# जगन्नाथ जैन महाविद्यालय

(विनोबा भावे विश्वविद्यालय की अंगीभूत इकाई)

Estd : 1960 NAAC Accredited 'B'

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पत्रांक _____ दिनांक 07/XI/2020

To,

The Registrar

B.B. M.K. University

Dhanbad ,

Ref. :- B.B. M.K. U/CCDC/R/274/ 2020, Dated 14/08/2020,

Received on Whatsapp on 04/09/2020,

Subject : Board of Studies of Post –Graduate Syllabus ( Chemistry ) Under CBCS System of B.B. M.K. U, Dhanbad .

Sir ,

Thanks for nominating me in the Board of studies for assessment of PG Syllabus under CBCS system .

I Have gone through the Syllabus for Post – Graduation of Science ( Chemistry ) provided to me on mail and have found the syllabus appropriate for the P.G. Courses in Chemistry .

I recommend for the implementation of this Syllabus .

With Regard .

Yours Sincerely

Mishra
07/XI/2020

( L.P. Mishra )

**Prof. Sanjoy Misra**
University Prof. & Head (Rtd)
Department of Chemistry
Ranchi University
Ranchi - 834 008. (Jharkhand) India

"Gautam's"
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Ranchi - 834009
Phone : 0651- 2542522
09431106793
email : sanjoy_misra@yahoo.com.

Date: .....

Dated 09/10/2020

**To**

The Registrar,

BBMK University,

Dhanbad

Ref: BBMKU/CCDC/R/724/2020 Dated 14/08/2020 received on Whatsapp on 04/09/2020

Subject: Board of Studies for PG syllabus (Chemistry)

Sir,

Thanks for nominating me in the Board of Studies for assessment of syllabus of PG Choice based Credit System.

I have gone through the syllabus for Post-Graduation of Science (Chemistry) provided to me on my mail and have found the syllabus appropriate for the PG courses in Chemistry.

I recommend the implementation of this syllabus.

Regards

Yours sincerely

9/10/20

(Sanjoy Misra)

**Syllabus for**

**Master of Science in *Chemistry***
**Under Choice Based Credit System**

**Academic Session:**
**w.e.f. 2020-2022**

***For All Constituent/Affiliated Colleges Under***
**Binod Bihari Mahto Koyalanchal University, Dhanbad**

**Members of Board of Studies of CBCS Post-Graduate Syllabus for Chemistry Under CBCS System as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad, Jharkhand**

| | | |
|---|---|---|
| 1. | **Dr. B. Kumar**<br>Associate Professor<br>Head, University Department of Chemistry,<br>BBMKU, Dhanbad | **Chairman** |
| 2. | **Dr. Sanjoy Mishra**<br>Professor<br>University Department of Chemistry Ranchi<br>University, Ranchi | **External Expert Member** |
| 3. | **Dr. L. P. Mishra**<br>Associate Professor<br>University Department of Chemistry VBU,<br>Hazaribag | **External Expert Member** |

| | | |
|---|---|---|
| 4 | **Dr. Leelawati Kumari**<br>Assistant Professor<br>University Department of Chemistry, BBMKU, Dhanbad | **Internal Members** |
| 5. | **Sri R. P. Singh**<br>Assistant Professor<br>University Department of Chemistry, BBMKU, Dhanbad | **Internal Members** |
| 6. | **Dr. Dharmendra Kumar Singh**<br>Assistant Professor<br>University Department of Chemistry, BBMKU, Dhanbad | **Internal Members** |

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**COURSE STUCTURE**

**Semester Wise Examination/Course Structure for Science Faculty**

| Semester | Paper Code (Credit, Lectures) | Paper Name | Full Marks | End Semester Marks | Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks) |
|---|---|---|---|---|---|
| I | CHE-F-101 (5 Credits, 60 Lectures + 15 Tutorials) | Foundation | 100 | 70 | 30 |
| | CHE-C-102 (5 Credits, 60 Lectures + 15 Tutorials) | Core | 100 | 70 | 30 |
| | CHE-C-103 (5 Credits, 60 Lectures + 15 Tutorials) | Core | 100 | 70 | 30 |
| | CHE-C/P-104 (5 Credits, 75x2 Lectures) | Practical | 100 | 70 | 30 |
| II | CHE-S-205 (5 Credits, 60 Lectures + 15 Tutorials) | Skill Development Course (SEC) | 100 | 70 | 30 |
| | CHE-C-206 (5 Credits, 60 Lectures + 15 Tutorials) | Core | 100 | 70 | 30 |
| | CHE-C-207 (5 Credits, 60 Lectures + 15 Tutorials) | Core | 100 | 70 | 30 |
| | CHE-C/P-208 (5 Credits, 75x2 Lectures) | Practical | 100 | 70 | 30 |
| III | CHE-A-309 (5 Credits, 60 Lectures + 15 Tutorials) | Open Elective | 100 | 70 | 30 |
| | CHE-C-310 (5 Credits, 60 Lectures + 15 Tutorials) | Core | 100 | 70 | 30 |
| | CHE-C-311 | Core | 100 | 70 | 30 |

| | | | | | |
|---|---|---|---|---|---|
| | (5 Credits, 60 Lectures + 15 Tutorials) | | | | |
| | CHE-C/P-312 (5 Credits, 75x2 Lectures) | Core/ Practical | 100 | 70 | 30 |
| **IV** | CHE-E-413A/ CHE-E-413B/ CHE-E-413C (5 Credits, 60 Lectures + 15 Tutorials) | Discipline Centric Elective Theory A: B: C: | 100 | 70 | 30 |
| | CHE-E-414A/ CHE -E-414B/ CHE -E-414C (5 Credits, 60 Lectures + 15 Tutorials) | Discipline Centric Elective Theory A: B: C: | 100 | 70 | 30 |
| | CHE -C-415 (5 Credits, 60 Lectures + 15 Tutorials) or CHE -E/P-415A/ CHE -E/P-415B/ CHE -E/P-415C (5 Credits, 75x2 Lectures) | Core or Discipline Centric Elective Practical A: B: C: | 100 | 70 | 30 |
| | CHE -D-416* (5 Credits, 150 Lectures) | Dissertation/ Project | 100 | 70 | 30 |
| | | **Total Marks** | **1600** | **1120** | **480** |

**Grades and Grade Points Conversion for Postgraduate Programme**

**TABLE - 06**

| **Class interval of ©Marks %** | **Grade Point** | **Letter Grade** | **Conventional Equivalent** |
|---|---|---|---|
| 90 and above | 10 | O (Outstanding) | First Class with Exemplary |
| 75 to less than 90 | 9 | A+ (Excellent) | First Class with Distinction |
| 60 to less than 75 | 8 | A (Very Good) | First Class |
| 55 to less than 60 | 7 | B+ (Good) | Second Class |
| 50 to less than 55 | 6 | B (Above Average) | |

| | | | |
|---|---|---|---|
| 45 to less than 50 | 5 | C (Average) | |
| 40 to less than 45 | 4 | P (Pass) | Pass |
| Below 40 | 0 | #F (Fail) | Fail |
| Absent | 0 | Ab (Absent) | |

- In case of fractional marks, 0.5 will be considered as higher whole number.
- A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

**Paper: CHEF- 101**

**(FOUNDATION COURSE)**

**Credits: Theory-04 +Tutorial-01 = 05, Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Full Marks: 30 (MSE) + 70(ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE): 1 ½ hrs.**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination shall have three components.**

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. **"Best of Two" shall be applicable for computation of marks for SIA. (Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90 % = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):**

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1**:- **USE OF COMPUTER PROGRAMMES**

Development of small computer codes involving simple formula in chemistry as Vander Waals equation. pH titration, kinetic, radioactive decay. Evaluation of lattice energy, and ionic radii from experimental data, linear simulations equation within the Huckel theory, elementary structural features such as bond lengths and bond angles etc. of molecules extracted from a database such as Cambridge data base.

Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory. Packages- MS-Word, MS-Excel, FOXPRO, MATLAB.

**UNIT 2**: -VSEPR theory

Shapes of inorganic molecules/ions, Bent's rule and energetic of hybridization, Role of p and d orbitals in bonding and their implications.

Electronic structure of free atoms/ions-L-S coupling & J-J coupling Schemes, Determination of term symbols of $p^n$ and $d^n$ (n=1,2,3) systems, Hund's rule for deciding relative energies of terms, Selection rules for electronic transitions.

**UNIT 3**:- Symmetry:

Symmetry elements, Symmetry operations, Point groups, Systematic approach to determine the point group of molecules/ions.

Multiplication of symmetry operations, Multiplication table for $C_{2v}$,$C_{2h}$

and $C_{3v}$ Point groups ($C_{2h}$ and $C_{3v}$), Use of character table in

vibrational spectroscopy.

