Department of Chemistry, Kakatiya University introduces Choice Based Credit System (CBCS) for M.Sc. (2 Year course) chemistry for the students admitted in M.Sc. Chemistry course from 2016-17 academic year onwards.

Scheme for CBCS, the workload for each paper, distribution of marks, the number of credits and scheme of examination are attached herewith.

Internal Assessment examination will be conducted twice in every Semester. The main examination (theory and practical) will be conducted at the end of each semester.

One open elective in III semester and one is in IV semester are offered by Department of Chemistry for all the PG-students.

Students joined in M.Sc. Chemistry should choose one open elective offered by Department of chemistry or any other Department of Kakatiya University.

The syllabi of theory and practical papers of I, II III, and IV semesters are enclosed. The syllabi of open elective offered in IV semester will be kept available for the next academic year.

- Prof. Gade Dayakar
Chairperson
Board of Studies in Chemistry
### Scheme of Examination

<table>
<thead>
<tr>
<th>S. No</th>
<th>Paper Code</th>
<th>Paper no.</th>
<th>Title of the paper</th>
<th>Instruction Hrs/ Week</th>
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<td>Inorganic Chemistry</td>
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### Curriculum

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### Scheme of Examination

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### Dean

Prof. Gade Dayakar, Chairperson, BOS in Chemistry, KU,
**II SEMESTER**

**PAPER-I: INORGANIC CHEMISTRY (2CHT5)**

(Marks-100, Total hrs: 60)

**Unit I Electronic-spectra of metal complexes:**
Free-ion terms and energy levels - Electron configuration, Microstates and Terms. Calculation of microstates for p and d configurations, Russel-Saunders (L-S) coupling. Derivation of terms for p² and d² configurations, Ground state term symbols for d configurations, Hole formalism, Hund’s rules to determine ordering of energy levels, Effect of weak fields on free ion terms, Selection rules governing electron transitions and breakdown of selection rules, Orgel diagrams for d¹ to d⁹ systems, Electronic spectra of [Ti(H₂O)₆]³⁺, [Cu(H₂O)₆]²⁺, [V(H₂O)₆]³⁺, [Ni(H₂O)₆]²⁺, [CoF₆]³⁻, [CoCl₄]²⁻ and [NiCl₄]²⁻ complexes, Charge transfer Spectra, Calculation of ligand field parameters - Racah parameter (B), Crystal field splitting (10DQ) and Nephelauxetic ratio (b).

**Unit II Organometallic Compounds:**
Classification and nomenclature of organometallic compounds, Principles of synthesis of organometallic compounds. Synthesis, structure and properties of organometallic compounds of Al and Sn. 18-electron rule and stability of organotransition metal compounds. Synthesis, structure and bonding of olefin, allyl and cyclopentadienyl organometallic compounds of Fe, Pd and Pt. Applications of organometallic compounds of B and Si in organic synthesis. Organometallic compounds in homogeneous catalysis – Hydrogenation, Hydroformylation and Isomerization processes.

**Unit III Bioinorganic Chemistry:**
**Metal ions in biological systems** - Brief survey of metal ions in biological systems, Basic principles underlying biological selection of elements, Physiological effects of metal ion concentration.

**Oxygen transport and storage** - Haemoglobin and Myoglobin, Geometric, electronic and magnetic aspects of dioxygen binding, oxygen adsorption isotherms and cooperativity, Physiological significance of hemoglobin, Role of globin chain in haemoglobin.

**Metals/ Metal compounds in medicine** - Introduction, Metal deficiency and disease, Iron deficiency, Zinc deficiency, and Copper deficiency; Metals used for diagnosis and radiodiagnosis; Lithium, Gold and Platinum compounds used in therapy.

---

Dean

Prof. Gade Dayakar, Chairperson, BOS in Chemistry, KU,
Unit IV Ligational aspects of diatomic molecules:

Metal Carbonyls: Classification of metal carbonyls, General methods of preparing metal carbonyls, Ligational properties of Carbon monoxide (CO), Donor and acceptor molecular orbitals of CO, Bonding modes of CO, Evidence for multiple bonding, Eighteen electron rule, Electron counting methods i) Neutral atom method and ii) Oxidation state method, Structural and bonding aspects of Ni(CO)\(_4\), Mn\(_2\)(CO)\(_{10}\) and Fe\(_2\)(CO)\(_9\).

Metal carbonyl clusters- Factors favouring metal-metal bond, Classification of metal carbonyl clusters, Structures of Fe\(_2\)(CO)\(_9\), Co\(_2\)(CO)\(_8\), Fe\(_3\)(CO)\(_{12}\), Ru\(_3\)(CO)\(_{12}\), Co\(_4\)(CO)\(_{12}\), and Rh\(_6\)(CO)\(_{16}\).

Metal nitrosyls: General methods of preparing metal nitrosyls, Donor and acceptor molecular orbitals of nitric oxide (NO), Bonding modes of NO, structural and bonding aspects of [IrCl(PPh\(_3\))\(_2\)(CO)(NO)]\(^+\) and [RuCl(PPh\(_3\))\(_2\)(NO)\(_2\)]\(^+\).

