 |
| Semester V | 12 |  |  |  | 12 | 24 |
| Semester VI | 12 |  |  |  | 12 | 24 |
|  | **84** | **04** | **24** | **04** | **24** | **140** |

CC=Core Course; AECC=Ability Enhancement Compulsory Course; GE=Generic Elective; SEC=Skill Enhancement Course; DSE=Discipline Specific Elective

## Table B-2: UG (B.A./ B.Sc./B.Com. Programme)

### Semester wise distribution of 120 Credits

|  | C.C | AECC | GE | SEC | DSE | Total credits |
|---|---|---|---|---|---|---|
| Semester I | 18 | 02 |  |  |  | 20 |
| Semester II | 18 | 02 |  |  |  | 20 |
| Semester III | 18 |  |  | 02 |  | 20 |
| Semester IV | 18 |  |  | 02 |  | 20 |
| Semester V |  |  |  | 02 | 18 | 20 |
| Semester VI |  |  |  | 02 | 18 | 20 |
|  | **72** | **04** |  | **08** | **36** | **120** |

CC=Core Course; AECC=Ability Enhancement Compulsory Course; GE=Generic Elective; SEC=Skill Enhancement Course; DSE=Discipline Specific Elective

**Table B-3: Sample calculation for SGPA for B.Sc./B.A./B.Com Honours Programme**

| Course | Credit | Grade Letter | Grade Point | Credit Point (Credit X Grade) | SGPA (Credit Point/Credit) |
|---|---|---|---|---|---|
| **Semester I** | | | | | |
| C-1 | 06 | A | 8 | 48 | |
| C-2 | 06 | B+ | 7 | 42 | |
| AECC-1 | 02 | B | 6 | 12 | |
| GE-1 | 06 | B | 6 | 36 | |
| **Total** | **20** | | | **138** | **6.9 (138/20)** |
| **Semester II** | | | | | |
| C-3 | 06 | B | 6 | 36 | |
| C-4 | 06 | C | 5 | 30 | |
| AECC-2 | 02 | B+ | 7 | 14 | |
| GE-2 | 06 | A+ | 9 | 54 | |
| **Total** | **20** | | | **134** | **6.7 (134/20)** |
| **Semester III** | | | | | |
| C-5 | 06 | A+ | 9 | 54 | |
| C-6 | 06 | 0 | 10 | 60 | |
| C-7 | 06 | A | 8 | 48 | |
| SEC-1 | 02 | A | 8 | 16 | |
| GE-3 | 06 | 0 | 10 | 60 | |
| **Total** | **26** | | | **238** | **9.15 (238/26)** |
| **Semester IV** | | | | | |
| C-8 | 06 | B | 6 | 36 | |
| C-9 | 06 | A+ | 9 | 54 | |
| C-10 | 06 | B | 6 | 36 | |
| SEC-2 | 02 | A+ | 9 | 18 | |
| GE-4 | 06 | A | 8 | 48 | |
| **Total** | **26** | | | **192** | **7.38 (192/26)** |
| **Semester V** | | | | | |
| C-11 | 06 | B | 6 | 36 | |
| C-12 | 06 | B+ | 7 | 42 | |
| DSE-1 | 06 | 0 | 10 | 60 | |
| DSE-2 | 06 | A | 8 | 48 | |
| **Total** | **24** | | | **186** | **7.75 (186/24)** |
| **Semester VI** | | | | | |
| C-13 | 06 | A+ | 9 | 54 | |
| C-14 | 06 | A | 8 | 48 | |
| DSE-3 | 06 | B+ | 7 | 42 | |
| DSE-4 | 06 | A | 8 | 48 | |
| **Total** | **24** | | | **192** | **8.0 (192/24)** |
| **CGPA** | | | | | |
| **Grand Total** | **140** | | | **1080** | **7.71 (1080/140)** |

**Table B-4: Sample calculation for CGPA for B.Sc./B.A./B. Com Honours Programme**

| Semester I | Semester II | Semester III | Semester IV | Semester V | Semester VI |
|---|---|---|---|---|---|
| Credit:20; SGPA:6.9 | Credit:20; SGPA: 6.7 | Credit:26; SGPA: 9.15 | Credit:26; SGPA: 7.38 | Credit:24; SGPA: 7.75 | Credit:24; SGPA: 8.0 |