**UNIT 4**:- NATURE OF BONDING IN ORGANIC MOLECULES

Delocalized chemical bonding–conjugation, cross conjugation resonance, hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons. Huckel's rule, Energy level of molecular orbitals, annulenes, antiaromaticity, aromaticity, homoaromaticity. Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

**UNIT 5:**- REACTION MECHANISM: STRUCTURE AND REACTIVITY

Types of mechanism, Types of reactions, Thermodynamic and kinetic requirements, kinetics thermodynamic control, Hammond's postulate, Curtin- Hammett principle, Potential energy diagram, transition states and intermediates, methods determining mechanism, isotopic effects, Hard - Soft acids and bases. Effect of structure reactivity

– resonance and field effects, Hammett equation and linear free energy relationship, substitution and reaction constants.

**UNIT 6:-** REACTION INTERMEDIATES

Generation, structure, stability, and reactivity of Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes and Benzynes. Application of NMR in detection of carbocations.

**SUGESSTED BOOKS:**


1. Advance organic chemistry, J. Singh and L.D.D. Yadav, Pragati Prakashan Meerut.

2. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wi1ey.

3. Advanced Organic Chemistry – F.A Carey and R.J. Sundberg, Plenum press, New York.

4. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Longman.

5. Structure and Mechanism in Organic Chemistry-C.S. Ingold, Cornell University Press.

6. Organic Chemistry- R.T. Morrison and R.N. Boyd, Prentice- Hall

7. Modern Organic Reactions- H.O., House, Benjamin.

8. Principles of Organic Synthesis – R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.

9. Reaction Mechanism in Organic Chemistry- S.M. Mukherji and S.P. Singh, Macmillan.

10.Comdex Computer course kit (XP Edition), Vikash Gupta, Dreamtech, New Delhi

11. Fox Pro for DOS & Windows, R.K. Taxali BPB Publication.

12. Programming in ANSIC, E. Balaguruswamy, Tata McGraw Hill.

13. Computer for Chemist, Bansal, Pragati Prakashan.

14. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson. John Wiley.

15. Inorganic Chemistry, J.E. Huhey, Harpes & Row.


**Paper: CHEC- 102**

**(PHYSICAL CHEMISTRY)**

**Credits: Theory-04 +Tutorial-01 = 05 , Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and (c) Day to day assessment (DDA) & extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90%= 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE): 3 Hrs.**

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1**: CHEMICAL KINETICS

Kinetics of Reversible First and Second order reactions, Kinetics of sequential first order reaction and parallel reactions. Derivation of Arrhenius equation, Activation energy, and its experimental determinations, frequency factor(A), Collision theory of reaction rates, Failure of Collison theory, Transition state Theory, Effect of ionic strength of reaction rates- Primary and secondary salt effects. The stationary state (steady state) hypothesis, kinetics of chain reactions- Hydrogen-Bromine reaction, Decomposition of ethane and ethanol. Kinetics of photochemical reactions - Hydrogen—Chlorine reaction, Hydrogen-Bromine reaction, Oscillatory reactions, Belousov- Zhabotinski reactions (B-Z reactions), Enzyme reactions, Kinetics of Enzyme reaction, Michaelis- Menten equation and its importance.

**Unit 2**:- Surface Chemistry

Derivation of Gibbs adsorption Equation, Surface film, Langmuir Theory of adsorption. Derivation of the BET equation and Estimation of surface area. Thermodynamics & statistical Mechanics of Adsorption. Chemical Reaction of Surface- Unimolecular

reactions, bimolecular reactions and Langmuir – Hinshelwood mechanism, Langmuir – Rideal mechanism.

**UNIT 3**:- Classical Thermodynamics:

Concept of free energy and entropy. Partial molar volume, Partial molar entropy and partial molar free energy, Chemical Potential, effect of temperature and pressure on chemical potential, Determination of partial molar quantities by Graphical method and method of intercepts

Fugacity change of fugacity with temperature and pressure, calculation of fugacity

**(a)** By graphical method

**(b)** From compressibility factor

**(c)** From equation of state.

Non-Ideal System: Activity and activity coefficient, Debye-Huckel theory of activity coefficient of electrolytic solutions, Determination of activity coefficient, ionic strength.

**UNIT 4:**-Statistical Thermodynamics

Sterling's approximation, Determination of Boltzmann distribution law, Partition function and its physical significances, Relationship between partition function and thermodynamic quantities- e.g.: Internal energy, Enthalpy, Entropy, Gibbs' free energy, work function and heat content. Statistical formulation of third law of thermodynamics, Derivation of relation between entropy and thermodynamic probability ($S = k \ln W$), residual entropy.

**UNIT 5:**- Electrochemistry

Debye-Huckel limiting law of activity co-efficient of electrolytes, verification and limitations of Debye-Huckel theory and its extension to make allowance for finite size, and ionic association parameters. Measurement of activity co- efficient by solubility, freezing point depression and e.m.f methods, Overpotential, exchange current density, Derivation of Butler-Volmer equation and Tafel Plot.

**BOOKS SUGGESTED**:

1. Physical Chemistry — P.W. Atkins, ELBS.

2. Textbook of Physical Chemistry — S. Glasstone, McMillan.

3. Physical Chemistry, Alberty and Daniels.

4. Chemical kinetics — K.J. Laidler, McGrow Hill.

5. Modern Electro Chemistry Vol.-I & Vol.-II – J.O.M. Bockris and A.K.N. Reddy, Plenum.

6. Mathematics for Chemistry — Doggett and Sutcliffe, Langman.

7.Basic Mathematics for Chemists- Tebbutt, Wiley

**Paper: CHEC-103**

**(INORGANIC CHEMISTRY)**

**Credits: Theory-04 +Tutorial-01 = 05, Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs.**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA. **(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90%= 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):**3Hrs

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT-1** Stereochemistry and Bonding in Main Group Compounds VSEPR theory, Walsh diagrams (tri-atomic molecules type $AH_2$),d$\Pi$-P$\Pi$ bonds, Bent rule and energetic of hybridization, some simple reactions of covalently bonded molecules, Atomic Inversion, Berry Pseudorotation.

**UNIT 2:** COMPLEXE COMPOUND:

Metal-Ligand Bonding, Crystal field theory-splitting of d-orbitals in low symmetry complexes like square planar, square pyramidal, trigonal bipyramidal complexes. Jahn Teller effect and its implications, thermodynamic effect, crystal field stabilization energy for octahedral and tetrahedral complexes, correlation of CFSE with

thermodynamic properties like Lattice energy, Hydration energy, stability of unusual oxidation states, structure of Spinels.

Limitations of crystal field theory, evidences in favour of M-L orbital overlap – Nephelauxetic effect, Molecular orbital theory, Molecular orbital diagram of tetrahedral and octahedral complexes with and without $\Pi$ bonding.

**UNIT 3:** Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Experimental methods of stability constant determination of complexes by spectrophotometry method, Job's method & Bjerrum method.

**UNIT 4:** Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories. The activation of octahedral complexes, mechanism of ligand substitution reaction in octahedral complexes, Hydrolysis reaction- acid hydrolysis ($S_N1$ mechanism), base hydrolysis, conjugated base mechanism, reactions without metal ligand bond cleavage. Factors affecting acid hydrolysis and base hydrolysis.

**UNIT 5:** Substitution reaction in square planer complexes:

The trans effect, theory of trans effect, differences between trans effect and trans influences, trans effect series, mechanism of ligand substitution reactions in square planar complexes, factors affecting the rate of ligand substitution reactions in square planar complexes, application of trans effect.

**UNIT 6:** Electronic Spectra and Magnetic properties of Transition

Metal Complexes:-

Studies of spectral properties of transition metal complexes, Spectroscopic ground state, correlation, Orgel and Tanabe- Sugano diagrams for transition metal complexes ($d^1$ – $d^2$ state), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

**BOOKS SUGGESTED:**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson. John Wiley.

2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.

3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow,Pergamon.

4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.

5. Magneto Chemistry, R.L. Carlin, Springer Verlag.

6.Comprehensive Coordination Chemistry, Q. Wilkinson, R.D. Gillars & J.A. McCleverty, Pergamon.

7. UGC Advanced Inorganic Chemistry, S.K. Agarwal & Keemti Lal.

**Paper: CHEC/P-104**

**CHEMISTRY**

**(PRACTICAL)**

**(Credits: Practical-05)**

**Practical: 75×2**

**Lectures.**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 3 Hrs.**

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) &extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA. **(Attendance: Upto75%= 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr): 06 Hrs**.

The question in Practical examination will be of equal to **70 marks**.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook, and **20%** in viva-voce.

**GROUP A**

**01.**Quantitative analysis involving two of the followings in Ores,

Alloys or mixture in the solution, one by volumetric and other by Gravimetric method – Cu, Fe, Cr, Mn, Ni, Zn, Ca, Mg, $Cl^-$ and $SO_4^{2-}$.