Metal dinitrogen complexes - Dinitrogen molecule (N\(_2\)) as a ligand, Molecular orbitals of N\(_2\), Bonding modes - Terminal and Bridging, Structures of Ru (II) and Os (II) dinitrogen complexes.

Recommended books:

2. Introduction to ligand fields, B. N. Figgis, Wiley.
Paper – V INORGANIC CHEMISTRY PRACTICALS (2CHP4)

I. Estimations:
   1. Glucose by using Fehling’s solution
   2. Vitamin – C
   3. Calcium in Milk
   4. Iodine value of Oil
   5. Chlorine in Bleaching Powder

II. Analysis of Binary Mixtures:
   1. Determination of Cu$^{2+}$ and Ni$^{2+}$
   2. Determination of Fe$^{3+}$ and Al$^{3+}$
   3. Determination of Cu$^{2+}$ and Zn$^{2+}$
   4. Determination of Ca$^{2+}$ and Mg$^{2+}$
   5. Determination of Ferrocyanide & Ferricyanide

   **Scheme of valuation**

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<td>and samples</td>
<td>– 15</td>
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Recommended Books:

1. A Text Book of quantitative inorganic analysis (3rd and 6th editions)
**Unit I** Named reactions in organic synthesis:
Beckmann rearrangement, Mannich reaction, Michael addition, Dienone-Phenol rearrangement, Robison annulation, Favor斯基 reaction, Baylis-Hillman reaction, Shapiro reaction, Ugi reaction, Grubbs reaction, Heck reaction, Suzuki coupling, Stille coupling, Sonogashira coupling, and Buchwald reaction.

**Unit II** Stereochemistry II:
Conformational analyses of Cycloalkanes: Conformations of small and medium sized rings and conformations of mono and disubstituted cyclohexanes. Factors governing the reactivity of equatorial and axial substituents attached to the cyclohexane ring – Relative stability and reactivity of conformational diastereomers – Stereochemistry of bicyclic systems involving five and six numbered rings. Conformations of cyclohexanone - Stereochemistry of addition to the carbonyl group in rigid cyclohexanone system.
Use of physical methods (dipole moment, IR and NMR) in determining the preferred conformers of simple organic molecules such as 1,2-dihalo ethanes, halohydrins and vicinal diols.
ORD studies: Optical rotation and optical rotatory dispersion, axial haloketone rule, octant rule, applications of ORD studies in the determination of configuration and conformation of organic molecules.

**Unit III** Protection of functional groups and Nucleic acids:
**Protection of functional groups:** Principles of (1) protection of alcohols – Ether formation: methyl, benzyl, allyl, methoxy ethoxy methyl (MEM), THP, silyl, and TBDMS ethers; Ester formation– methyl, benzoyl, tosyl, and p-nitro benzoyl ester (2) protection of diols – acetal, ketal and carbamate formation (3) protection of carboxylic acids – Ester formation: methyl, benzyl, t-butyl, p-nitrobenzyl, p-bromophenacyl, and silyl esters (4) protection of amines – Amide and Carbamate formation with formyl, acetylation, benzoyl, benzyloxy carbonyl (CBZ), tert-butyloxy carbonyl (BOC), tert-butyl azido formyl, phthaloyl, di-tert-butyl pyrocarbonyl, Fluorenylmethylloxycarbonyl (FMOC), and triphenyl methyl groups (5) protection of carbonyl groups – acetal, ketal, 1,3-dioxolane, 1,3-dioxane, 1,3-dithiolane, 1,3-oxathiolane and 1,3-dithiane formation.

**Nucleic acids:** Isolation, structure, and properties of RNA & DNA – synthesis of nucleosides, nucleotides, and synthesis of polynucleotides. Biosynthesis of RNA and DNA.
Unit IV Nonbenzenoid aromatic compounds:
Concept of aromaticity, Robinson’s sextet theory, Huckel’s rule, basis for the Huckel’s rule, limitations of the Huckel’s rule- Alternant and Non-alternant hydrocarbons Craig’s rule – Various Nonbenzenoid aromatic molecules – Synthesis and properties of aromatic 3,4,5,6,7,8-membered rings, metallocenes, annulenes, heteroannulenes, azulenes, fullerences(C60), Sydnones – Antiaromatic compounds,

Recommended Books:

1. Reaction mechanisms – Jerry March
3. Carbohydrate chemistry – Davidson
4. Textbook of organic chemistry – Morrison and Boyd
5. Organic reagents – Fieser and Fieser
6. Modern textbook of organic chemistry – Furguson
Identification of Organic compounds – Systematic qualitative analysis:
Physical data – Boiling points/ Melting points; Ignition test, Solubility classification, Detection of extra elements N,S and Halogens (Lassaigne sodium fusion test, Beilstein test). Functional group tests and preparation of two rational derivatives - determine the melting points of solid derivatives and reference to literature to identify the compounds. A minimum of eight following compounds to be studied as unknown covering at least one from each of the solubility classes.