Thus CGPA= (20x6.9+20x6.7+26x9.15+26x7.38+24x7.75+24x8.0)/140=**7.71**

**Table B-5: Sample calculation for SGPA for B.A./B.Sc./B.Com. Program**

| Course | Credit | Grade Letter | Grade Point | Credit Point (Credit X Grade) | SGPA (Credit Point/Credit) |
|---|---|---|---|---|---|
| **Semester I** | | | | | |
| DSC - 1A | 06 | B | 6 | 36 | |
| DSC - 2A | 06 | B+ | 7 | 42 | |
| DSC - 3A | 06 | C | 5 | 30 | |
| AECC – 1 | 02 | **B** | 6 | 12 | |
| **Total** | **20** | | | **120** | **6.0 (120/20)** |
| **Semester II** | | | | | |
| DSC - 1B | 06 | B | 6 | 36 | |
| DSC - 2B | 06 | B | 6 | 36 | |
| DSC - 3B | 06 | C | 5 | 30 | |
| AECC – 2 | 02 | A+ | 9 | 18 | |
| **Total** | **20** | | | **120** | **6.0 (120/20)** |
| **Semester III** | | | | | |
| DSC - 1C | 06 | A | 8 | 48 | |
| DSC - 2C | 06 | A+ | 9 | 54 | |
| DSC - 3C | 06 | A | 8 | 48 | |
| SEC – 1 | 02 | A | 8 | 16 | |
| **Total** | **20** | | | **166** | **8.3 (166/20)** |
| **Semester IV** | | | | | |
| DSC - 1D | 06 | C | 5 | 30 | |
| DSC - 2D | 06 | B | 6 | 36 | |
| DSC - 3D | 06 | B+ | 7 | 42 | |
| SEC - 2 | 02 | A+ | 9 | 18 | |
| **Total** | **20** | | | **126** | **6.3 (126/20)** |
| **Semester V** | | | | | |
| DSE - 1A | 06 | B | 6 | 36 | |
| DSE - 2A | 06 | A+ | 9 | 54 | |
| DSE - 3A | 06 | A | 8 | 48 | |
| SEC – 3 | 02 | B | 6 | 12 | |
| **Total** | **20** | | | **150** | **7.5 (150/20)** |
| **Semester VI** | | | | | |
| DSE - 1B | 06 | B+ | 7 | 42 | |
| DSE - 1B | 06 | B | 6 | 36 | |
| DSE - 1B | 06 | C | 5 | 30 | |
| SEC - 4 | 02 | C | 5 | 10 | |
| **Total** | **20** | | | **118** | **5.9 (118/20)** |
| **CGPA** | | | | | |
| **Grand Total** | **120** | | | **800** | **6.67 (800/120)** |

### Table B- 6: Sample calculation for CGPA for B.A./B.Sc./B.Com. Program

| Semester I | Semester II | Semester III | Semester IV | Semester V | Semester VI |
|---|---|---|---|---|---|
| Credit:20; SGPA: 6.0 | Credit:20; SGPA: 6.0 | Credit:20; SGPA: 8.3 | Credit:20; SGPA: 6.3 | Credit:20; SGPA: 7.5 | Credit:20; SGPA: 5.9 |

**Thus CGPA=** (20x6.0+20x6.0+20x8.3+20x6.3+20x7.5+20x5.9)/120=**6.67**

MARKS DISTRIBUTION FOR EXAMINATIONS AND FORMAT OF QUESTION PAPERS

### Marks Distribution of Mid Semester Theory Examinations:

**Table No. 15:** Marks distribution of Theory Examinations of Mid Semester

| Topic | Code | Full Marks | Pass Marks | Time | Group-A (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M. | Group-B (Descriptive Questions with Choices) No. of Questions x Marks = F.M. | Total No. of Questions to Set | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Group A | Group B |
| Mid Sem* | T15 | 15 | 6 | 1 Hr | 5 x1 =5 | 2 (out of 3) x5 =10 | 5 | 3 |
| | T25 | 25 | 10 | 1 Hr | 5 x1 =5 | 4 (out of 6) x5 =20 | 5 | 6 |

### Marks Distribution of End Semester Theory Examinations:

**Table No. 16:** Marks distribution of Theory Examinations of End Semester

| Topic | Code | Full Marks | Pass Marks | Time | Group-A# (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M. | Group-B (Descriptive Questions with Choices ) No. of Questions x Marks = F.M. | Total No. of Questions to Set | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Group A# | Group B |
| End Sem | T60 | 60 | 24 | 3 Hrs | Q.No.1 (10x1) + 1x5 =15 | 3 (out of 5) x15 =45 | 2 | 5 |
| | T75 | 75 | 30 | 3 Hrs | Q.No.1 (10x1) + 1x5 =15 | 4 (out of 6) x15 =60 | 2 | 6 |
| | T100 | 100 | 40 | 3 Hrs | Q.No.1 (10x1) + 2x5 =20 | 4 (out of 6) x20 =80 | 3 | 6 |
| | T50 +T50 | 50X2=100 | 20 | 3 Hrs | 2 x5 =10 | 2 (out of 3) x20 =40 | 2 | 3 |