**02.** Determination of COD and Hardness of water volumetrically.

**03.** Preparation of selected inorganic complex compounds-

(i) Cis- $K[Cr(C_2O_4)(H_2O)].2H_2O$

(ii) $K_3[Fe(C_2O_4)].3H_2O$

(iii) $[Ni(NH_3)_4]Cl2$

**GROUP B**

04. Organic Synthesis

One step organic synthesis

(i)Benzophenone Oxime from Benzophenone

(ii) Phthalimide from Phthalic Anhydride

(iii) Ortho Chloro Benzoic acid from Anthranilic acid (Sandmeyer's reaction)

(iv) Benzil from Benzoin (Oxidation)

(v) Phenyl azo β-Naphthol from Aniline (Diazo coupling reaction)

(vi) 1-Amino 2-Hydroxy Naphthalene from Phenyl azo-β- Naphthol (Reduction)

(vii) Benzilic acid from Benzil

(viii) Picric Acid from Phenol (Nitration)

(ix) Cinnamic acid from Benzaldehyde and Malonic acid (Knoevenagel reaction)

(x) Para nitro acetanilide from acetanilide.

**GROUP C**

5. Distribution law:-

(a) To determine the partition coefficient of benzoic acid or acetic acid between benzene and water.

(b) To study the complex formation between $Cu^{+2}$ and to determine the formula of the complex ion and ammonia

(c) To determine the equilibrium constant of the reaction $KI + I = KI_3$ .

6. Chemical Kinetics.

(a) To determine the velocity constant of hydrolysis of methyl acetate catalysed by HCl by Titrimetric method.

(b) To determine the velocity constant of Saponification of ethyl acetate conductometrically.

(c) To determine the acid catalysed reaction between $I_2$ and acetone.

7. Viscosity

(a) To determine the radius of molecules from viscosity measurement.

(b) To determine the composition of liquid mixture viscometrically.

**Paper: CHES-205**

**Analytical Chemistry**

**Skill Enhancement Course (SEC)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

(c) Day to day assessment (DDA) and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** INTRODUCTION

Role of analytical chemistry. Classification of analytical methods- classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations - dissolution and decompositions. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

**UNIT 2:** ERRORS AND EVALUATION

Definition of terms in mean and median. Precision-standard deviation, Relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data- determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.

**UNIT 3:** ENVIRONMENTAL MONITORING

(A) Monitoring of water quality: Method of sampling, principle and procedure of the monitoring BOD, COD, DO, nitrite, nitrate, Fluoride, iron and total hardness of water as in water sample.

(B) Analysis of soil samples: Principle and Procedure of the analysis of moisture, salinity, soil colloids, cation and anion exchange capacity.

(C) Air pollution monitoring: Sampling and analysis of air pollutants such as $SO_2$, $NO_x$ $NH_3$,$O_3$ and suspended particulate matter (SPM).

**UNIT 4:** PRINCIPLE OF FOOD ANALYSIS

(A) Principle and procedure of analysis of food and vegetable products, milk and pesticide residue.

(B) Pharmaceutical Analysis: Principle and Procedure of analysis of Aspirin, Vitamin A, Vitamin C, Vitamin $B_{12}$.

(C) Clinical Analysis: Principle and procedure of analysis of Urea, Glucose Albumin, Sodium and Potassium (By Flame photometer method).

**UNIT 5:** ANALYSIS OF METALS AND MINERALS

(a) Principle and procedure of the analysis of Brass, Steel, Limestone, Cement.

(b) Application of UV visible spectroscopy in qualitative and quantitative analysis

(c) Coal- ultimate and proximate analysis, heating values - grading of coals.

**UNIT 6:** RISKS & HAZARDS OF CHEMICALS AND PROCEDURES

(a) Hazards of handling ordinary chemicals, Fire hazards, handling corrosive Chemicals, Poisonous chemicals.

(b) Carcinogens- toxicity of Cd, Hg, Pb, AS, Se, Pu, Oxides of Nitrogen and Sulphur, Benzene, Halogenated hydrocarbons, Aromatic amino compound, Benzopyrene and related compounds, Plastic Waste Management.

(c) Role of incineration in the production of carcinogens like dioxanes. Treatment of hazardous waste and its disposal, radio chemical waste and technique of safe disposal of them.

**UNIT 7:** FUNDAMENTALS OF AGRICULTURAL TOXICOLOGY:

Toxicology, poison & poisoning, toxicity of pesticides, threshold dose or T.L.V. for some common chemical toxic, sub lethal dose, lethal dose, Toxicity indices (LD-50, ED-50 etc.). Penetration of poisonous substances into cell-action on enzymes, Metabolism of poison in organism, Toxicity of pesticides to harmful organism and factors determining it.

**BOOKS SUGGESTED:**

1. Environmental chemistry, S.E. Manahan, Lewis Publication

2. Environmental chemistry, A.K. Dey, New Age International

3. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.

**Paper: CHEC-206**

**(Theoretical Chemistry)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE: 20Th. + 5Attd. + 5 DAA.) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and (c) Day to day assessment (DDA)and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Quantum Chemistry-Operators

Linear and non-linear operators, Hamiltonian operator, Hermitian operator and its significance, operators and commutation relations, Angular momentum operators and their commutation relations, operator using ladder operators.

**UNIT 2:** Quantum Mechanical Results & Approximate method

Derivation of Schrodinger wave equation, solution and discussion of Schrodinger wave equation to some model system viz. particle in one- dimension box, particle in three-dimensional box, particle on a ring, Harmonic oscillator, rigid rotor, Hydrogen atom-simple and generalized treatment. First order time independent perturbation theory for non-degenerate state, the variation theorem, application of variation method and perturbation theory to Helium atom. Huckel Molecular Orbital Theory Huckel theory of conjugated system, Application of HMO to ethene, butadiene, cyclopropenyl radical and cyclobutadiene, Bond order and charge density calculation.

**UNIT 3:** Microwave Spectroscopy

Classification of molecules, rotational energy levels, isotope effect in rotational spectra, and intensity of rotational lines, non-rigid rotator, vibrational excitation effect, symmetric top molecules, asymmetric top molecules, stark effect, and information derived from rotational spectra.

**UNIT 4:** Infrared spectroscopy

Vibrational energy of diatomic molecules, zero-point energy, force constant, anharmonicity, Morse potential energy diagram, vibration- rotation spectroscopy, P, Q,R branches, vibration of polyatomic molecules, normal modes of vibration, overtones, factors affecting the band positions and intensity.

**UNIT 5:** Raman Spectroscopy

Classical and Quantum theories of Raman spectrum, Rotational Raman spectra-linear molecules, symmetric top molecules, vibrational Raman spectra, mutual exclusion principle.

**UNIT 6:** X-ray Diffractions

Bragg condition, miller indices, Laue method, Bragg method, Debye – Scherrer method of X-ray structural analysis of crystals, index reflections identification of unit cells from systematic absences in diffractions pattern. Structures of simple lattices and X-ray intensities, structure factor and its relation analysis, absolute configuration of molecules Ramachandran diagram.

**BOOKS SUGESSTED:**

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

2. Quantum Chemistry, Ira N. Levine, Prentice Hall.

3. Modern Spectroscopy, J.M. Hollas, John Wiley.

4. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.F.-L. Ho. Wiley Inter science.

5. NMR, NOR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.

6. Physical Methods in Chemistry, R.S. Drago, Saunders College.

7. Chemical Applications of Group Theory, F. A. Cotton.

8. Introduction to Molecular Spectroscopy, Q.M. Barrow, McCraw Hill.

9. Basic Principles of Spectroscopy. R. Chang, McGraw- Hill.

**Paper: CHEC-207**

**CHEC-207 (Organic Chemistry)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** STEREOCHEMISTRY OF ORGANIC COMPOUNDS

Fischer, Newman Sawhorse and Flying–Wedge projections and their interconversions, molecular symmetry and point groups, asymmetry and dissymmetry, stereochemical, descriptors, center of chirality, assigning of absolute stereochemistry, CLP rules, isotopic asymmetry, variation of specific rotation in sign and magnitude under different conditions, optical isomerism of compounds containing more than one asymmetric carbon atoms, number of stereoisomers, optical activity in the absence of chiral carbon like biphenyl, allenes, spiranes etc., prochirality-topacity- homotopic and heterotopic, prostereoisomerism. Geometrical isomerism: Nomenclature of geometrical isomers (E-Z notation) of compounds with one and more double bonds in acyclic system, methods of determination of the configuration of geometrical isomers in acyclic and cyclic system, interconversion of geometrical isomers. Stereochemistry of aldoximes and ketoximes- naming, types of isomerism, methods of determining configurations. Annulenes- Binary number methods of designing the stereochemistry of annulenes.

CONFORMATIONAL ISOMERISM

Conformational analysis of butane, cyclohexane and decalins including their relativities of the axial and equatorially substituted conformers. Steric strain due to unavoidable crowding. Conformation of saturated heterocycles: The anomeric effect and the double anomeric effect.

**UNIT 2**: ELECTROPHILIC SUBSTITUTION REACTIONS

(a) Aliphatic electrophilic substitution: Bimolecular mechanism $SE^1$, $SE^2$ and $SE^i$ mechanism. Electrophilic substitution accompanied by double – bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

(b) Aromatic electrophilic substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams, the ortho para ratio, ipso attack, orientation in other ring system. Quantitative treatment of reactivity in substrates and electrophiles, Diazonium coupling, Gattermann Koch reaction, Vilsmeir reaction.

**UNIT 3:** Nucleophilic Substitution

(a) Aliphatic nucleophilic substitution: The $SN^2$, $SN^1$, mixed $SN^1$ and $SN^2$ mechanisms. The neighbouring group mechanism, neighbouring participation by σ and π bonds.

(b) The $SN^1$ mechanism Nucleophilic substitution at an allylic aliphatic trigonal and at vinylic carbon. Reactivity effect of substrate structure, attacking nucleophile, leaving group and reaction medium, ambient nucleophile, regioselectivity.

(c) Aromatic Nucleophilic Substitution: The $S_N^{Ar}$, $S_N1$, benzyne and $S_{RN}1$ mechanism. Reactivity effect of substrate structure. Leaving group and attacking nucleophile. The Von Richter and Smiles rearrangement.

**UNIT 4:** ADDITION TO CARBON- CARBON MULTIPLE BONDS

Mechanism and stereochemical aspects of addition reactions involving electrophiles, Nucleophiles and Free radicals, region and chemo selectivity, Orientation and reactivity, Addition to cyclopropane ring. Hydrogenation of double and triple bonds. Hydrogenation of Aromatic rings. Hydroboration, Michael reaction, Sharpless asymmetric epoxidation.

**UNIT 5:** ADDITION TO CARBON-HETERO-MULTIPLE BONDS

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters nitriles. Addition of Grignard's reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Mechanism of condensation reactions involving enolates Aldol. Knoevenagel, Claisen, Mannich, Perkin and Stobbe reactions. Hydrolysis of ester and amides.

**UNIT 6(a):** ELIMINATION REACTIONS

The E2, E1, and $E1_{CB}$ mechanism and their spectrum, orientation of double bond. Reactivity- effects of substrate, Structures, attacking base, the leaving group and the medium.

**UNIT 6(b):** MOLECULAR REARRANGEMENT REACTIONS

General mechanistic approach to molecular rearrangement reactions, Carbocation rearrangement, Migratory aptitude and Memory effects, Brief study of following rearrangement reactions Pinacol-Pinacolone, Favorskii, Baeyer-Villiger oxidations, Arndt-Eistert synthesis, Beckmann, Hofmann, Curtius, Fries and Claisen rearrangement.

**BOOKS SUGGESTED:**

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley.

2. Advanced Organic Chemistry – F.A Carey and R.J. Sundberg, plenum.

3. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4. Structure and Mechanism in Organic Chemistry-C.S. Ingold, Cornell University Press.

5. Organic Chemistry- R.T. Morrison and R.N. Boyd, Prentice- Hall

6. Modern Organic Reactions- H.O., House, Benjamin.

7. Principles of Organic Synthesis – R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.

8. Reaction Mechanism in Organic Chemistry- S.M. Mukherji and S.P.Singh, Macmillan.

9. Stereo Chemistry of Organic Compounds- P.S. Kalsi, New Age International.

10. Stereochemistry of Organic Compounds – P.S. Kalsi, New Age International.

11.Advance organic chemistry, J. Singh and L.D.D. Yadav, Pragati Prakashan, Meerut.

**Paper: CHEC/P-208**

**CHEMISTRY**

**(PRACTICAL)**

**Marks: 30 (MSE) + 70 (ESE) =100**

**(Credits: 05)**

**Pass Marks (MSE: 12 + ESE: 28) =40**

**Practical: 75 ×2 Lectures.**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 3 Hrs**

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA)and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr):** 06 hrs

The question in Practical examination will be of equal to **70** marks.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook, and **20%** in viva-voce.

**Group- A**

1. Qualitative analysis of mixture containing eight radicals including some less common metal ions and interfering radicals from among the following by common method (preferably semi micro)

Basic radicals:Pb, Cu, Cd, Bi, Sn Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K, $NH_4^+$

Acid radicals: -Carbonate, Sulphate, Sulphite, Nitrite, Acetate, Fluoride, Chloride, Bromide, Iodide, Nitrate Borate, Phosphate, Silicate, Chromate, Arsenite, Arsenate, Permanganate.

**GROUP B**

2. Estimate of glycine

3. Estimate of glucose

4. Determination of saponification value of given oil / fat.

5. Estimation of phenol

6. Estimation of hydroxyl group.

7. Determination of equivalent weight of carboxylic acid by titration method.

8. Determination of N-acetyl group in organic compound.

**GROUP C**

9. Determination of the velocity constant, order of reaction and energy of

activation of saponification of Ethyl Acetate by NaOH conductometrically.

10. Determination of solubility and solubility product of sparingly soluble

salt like $PbSO_4$ , $BaSO_4$ conductometrically

11. To study the effect of solvent on the conductance of $AgNO_3$, Acetic

Acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their picture (DMSO, DMF, Dioxane, acetone, water) and to test the validity of Debye- Onsager equation.

12. Determination of activity coefficient of $Zn^{++}$in the solution of 0.02 M, $ZnSO_4$ using Debye-Huckel Limiting law.

13. Acid-Base titration in a non-aqueous medium using pH meter.

14. Determination of strength of strong and weak acid of a given mixture using potentiometer / pH meter.

**Paper: CHE-A-309**

**(ENVIRONMENTALCHEMISTRY)**

**(Open Elective)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures; Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12+ ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks;85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs. There will be two groups of questions. Group A is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Environmental Chemistry:

Introduction: Environmental Chemistry, environmental segments, classification of environmental pollution. Composition or structure of atmosphere (Troposphere, Stratosphere, Mesosphere, Ionosphere), reactions of atmospheric oxygen, reactions in troposphere and stratosphere.

BIOCHEMICAL CYCLES IN ENVIRONMENTS: Biochemical cycles, Sulphur cycle, Carbon hydrogen cycle, Oxygen cycle, Nitrogen cycle, Biodistribution of elements.

**UNIT 2:** Air pollution:

Introduction, Air pollutants, Primary pollutants-Sources (CO, $NO_X$ hydrocarbons, $SO_2$ and particulates). Particulates-Sources (Inorganic and Organic particulate matters). Effects on: Humans, materials, vegetation and animals. Air quality standards, Sampling, monitoring and analysis: CO, $NO_X$ by spectrophotometric method.

Control of air pollution: Control of particulate matter and gaseous pollutants. Green House effect, Global warming, Acid rain, Ozone layer depletion and climate change.

**UNIT 3:** Radioactive pollution:

Introduction, sources, radiation from natural and manmade activities, radioactive effects on human and plants, Protection and control from radiation, storage and disposal of radioactive waste, detection and monitoring of radioactive pollutants,

**UNIT 4:** Water pollution:

Introduction, sources, types of water, pollutants classification: Organic pollutants-Pesticides, Insecticides Detergent. Inorganic pollutants, sediments, radioactive materials and thermal pollutants. Drinking water supplies, trace elements in water. COD. BOD.

Monitoring techniques and methods: Determination of pH, conductance, dissolved oxygen by Winkler's method, nitrate/nitrite by diazo coupling, and chloride by Mohr's and Volhard's method and fluoride by Alizarin Visual method.

**UNIT 4:** Industrial Pollution:

Cement, Sugar, Distillery, Paper and Pulp, thermal power plants, nuclear power plants, metallurgy, polymer, drugs etc. Radionuclide analysis, Disposal of wastes and their management.

**UNIT 5:** Environmental Toxicology:

Chemical solutions to environmental problems, biodegradability, principles and decomposition. Best industrial process, Bhopal Gas tragedy, Chernobyl, Three miles island, Seveso, and Minamata disaster.

**UNIT 6:** Green Chemistry:

Definition and Objective The twelve principles of Green Chemistry, atom economy in chemical synthesis, important technique employed in practice of Green Chemistry. Application of microwave irradiation and ultrasound in chemical reactions. Use of renewable raw materials and biosynthesis, organic waste management, use of safer reagents and green solvents and green catalysts.