**# Question No.1 in Group-A carries 10 very short answer type 1 Mark Questions.**

## Marks Distribution of Mid/End Semester Practical Examinations:

**Table No. 17:** Marks distribution of Practical Examinations of End Semester

| Topic | Code | Full Marks | Pass Marks | Time | Distribution of Marks | | | Total No. of Questions to Set |
|-------|------|-----------|-----------|------|-----------|--------|------|-------------------------------|
| | | | | | Experiment | Record | Viva | |
| **End Sem** | P25 | 25 | 10 | 3 Hrs | 15 | 5 | 5 | |
| | P50 | 50 | 20 | 3 Hrs | 30 | 10 | 10 | Pr. with components of both papers |
| | P75 | 75 | 30 | 3 Hrs | 45 | 15 | 15 | Pr. with components of all three papers |
| | P100 | 100 | 40 | 3 Hrs | 60 | 20 | 20 | Pr. with components of all four papers |

**Abbreviations: T**= Theory Examination, **P**= Practical Examination.

**Mid Sem\* :** There will be 15 Marks Theory Examination in Practical Subjects and 25 Marks Theory Examination in Non-Practical Subjects/ Papers. 25 Marks Theory Examination may include 10 Marks questions from Assignment/ Project/ Tutorial where ever applicable.

**Note   :** There may be subdivisions in each question asked in Theory Examinations.

FORMAT OF QUESTION PAPER FOR MID SEM EXAMINATION

OF SUBJECTS WITH PRACTICAL

# Nilamber-Pitamber University, Medininagar

Mid Sem <u>No.</u>

Exam <u>Year</u>

## Subject/ Code

**F.M.** =15

**Time**=1Hr.

**General Instructions:**

सामान्य निर्देश :

i.    **Group A** carries very short answer type compulsory questions.
      (खंड 'A' में अत्यंत लघु उत्तरीय अनिवार्य प्रश्न हैं।)

ii.   **Answer 2 out of 3** subjective/ descriptive questions given in **Group B**.
      (खंड 'B' के तीन में से किन्हीं दो विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)

iii.  Answer in your own words as far as practicable.
      (यथासंभव अपने शब्दों में उत्तर दें।)

iv.   Answer all sub parts of a question at one place.
      (एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.    Numbers in right indicate full marks of the question.
      (पूर्णांक दायीं ओर लिखे गये हैं।)

### Group A

1. ...............                                                    [5x1=5]
2. ...............
3. ...............
4. ...............
5. ...............

### Group B

6. ...............                                                    [5]
7. ...............                                                    [5]
8. ...............                                                    [5]

**Note:** There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR MID SEM EXAMINATION

OF SUBJECTS WITHOUT PRACTICAL

# Nilamber-Pitamber University, Medininagar

Mid Sem No.

Exam Year

## Subject/ Code

**F.M.** =25

**Time**=1Hr.

**General Instructions:**

समान्य निर्देश :

i.   **Group A** carries very short answer type compulsory questions.
     (खंड 'A' में अत्यंत लघु उत्तरीय अनिवार्य प्रश्न हैं।)

ii.  **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
     (खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)

iii. Answer in your own words as far as practicable.
     (यथासंभव अपने शब्दों में उत्तर दें।)

iv.  Answer all sub parts of a question at one place.
     (एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.   Numbers in right indicate full marks of the question.
     (पूर्णांक दायीं ओर लिखे गये हैं।)

### Group A

1.  ...............                                              [5x1=5]
2.  ...............
3.  ...............
4.  ...............
5.  ...............

### Group B

6.   ...............                                             [5]
7.   ...............                                             [5]
8.   ...............                                             [5]
9.   ...............                                             [5]
10.  ...............                                             [5]
11.  ...............                                             [5]

**Note:** There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

OF AECC NH + MB COMMUNICATION

# Nilamber-Pitamber University, Medininagar

End Sem No.