**BOOKS SUGGESTED:**

1. Environmental Chemistry and Green Chemistry, Asin Kr Das, Books and Allied (P) Ltd. Kolkata.

2. Environmental Chemistry, H. Kaur, Pragati Prakashan.

3. Environmental Chemistry, S.F. Manahan, Lewis Publishers

4. Environmental Chemistry, A.K. Dey, Wiley Eastern.

5. 5. Environmental Chemistry. Baird, W.H. Freeman.

**Paper: CHE-C-310**

**(Inorganic chemistry-II)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures; Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) and extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80-85% = 3 marks;85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs. There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Chemistry of main group elements

Synthesis, properties and structure of Boranes, Carboranes, Borazines, Silicates, Silicones, Phosphazene and S-N ring & chain compounds.

**UNIT 2:** Complexes with Pi acceptor ligands

Metal carbonyls-Mononuclear, binuclear, trinuclear and polynuclear carbonyls and their preparation, properties, structure, bonding, & applications, reaction of coordinated CO, metal nitrosyls- preparation, reactions, bonding and structure, reaction of coordinated NO, dinitrogen and dioxygen complexes.

**UNIT 3:** Metal-Metal bonding and metal cluster compounds:

M-M multiple bonds, factors favouring the formation of M-M bond, evidences in support of M- M Bond, Metal clusters- classification-dinuclear cluster, trinuclear clusters tetranuclear clusters and Hexanuclear clusters.

**UNIT 4 (a) :** Electron transfer-reactions

Basic concepts of oxidation and reduction reactions, Electron transfer reactions in coordination compounds by outer sphere and inner sphere mechanisms, The Marcus theory and the factors affecting the rate of electron transfer reactions by outer sphere mechanism, complementary and non-complementary electron transfer reactions.

**UNIT 4 (b):** Photochemical reactions

Basic concepts of photochemistry, Photochemical and thermal excitation of complexes and fates of excited complexes, Photochemical reactions of cobalt (III) and chromium (III) complexes, photo-oxidation, Photo reduction, intervalence transitions.

**UNIT 5 (a):** METAL IONS IN BIOLOGICAL SYSTEMS

Essential and trace metals. $Na^+/K^+$ Pump, Role of metals ions in biological processes, DNA polymerization, glucose storage, metal complexes in transmission of energy; chlorophylls, photosystem I and photosystem II in cleavage of water Model System.

**UNIT 5 (b):** TRANSPORT AND STORAGE OF DIOXYGEN

Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanin and hemerythrin, model synthetic complexes of iron, cobalt and copper.

**UNIT 5(c):** ELECTRON TRANSFER IN BIOLOGY

Structure and function of metalloproteins in electron transport processes – cytochromes and iron-sulphur proteins, synthetic models

Nitrogenase Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other nitrogenase model systems.

**Books Suggested:**

1Advanced Inorganic Chemistry, Cotton and Wilkinson, John Wiley & sons.

2. Inorganic Chemistry-Principles of Structure and Reactivity,Huheey,Keiter,Harper Collins Colleges Publishers.

3. Modern Inorganic Chemistry W. L. Jolley, McGraw Hill

4.Principles of Bioinorganic chemistry, S. J. Lippard, J M Berg U

**Paper: CHE-C-311**

**(Organic chemistry-II)**

**Credits: Theory-04 +Tutorial-01 = 05**

**Theory: 60 Lectures; Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) and extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3**

**marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs. There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Selectivity:

Types of selectivity: Regio, stereo, and chemoselectivity, reagents for reduction of alkenes, alkynes, arenes and carbonyl compounds, mechanism of action- dissolving metal reduction, removal of functional groups, reduction of benzene rings and alkynes, protection of aldehyde, ketones, alcohols, and amines, carrying out reaction at least reactive group in the presence of more reactive group, reagent for chemoselective oxidation of (a) C=C double bonds e.g. peracids, osmium tetroxide, (b) alcohols and carbonyl compounds e.g. Cr(VI) and Mn(VII) compounds.

**UNIT 2:** Making new carbon-carbon Bond

(A) Alkylation of nitroalkanes, alkyl nitriles, Lithium enolates of carbon compounds such as ketones, esters and carboxylic acids. Alkylation of aldehydes and ketones using a specific enol equivalents such as enamines (Stark enamine reaction), Silyl enol ethers, aza-enolate derived from imines. Regioselective formation of enolates from ketones, thermodynamics enolates and kinetic enolates, alkylation of β-dicarbonyl compounds.

(B) Acylation at carbon- Direct C- acylation of enols and enolates, acylation of enols under acidic condition, acylation at nucleophilic carbon (other than enols and enolates).

(C) Conjugate addition of enolates: Conjugate addition (i) under thermodynamics control (ii) under Kinetic control condition, conjugate addition of (i) enols (ii) enolates

(iii) enamines (iv) silyl enol ether, electrophilic alkenes: exo methylene, ketones - a component obtained from Mannich reaction, Robinson's annulation reaction, use of Lithium dialkyl cuprate.

(D) Carbon carbon Bond formation using radicals: Barton and Hofmann- Loffler-Freytag reaction

**UNIT 3:** Pericyclic reactions:

Molecular orbital symmetry, Frontier orbital of Ethylene, 1, 3- butadiene, 1, 3, 5-hexatriene and allyl system, classification of pericyclic reactions. Woodward Hoffmann correlation diagrams, FMO and PMO approach. Electrocyclic reactions - 4n, 4n+2 and allyl systems. Cycloaddition reactions - 4n, (4n+2) system, (2+2) addition of ketenes, 1, 3-dipolar cycloaddition and cheletropic reaction.

Sigmatropic reaction: suprafacial and antarafacial shifts of H, Sigmatropic shift involving carbon moieties, (3,3) and (5,5) sigmatropic rearrangement- Claisen and cope rearrangement, Fluxional tautomerism, Ene reaction.

**UNIT 4:** PHOTOCHEMISTRY

(a) Basic concepts, electronic transition, Jablonshki diagram, inter system crossing, energy transfer, molecular orbital view of excitation.

(b) Photochemistry of alkenes: intermolecular reactions of olefinic bond, geometrical isomerism, cyclization reactions, rearrangement of (1,4) and (1,5)- dienes, di- $\Pi$ methane rearrangement.

(c) Photochemistry of carbonyl compounds: intermolecular reactions of carbonyl compounds, saturated cyclic and acyclic, β, γ- unsaturated and α, β unsaturated compounds, cyclohexadienone, intermolecular cycloaddition reactions, dimerization and oxetane formation.

(d) Photochemistry of aromatic compounds: Isomerization, additions and substitutions.

(e) Miscellaneous photochemical reaction: Photo Fries reactions of anilides, Photo Fries rearrangement, Barton reaction, singlet molecular oxygen reaction.

**UNIT 5:** APPLICATIONSOF SPECTROSCOPY IN ORGANIC CHEMISTRY

(a) UV visible spectroscopy: electronic transitions of enes, enones and arenes. Woodward-Fieser rules, effect of solvent polarity on UV absorption, application of Woodward-Fieser rules for calculating absorption Maxima in cyclic and acyclic conjugated dienes and enones. Problems based on the above rules, carbonyl chromophores, steric hindrance and coplanarity- distinction between Cis and Trans isomers.

(b) IR spectroscopy: vibration rotational spectrum, theory of molecular vibrations, stretching, bending vibrations, hydrogen bond and frequency distinction between inter and intramolecular hydrogen bonding, fingerprint region. Characteristic group

frequencies –OH group in alcohols and phenols, CO group in aldehydes, ketones, acid chlorides, acid anhydride, amides and esters. Simple problems based on these data.

(C) NMR spectroscopy: chemical shift anisotropic effect and coupling constants in organic compounds. Spin-spin interactions in typical systems, effect on magnetic field strength on sensitivity and resolution, Karplus relationship of 'J' on dihedral angle. $^{13}C$ chemical shift, spectra interpretation and structure identification, solving of structural problems on the basic of numerical and Spectrum based data.

(d) Mass spectroscopy: Fragmentation pattern, molecular Ion peak, metastable peak, McCafferty rearrangement, examples of mass spectral fragments of organic compounds, solving of structural problems.

**Books Suggested:**


1. W. Kemp, "Organic Spectroscopy", Longman.

2. Jerry March, "Advance Organic Chemistry"

3 Organic Spectroscopy by Y.R. Sharma

4 Introduction to Organic Spectroscopy, Silverstein

5. Fundamentals of Photochemistry by K.K. Rohatgi Mukherjee

6. Organic Chemistry by Claydon, Oxford University Press

7. Organic Reaction & Mechanism by Singh & Mukherjee

8. Pericyclic & Photochemistry-Yadav Singh

9. Spectroscopy-Kalsi, Pragati Prakashan

10. Conservation of Orbital Symmetry-Woodward & Hoffman.


**Paper: CHEC/P-312**

**CHEMISTRY**

**(PRACTICAL)**

**Marks: 30 (MSE: 20 viva. + 5Attd. + 5 DDA.) + 70(ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

**(Credits: 05)**

**Lectures**

**Practical: 75 ×2**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 3 Hrs**.

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr):** 06 Hrs.

The question in Practical examination will be of equal to **70** marks.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook, and **20%** in viva- voce.

**GROUP ‘A’**

1. Determination of standard deviation and correlation coefficient.

2. Quantitative calculation based on Beer’s law.

3. Analysis of Dolomite, Pyrolusite and Hematite.

**GROUP 'B'**

4. Identification of organic compounds containing not more than two functional groups using chemical analysis (10 compounds are to be identified in the lab work)

**GROUP ‘C’**

5. To determine the equivalent conductance of an electrolyte at infinite dilution and determine the dissociation constant.

6. To determine the pKa value of given dibasic acids potentiometrically.

7. To determine pH of various mixtures of acetic acid and sodium acetate in aqueous solutions and hence the dissociation constant of the acid.

8. Titrate ferrous ammonium Sulphate against $K_2 Cr_2 O_7$ /$KMnO_7$ and determine redox potential of $Fe^{2+}$ / $Fe^{3+}$ system potentiometrically.

9. To determine ionization constant of polybasic acid potentiometrically.

**Paper: CHE-E-413 (A)**

**INORGANIC CHEMISTRY**

**SPECIAL**

**(DCE-1)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory:**

**60 Lectures;Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3Hrs.There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Alkyl and Aryls of Transition metals

Stability of transition metal alkyls, classification of σ-bonded hydrocarbyls, general methods of preparation, general characteristics, structure and bonding in organocopper compounds.

**UNIT 2:** Transition metal π-complexes

Transition metal Pi complexes with unsaturated organic molecules/ group- alkenes, alkynes, allyl, diene, dienyl, trienyl, arenes synthesis, nature of bonding and structural features, important reaction relating to nucleophilic and electrophilic attack on coordinated ligand.

**UNIT 3:** Reactions of organometallic compounds:

Substitution reaction of carbonyl complexes, oxidative addition reaction, reductive elimination reaction, insertion reaction and deinsertion reaction.

**UNIT 4:** Catalysis by organometallic compounds & Fluxional organometallic compounds:

General features of catalysis, types of catalysis, catalytic steps, hydrogenation of alkenes (Wilkinson's catalyst), hydroformylation of alkenes, Ziegler-Natta polymerization of alkene, Wacker process, Monsanto acetic acid synthesis, water gas shift reaction, Fischer-Tropsch synthesis, hydrosilylation, activation of C-H bond. Fluxional Organometallic Compounds, Fluxionality and dynamic equilibrium in compounds such as η-olefine, η-allyl and dienyl complexes.

**UNIT 5:** Metals in Medicine

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs

**UNIT 6:** Supramolecular Chemistry: Concepts and language.

(A) Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.

(B) Supramolecular reactivity and catalysis.

(C) Transport processes and carrier design.

(D) Supramolecular devices. Supramolecular photochemistry, Supramolecular electronic, ionic and switching devices. Some example of self-assembly in supramolecular chemistry

**BOOKS SUGGESTED:**

1.Principles and Application of Organotransition Metal Chemistry, J.P.

Collman, L.S. Hegedus. J.R. Norton and R.G. Finke, University Science Books.

2. Organometallic Compounds, I. Kumar, Pragati Prakashan

3. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.

4. Metallo-organic Chemistry, A.J. Pearson, Wiley.

5. Organometallic Chemistry, New Age International. R.C. Mehrotra and A. Singh

**Paper: CHE-E-413 (B)**

**ORGANIC CHEMISTRY**

**SPECIAL**

**(DCE-1)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs. There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Asymmetric synthesis:

Definition, different methods of asymmetric synthesis, resolution, chiral pool, chiral auxiliary, chiral reagent and chiral catalyst. CBS reagent, Sharpless asymmetric epoxidation, Sharpless asymmetric dihydroxylation, Baker’s yeast.

**UNIT 2:** Fragmentation reaction:

Definition, factors affecting fragmentation, polarization of C-C bond, electron push and pull, stereochemical requirement. Fragmentation of (a) Three (b) Four and (c) six membered rings. Ring expansion by fragmentation -Eschenmoser fragmentation, Beckmann fragmentation.

**UNIT 3a:** Stereospecific and stereoselective reactions:

Definition and Examples Stereoselective reactions on (a) Four (b) Five (c) Six membered rings with (1) trigonal carbon (2) two or more trigonal carbons (d) bicyclic-fused, bridged and spiro systems (e) more hindered face.

**UNIT 3b:** (A) Stereospecific alkene transformations: (a) Bromination (b) iodolactonization (c) epoxidation (d) Cis- 1, 2 diol and (e) Trans-1, 2 diol formation(f) hydroboration.

(B) Stereoselective chiral alkene transformations: (a) epoxidation of chiral alkenes (b) alkylation of chiral enolates- Explanation by the Houk model. (c) Stereoselective addition of carbonyl groups with adjacent stereogenic center, Cram's rule, Felkin -Anh model, Effect of electronegative atoms and chelation on stereoselectivity. (d) Synthesis of syn and anti-Aldol, Zimmermann's model.

**UNIT 4:** Synthesis of single geometrical isomers of double bonds:

(a) Stereoselective formation of olefins: The Julia olefination, Stereoselectivity of olefination through E1, E2 and E1CB mechanism, Witting reaction-E selective and Z selective alkenes, Synthesis of Z and E selective enolates.

(b) Stereospecific formation of olefins: E1, E2 elimination-Formation of trisubstituted alkenes, The Peterson reaction, Formation by fragmentation of cyclic compounds.

**UNIT 5:** TERPENOIDS AND CAROTENOIDS

Classification, nomenclature, occurrence, isolation, general methods of structure determination, Isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, α - terpineol, α-pinene

**UNIT 6:** ALKALOIDS

Definition nomenclature and physiological action of isolation, general methods of structure elucidation degradation classification based on nitrogen heterocyclic ring role of alkaloids in plants Structure stereochemistry synthesis and biosynthesis of the following: Atropine, Quinine, Morphine and Narcotine.

**UNIT 7:** STEROIDS:

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, structure determination and synthesis of Cholesterol, Androsterone, Testosterone, Progesterone, Biosynthesis of Steroids.

**Paper: CHE-E-413 (C)**

**PHYSICAL CHEMISTRY**

**SPECIAL**

**(DCE-1)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***

**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3 Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Energy of Molecules & Wave Functions

The hydrogen molecule ion, Evaluation of ψ and $\psi^2$. Electronic Energy of molecules, Hybrid orbitals -Combination of 1s and one 2p orbital, Combination of 2s and two 2p orbitals, combination of one 2s and 2p orbitals.

**UNIT 2:** Hartree Fock Theory

Born-Oppenheimer Approximation, Slater Condon rules, Hartree-Fock equation Koopmans's Theorem and Roothaan's Equation.

**UNIT 3:** Semi-Empirical Theories

Application of HMO Theory to Benzene, Heteronuclear system- Pyrrole and Pyridine. Extended Huckel theory, The Pariser- Parr- pople (PPP) method and its treatment to Ethene and butadiene.

**UNIT 4:** Density Functional Theory:

Hohenberg -Kohn Theorems, Kohn-sham Equations, Density functional theory and its Applications

**UNIT 5:** Scattering Theory

Scattering Cross — section, scattering length, Law energy, scattering Theory, charged particle scattering and coulomb wave function, Resonance scattering- Breit- Wigner Formula, Levinson's Theorem. Application of Scattering theory in (a) square well potential, (b) Bound States (c) Resonance (d) Proton — Proton Scattering.

**Paper: CHE-E-414 (A)**

**INORGANIC CHEMISTRY**

**SPECIAL**

**(DCE-2)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Full Marks: 30 (MSE) + 70(ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE): 1 ½ Hrs**

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & Extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks) End Semester**

**Examination (ESE):** 3 Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of

fourteen marks each, out of which any four are to be answered.

**UNIT 1:** IR Spectroscopy:

Application of IR Spectroscopy in the elucidation of structure of metal carbonyl, nitrosyls, dinitrogen complexes and complexes with ambidentate ligands such as $NO_2$, SCN, CN etc.

**UNIT 2:** Electronic Spectroscopy

Study of spectral properties of metal complexes, splitting of terms of $d^1$ and $d^2$ ions in (i) octahedral (ii) tetrahedral and (iii) Square planar crystal fields. Orgel diagram, Tanabe-Sugano diagram, selection rules for electronic transitions, Racah parameters and their calculation, Chart transfer spectra.

**UNIT 3:** ESR Spectroscopy

Basic principle, presentation of spectrum, hyperfine splitting in some simple system, g- value, Zero field splitting, Kramer degeneracy, and simple application of ESR spectroscopy.