Exam Year

## Subject/ Code

**F.M.** =50                              **P.M.**=20

**Time**=1.5Hrs.

**General Instructions:**

i.   **Group A** carries short answer type **compulsory** questions.
    (खंड 'A' में लघु उत्तरीय अनिवार्य प्रश्न हैं।)

ii.  **Answer 2 out of 3** subjective/ descriptive questions given **in Group B**.
    (खंड 'B' के तीन में से किन्हीं दो विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)

iii. Answer in your own words as far as practicable.
    (यथासंभव अपने शब्दों में उत्तर दें।)

iv.  Answer all sub parts of a question at one place.
    (एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.   Numbers in right indicate full marks of the question.
    (पूर्णांक दायीं ओर लिखे गये हैं।)

## Group A

1. ...............                                                      [5]

2. ...............                                                      [5]

## Group B

3. ...............                                                      [20]

4. ...............                                                      [20]

5. ...............                                                      [20]

**Note:** There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

OF SUBJECTS WITH PRACTICAL

# Nilamber-Pitamber University, Medininagar

End Sem No.

Exam Year

## Subject/ Code

**F.M.** =60                  **P.M.**=30 (Including Mid Sem)

**Time**=3Hrs.

**General Instructions:**

i.   **Group A** carries very short answer type **compulsory** questions.

ii.  **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
     (खंड 'B' के पाँच में से किन्हीं तीन विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)

iii. Answer in your own words as far as practicable.
     (यथासंभव अपने शब्दों में उत्तर दें।)

iv.  Answer all sub parts of a question at one place.
     (एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.   Numbers in right indicate full marks of the question.
     (पूर्णांक दायीं ओर लिखे गये हैं।)

### Group A

1.                                                      [10x1=10]

    i.     ...............                          [10x1=10]
    ii.    ...............
    iii.   ...............
    iv.    ...............
    v.     ...............
    vi.    ...............
    vii.   ...............
    viii.  ...............
    ix.    ...............
    x.     ...............

2. ...............                                      [5]

### Group B

3. ...............                                      [15]

4. ...............                                      [15]

5. ...............                                      [15]

6. ...............                                      [15]

7. ...............                                      [15]

**Note:** There may be subdivisions in each question asked in Theory

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

OF SUBJECTS WITHOUT PRACTICAL

# Nilamber-Pitamber University, Medininagar

End Sem <u>No.</u>

Exam <u>Year</u>

## Subject/ Code

**F.M.** =75                    **P.M.**=40 (Including Mid Sem)

**Time**=3Hrs.

**General Instructions:**

i.  **Group A** carries very short answer type **compulsory** questions.

ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.

(खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)

iii. Answer in your own words as far as practicable.

(यथासंभव अपने शब्दों में उत्तर दें।)

iv. Answer all sub parts of a question at one place.

(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.  Numbers in right indicate full marks of the question.

(पूर्णांक दायीं ओर लिखे गये हैं।)

## Group A

1.                                                          [10x1=10]

    i.     ...............
    ii.    ...............
    iii.   ...............
    iv.   ...............
    v.    ...............
    vi.   ...............
    vii.  ...............
    viii. ...............
    ix.   ...............
    x.    ...............

2.  ...............                                          [5]

## Group B

3.  ...............                                          [15]

4.  ...............                                          [15]

5.  ...............                                          [15]

6.  ...............                                          [15]

7.  ...............                                          [15]

8.  ...............                                          [15]

**Note:** There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

OF GE, SEC, GENERAL & AECC HINDI/ ENGLISH COMMUNICATION

# Nilamber-Pitamber University, Medininagar

End Sem No.

Exam Year

## Subject/ Code

**F.M.** =100                                    **P.M.**=40

**Time**=3Hrs.

**General Instructions:**

i.    **Group A** carries very short answer type **compulsory** questions.

ii.   **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
     (खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)

iii.  Answer in your own words as far as practicable.
     (यथासंभव अपने शब्दों में उत्तर दें।)

iv.   Answer all sub parts of a question at one place.
     (एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)

v.    Numbers in right indicate full marks of the question.
         (पूर्णांक दायीं ओर लिखे गये हैं।)

## Group A

1.                                                                      [10x1=10]

    i.       ...............
    ii.      ...............
    iii.     ...............
    iv.      ...............
    v.       ...............
    vi.      ...............
    vii.     ...............
    viii.    ...............
    ix.      ...............
    x.       ...............

2.   ...............                                                     [5]

3.   ...............                                                     [5]

## Group B

4.   ...............                                                     [20]

5.   ...............                                                     [20]

6.   ...............                                                     [20]

7.   ...............                                                     [20]

8.   ...............                                                     [20]

9.   ...............                                                     [20]

**Note:** There may be subdivisions in each question asked in Theory Examination.