**UNIT 4:** NMR Spectroscopy:

Application of $^{9}F$, $^{13}C$ and $^{31}P$ NMR spectroscopy in elucidation $^{1}H$, $^{11}B$, structure of inorganic molecules/ions

**UNIT 5:** Mossbauer Spectroscopy

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of $Fe^{+2}$ and $Fe^{+3}$ compounds including those of intermediate spin, (2) $Sn^{+2}$ and $Sn^{+4}$ compounds - nature of M- L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

**UNIT 6:** Nuclear and radiochemistry

Nuclear structure and nuclear stability: nuclear models, radioactivity and nuclear reactions (including nuclear fission and fusion reactions) Hot atom chemistry, nuclear fission and fusion reactors. The interaction of nuclear radiations with matter, radiation hazards and therapeutics. Detectors and their principles. The direction of radioactivity: The counting errors and their corrections.

**BOOKS SUGGESTED:**

1. Physical Methods in inorganic Chemistry, R.S. Drago, Saunders Company.

2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.

3. Infrared and Raman Spectra: Inorganic and Co-ordination Compounds, K. Nakamoto, Wiley.

4. Progress in Inorganic Chemistry Vol. 8, ed, F.A. Cotton, Vol. 15, ed,

S.J. Lippard, Wiley.

5. Transition Metal Chemistry (Ed). R.L. Carlin Vol.1. M. Dekker.

6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.

**Paper: CHE-E-414 (B)**

**ORGANIC CHEMISTRY**

**(SPECIAL)**

**(DCE--2)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Full Marks: 30 (MSE) + 70(ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE)**: 1 ½ Hrs

There will be two groups of questions in written examinations of 20 marks

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and (c) Day to day assessment (DDA) & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions eachof 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT 1:** Special techniques of organic synthesis:

Polymer supported reagents and synthesis, introduction properties of polymer support advantage of polymer supported reagents choice of polymer, classification of reactions involving polymer, Synthesis of peptide, solid state Edman degradation, Asymmetric

synthesis, of Atrolactic acid- Example of increased stereoselectivity; use of poly N-bromosuccinimide, polystyrene, carbadiimide in organic synthesis use of polymer supported photosensitizer and polymer supported phase transfer catalysts and Crown ethers.

**UNIT 2:** Microwave induced organic synthesis:

Introduction, microwave oven, reaction, vessel, reaction medium, advantage, limitations, precautions, applications: synthesis of Chalcones (use of solvent), enaminoketones (support catalysis), Knoevenagel reaction (without solvent).

**UNIT 3:** Phase transfer catalyst:

Introduction, factors affecting use of PTC, mechanism of PTC reactions, types of PTC, advantages, types of phase transfer catalyst reactions, preparation of his transfer catalyst, important applications of phase transfer catalyst in organic synthesis.

**UNIT 4:** Six membered heterocyclic compounds with one heteroatom

Synthesis and reaction of Pyrylium salts, Pyrones and their comparison with pyridinium and thiopyrylium salt and pyridines. Six membered heterocycles with two or more heteroatoms: Synthesis and reaction of diazines, tetrazines and thiazenes

**UNIT 5:** Carbocyclic ring synthesis:

(i) Three membered rings: use of carbine intermediates - Simmon-smith reaction, use of diazoketone.

(ii) Four Membered rings: photochemical (2 + 2) cycloaddition, regioselectivity, synthesis of ionic reactions, expansion of three membered ring, use of ketenes.

(iii) Five membered rings: From 1,4 - dicarbonyl compounds, from 1, 6 - dicarbonyl compounds, pericyclic rearrangement: dieneone to cyclopentenone, vinyl cyclopropane to cyclopentene rearrangement, synthesis via. intramolecular radical intermediates cyclization.

(vi) Six membered rings: carbonyl condensations, Robinson annellation, Diels- Alder reaction, partial/total reduction of aromatic compounds.

(v) Larger rings:

(a) Intramolecular cyclization of dinitriles: Ziegler's method

(b) Intramolecular cyclization of diketenes: Blomquist method.

(c) Acyloin Synthesis.

**Paper: CHE-E-414 (C)**

**PHYSICAL CHEMISTRY**

**SPECIAL**

**(DCE-2)**

**Credits: Theory-04 +Tutorial-01 = 05 Theory: 60 Lectures;**

**Tutorial: 15 Lectures**

**Full Marks: 30 (MSE) + 70(ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE)**: 1 ½ Hrs

There will be two groups of questions in written examinations of 20 marks.

**Group A** is compulsory and will contain five questions of multiple answer type consisting of 1 mark each.

**Group B** will contain descriptive type five questions of five marks each, out of which any three are to be answered.

**The Mid Semester Examination** shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA)& Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Examination (ESE):** 3Hrs.

There will be two groups of questions.

**Group A** is compulsory and will contain two questions.

**Q.No. 1(A)** will be multiple type six questions of 1 mark each.

**Q. No. 1(B)** will contain two short answer type questions each of 4 marks.

**Group B** will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

**UNIT1:** INTRODUCTION TO MOLECULAR REACTION DYNAMICS

Dynamics of reaction, mechanism of activation, concept and shape of potential energy surfaces, rate of reaction on theoretical Potential energy surfaces, determination of position and properties of the transition state on the surfaces, Dynamic calculation Vs Transition state theory.

**UNIT 2:** KINETICS OF CONDENSED PHASE REACTION

Factors determining reaction rate in solution, diffusion controlled reactions and activation controlled reactions, collision on solution encounter, Transition state theory in solution, kinetics of ionic reactions, Single and double spherical model, kinetics of dipole-dipole reaction, ion-dipole reactions, Dependence of rate constant on ionic strength and dielectric constant of the medium, Bronsted - Bjerrum equation.

**UNIT 3:** CATALYSIS AND OSCILLATORY BEHAVIOUR

General mechanism and kinetics of c a t a l y t I c reactions, Arrhenius intermediates, Vant Hoff intermediates, Theory of acid-base catalysis, Effect of salt on acid-base catalysis, Bronsted Catalysis law, linear free energy relationship, Hammet equation, Oscillatory reactions, Lotka-Volterra model, B-Z reactions and its mechanism.

**UNIT 4:** STUDY OF FAST REACTIONS

Flash photolysis, relaxation technique, method, Molecular beam and shock tube kinetics, stop flow method, isolnerisation, Photo dissociation and recombination reactions.

**UNIT 5:** KINETICS OF ELECTRODE REACTIONS

Faradaic and Non-faradaic current, Rate law in faradaic process, current density, factors affecting electrode reaction rate, Nernst diffusion layer treatment, Exchange current density, stoichiometric number and transfer coefficient, energy barrier for multistep reactions, effect of double layer structure on electrode reaction rates.

**UNIT 6:** ELECTRODE DEPOSITION AND CORROSION PROCESS

Electrocatalysis, Electrocatalytic rate, electrocatalysis in redox system, Total deposition, current density, Time variation of the overpotential and rate determining step in electrode deposition.

**Suggested Books:**

1. Advanced Concept in Physical Chemistry, Kaufman, International student Edn.

2. Chemical Kinetics, K.J. Laidler, TMH.

3. Advanced Chemical Kinetics-K.N. Upadhyay

4. Physical Chemistry, Barrow, TMH.

5. Physical Chemistry, Atkins, Oxford

**Paper: CHE-E/P-415 (A)**

**INORGANIC CHEMISTRY SPECIAL**

**(PRACTICAL) (DCE-3)**

**(Credits: Practical-05)**

**Practical: 60**

**Lectures**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE):** 3 Hrs.

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) &extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr):** 06 Hrs.

The question in Practical examination will be of equal to **70** marks.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook and **20%** in viva-voce.

1. Quantitative analysis of a mixture containing not more than three metal ions using volumetric or gravimetric techniques

Or Spectrophotometric determination of metal ions/anions

Or Quantitative estimation of major constituents of any one of the following:

(a) Dolomite

(b) Brass

(c) Stainless steel

(d) Bronze

(e) Solder

Analysis of two cations system using complexometric method or Determination of halide or silver ion by indirect EDTA titration.

2. Synthesis, purification and crystallization of coordination compounds of any of the following Cu (II), Cr (II), Co (II) and Fe (III) ions.

3. Analysis of inorganic mixture containing not more than six radicals including rare earths, interfering radicals and insoluble compounds

**Paper: CHE-E/P-415 (B)**

**ORGANIC CHEMISTRY SPECIAL**

**(PRACTICAL) (DCE-3)**

**(Credits: Practical-05)**

**Lectures: 75×2**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

*Instruction to faculty members and Question Setter for:*
**Mid Semester Examination (MSE): 3 Hrs.**

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

(c) Day to day assessment (DDA) &extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr):** 06 Hrs.

The question in Practical examination will be of equal to **70** marks.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook and **20%** in viva-voce.

1. Qualitative analysis:

Separation, purification and identification of the compounds of binary mixture of organic compounds.

2. Two steps synthesis of organic compounds:

(a) p - nitroaniline from Acetanilide.

(b) p – Chlorotoluene from p –toluidine.

(c ) p – amino azobenzene from aniline.

(d) Benzilic acid from Benzoin.

(e) Benzanilide from Benzophenone.

3. Extraction of organic compounds from Natural sources:

(a) Extraction of Caffeine from tea leaves.

(b) Isolation of casein from milk.

(c) Isolation of lactose from milk.

(d) Isolation of Lycopene from tomatoes

(e) Isolation of β-carotene from carrots

4. Identification of simple organic compounds by the analysis of their spectral data (UV, IR, NMR, MS record, spectral graphs/data will be supplied)

## Paper: CHE-E/P-415 (C)

## PHYSICAL CHEMISTRY SPECIAL

**(PRACTICAL) (DCE-)**

**(Credits: Practical-05)**

**Lecture: 75×2**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Instruction to faculty members and Question Setter for:***
**Mid Semester Examination (MSE):** 3 Hrs.

The Mid Semester Examination shall have three components.

**(a)** Two Semester Internal Assessment Test (SIA) of 20 Marks each,

**(b)** Class Attendance Score (CAS) of 5 marks and

**(c)** Day to day assessment (DDA) & extracurricular activities of 5 marks. "Best of Two" shall be applicable for computation of marks for SIA.

**(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)**

**End Semester Practical Examination (ESE Pr):** 06 Hrs.

The question in Practical examination will be of equal to **70** marks.

Distribution of marks of an end semester examination will be of **60%** in performance of experiment, **20%** in record/notebook, and **20%** in viva-voce.

1. To determine the critical solution temperature in phenol water system.

2. To determine the eutectic temperature and composition of the eutectic mixture.

3. To determine the order of reaction between $I_2$ and $CH_3COCH_3$ catalysed by acids.

4. To study the ad Johnson of Acetic Acid on charcoal.

5. To determine $K_f$ of Camphor and the molecular weight of solute by Rast's method.

6. To determine the heat of neutralization of HCl against caustic soda and heat of ionization of Acetic Acid.

7. Determination of relative strengths of HCl and $H_2SO_4$($k_1$ / $k_2$ ) for the hydrolysis of methyl acetate.

8. Determination of relative strengths of $HNO_3$ and $H_2SO_4$ ($k_1$ /$k_2$) for the hydrolysis of methyl acetate.

9. To determine the basicity of succinic acid thermodynamically.

**Paper: CHE-D-416 (PROJECTWORK)**

**(Credits: Practical-05 )**

**Marks: 30 (MSE) + 70 (ESE) =100**

**Pass Marks (MSE: 12 + ESE: 28) =40**

***Dissertation/Project:** Evaluation of project dissertation work may be as per the following guidelines:

- **Mid-Semester/Internal Assessment Examination** = 30 marks **(Annexure-1)**
- **End Semester Examination:** Project model (if any) and the Project record notebook, Project presentation and viva-voce = 70 marks
  (Jointly conducted by One External & One Internal Examiners)

**Overall project dissertation may be evaluated under the following heads:**

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship programme with reputed organization
- Application of Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

- **Note:**

**(a)** Each student must submit two copies of the dissertation work duly forwarded by the Head of the Department and duly signed by the supervisor concerned. The forwarded copies will be submitted to the concerned Department of University, for evaluation.
The paper will consist of
  - Field work/Lab work related to the project.
  - Preparation of dissertation based on the work undertaken.
  - Presentation of project work in the seminar on the assigned topic & open viva there on.

**(b)** Each student shall have to complete a project work on any topic of his choice, but relevant to the frontier area of Science and Technology, or on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the Department.

**(c)** Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.

**(d)** Students will select topics for the project work in consultation with a teacher of the Department. The Seminar will be held in the concerned Department of University.

## Format of the Dissertation/Project:

**The Dissertation/Project shall be presented with the following specifications:**

(a) **Size of Paper**: A4. Dissertation/Project must be printed on one side of the paper.
(b) **Font Type**: Times New Roman/Arial for English and Kruti Dev 010 for Hindi.
(c) **Font Size**: Font size for English text is 12pt. in standard form and for Hindi is 14pt.
(d) **Font of Chapter Headings and Sub-Headings**:
- Chapter headings may be written in all Capitals, bold text in point size 15
- Sub-headings are written with left margin alignment
- First level sub-headings are written in normal sentence case using bold text in point size 14
- Second level sub-headings are point size 13

(e) **Spacing and Paragraphing**:
- Printing shall be in standardised form with 1.5 line spacing
- Leave as triple spacing (2 empty lines) in base point size 12 before and after sub-headings and one empty line after all sub-headings
- Use one empty line between left-justified paragraphs

(f) **Margin**: Left margin should be 4cms and right and top margin should be 2cms. Bottom margins should be 2.5cms. No ornamental bordering of sides is permitted.
(g) **Page Numbering**: Preliminary pages of the **Dissertation/Project**, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Page No 1 on the first page of chapter 1.
(h) Preliminary sections of the **Dissertation/Project** should include, Declaration of Attendance**,** Certificate from Supervisor**,** Declaration by Candidate and Supervisor regarding Plagiarism**,** Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.
(i) **Referencing and Citation Style**: Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilised to support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc.

The referencing of work and Citation style in the Dissertation/Project submitted in **Faculty of Science and Social Science** will be in **American Psychological Association (APA) style (6$^{th}$ edition)**, for **Faculty of Humanities** except for the Indian Languages, format shall be **Modern Language Association (MLA) (8$^{th}$ edition)** and for **Medical Science**, it shall be **Vancouver style**.

## ANNEXTURE -1

## Research Methodology (Common for All Faculties)

## M.A./M.Sc./M.Com.

## Courses Semester-IV

## Paper Code : CHE-D-416

**Mid Semester Examination (MSE):** There will be two groups of questions in written examinations of 30 marks.

**Group A** is compulsory and will contain ten questions of multiple type questions consisting of 1 mark each.

**Group B** will contain descriptive type eight questions of five marks each, out of which any four are to be answered.

**Broad topics of the syllabus are as under:**

Introduction of Research Methodology: Meaning of Research, Objectives of Research, Research Methods Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research Process: Basic Overview; Literature Review; Formulating the Research Problem, Hypothesis, Research Questions, Research Methodology Data Collection: Primary and Secondary Data, Sampling Method, Observation Method, Interview Method, Questionnaires, Case Study Method, Historical Method, Processing and Analysis of Data, Interpretation of Data/Results, Conclusions/Findings.

Research Writing: Synopsis, Article/Research Paper, Research Project, Thesis, Dissertation, Book, Book-Review, Case Review, Criteria of Good Research, Plagiarism Citation Style & Methods: MLA, APA, Foot Note, Text Note, End Note, Footnotes, Bibliography, References

**Reference Books:**

a) Best and Kahn, Research Methodology, PHI Limited.

b) Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.

**Format of question Paper of Mid-Semester Theory Examination**

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**Binod Bihari Mahto Koyalanchal University, Dhanbad Mid-**

**Semester Examination xxxx (Session : xxxx-xx) Subject/Code :**

**Full Marks: 20**

**Pass Marks: 08**

**Time: 1.5 hrs.**

General Instructions:

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

Group A

1. Multiple Choice Questions

(1x5=05)

(i) ……..

(ii)……..

(iii)……..

(iv)……..

(v)……..

Group B

(Descriptive answer type questions) (5x3 =15)

Answer any Three questions

2. --------

3.--------

4.------

5-------

6.--------

Note: The Mid Semester Examination shall have three components.

(a) Two Semester Internal Assessment Test (SIA) of 20 Marks each,

(b) Class Attendance Score of 5 marks and

(c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.

(Attendance Upto75%, 1 mark; 75<Attd. <80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks ).

**Format of question Paper of End-Semester Theory Examination**

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**Binod Bihari Mahto Koyalanchal University, Dhanbad End-**

**Semester Examination xxxx (Session : xxxx-xx) Subject/Code :**

**Full Marks: 70**

**Pass Marks: 28**

**Time: 3 hrs.**

**General Instructions**:

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

Group A

1. (A) Multiple Choice Questions (1x6=6)

(i)…….

(ii)……..

(iii)…….

(iv)……

(v)…….

(vi)…….

(B) Short answer type questions (4x2=8)

(a)……

(b)……

Group-B

(Long answer type questions)

Answer any four of the following (14x4=56)

1.----

2.----

3.---

4.------

5.-------

6------

7.------

8.------

9. Short notes type questions (7x2=14)

(a)----------

(b)--------

(c ) --------

(d)----------