List of suggested compounds:
Glucose, Fructose, Benzaldehyde, p-Anisaldehyde, p-Chlorobenzaldehyde, Acetophenone, p-Nitroacetophenone, Benzophenone, Benzoic acid, p-Nitrobenzoic acid, p-Chlorobenzoic acid, Anisic acid, Phenol, p-Cresol, b-Naphthol, p-Chlorophenol, Aniline, p-Toluidine, p-Anisidine, o-Chloroaniline, m-Chloroaniline p-Chloroaniline, Diphenylamine, N-methyl aniline N,N-dimethyl aniline, Benzamide, Ethyl benzoate, methyl benzoate, Nitrobenzene, Chlorobenzene, Bromobenzene, Naphthalene and Anthracene, Biphenylanthracene.

Scheme of valuation

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<td>Determination of M.P/ B.P, Extra element test, Solubility test</td>
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<td>Functional group test</td>
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<td>Preparation of derivatives</td>
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Recommended books:
1. Vogel's textbook of practical organic chemistry – Arthur Israel Vogel, B. S. Furniss
2. Practical Organic Chemistry - Frederick George Mann and Bernard Charles Saunders
II SEMESTER  
PAPER-III: PHYSICAL CHEMISTRY (2CHT7)  
(Marks-100, Total hrs: 60)

Unit I Thermodynamics – II:

Unit II Solid State:
Defects in crystals: Point defects, colour centers, line defects and plane defects.
Specific heats of solids: Dulong and Pettit's law, Einstein theory and Debye theory of specific heats. Solid state reactions: Classification and theory of solid state reactions D-Wagner’s theory - examples.

Unit III Chemical Kinetics - II:
Chain reactions: General Characteristics–Kinetics of Chain reactions–Mechanisms of thermal reaction of hydrogen with chlorine and bromine and their rate expressions–thermal decomposition of N₂O₅ and C₂H₆–general kinetic schemes-Inhibition of chain reactions by NO.
Unit IV Quantum Chemistry - II:

**Rigid rotator:** Application of Schrödinger equation to rigid rotator—derivation of energy expression and wave function of a rigid rotator—solution of \( j \) and \( q \) parts of wave functions—total wave function of rigid rotator.

**Hydrogen atom:** Separation of \( r \), \( j \) and \( q \) equations—Solution of radial equation—Total wave function for hydrogen atom—radial and angular plots—probability functions and radial probability density plots for 1s and 2s orbitals.

**Approximation methods:** Variation method—principle and its application to hydrogen atom—perturbation method—First order correction terms of energy and wave function—application to particle in a one-dimensional box under an electric field.

**Bonding in molecules:** Born-oppenheimer approximation—construction of molecular orbitals by LCAO. MO theory of \( H_2^+ \) ion. Energy and wave function expressions (no derivation). Basic postulates of Hückel’s \( p \) electron theory and its applications to ethylene system.

**Recommended books:**

1. Physical Chemistry by Donal D; Mcquarrie & John D Simon.
2. Atomic Structure and the Chemical Bond including Molecular Spectroscopy – Manas Chanda (4th edn)
3. Physical Chemistry - Peter Atkins and de Pulpa Oxford University Press.
6. Quantum Chemistry - R.K.Prasad
7. Thermodynamics - Samuel Glasstone
8. Chemical Kinetics by K.J. Laidler
Paper – VII PHYSICAL CHEMISTRY - PRACTICALS (2CHP6)

1. Potentiometry:
   a. Acid–base titrations:
      (i) Strong acid with strong base.
      (ii) Weak acid with strong base and determination of $P_\text{ka}$ of weak acid.
      (iii) Mixture of acids with strong base.
   b. Redox titrations:
      (i) Ferrous ion with $\text{KMnO}_4$ or $\text{K}_2\text{Cr}_2\text{O}_7$  
      (ii) Ferrous ion with Ce$^{+4}$
   c. Precipitation titrations:
      (i) KCl or KI with $\text{AgNO}_3$
      (ii) Mixture of (KCl + KI) with $\text{AgNO}_3$

2. Colorimetry:
   Verification of Lambert-Beer’s law and determination of molar extinction coefficient of $\text{KMnO}_4$, $\text{CuSO}_4$, $\text{K}_2\text{Cr}_2\text{O}_7$, $\text{Cu} (\text{NH}_4)_6\text{SO}_4$

3. Verification of Freundlich adsorption isotherm – Acetic acid–activated charcoal system

4. Distribution of Iodine between $\text{CCl}_4$ and aqueous KI. (determination of unknown concentration of KI)

5. Determination of partial molar volume of methanol in aqueous methanol.

**Scheme of valuation**

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**Recommended Books:**

2. Practical Physical Chemistry - B. Vishwanathan and P.S. Raghavan,
II SEMESTER
Paper-IV: Spectroscopy (2CHT8)
(Marks=100, Total hrs 60)

Unit I Symmetry & Group Theory:

Unit II Microwave & Electronic Spectroscopy:


Unit III Infrared and Raman Spectroscopy:

**Unit IV NMR Spectroscopy and ESR Spectroscopy:**


**Electron spin resonance spectroscopy (ESR):** Introduction-Principles involved in ESR spectroscopy. Instrumentation, presentation of ESR spectra, hyperfine coupling constant. ESR spectrum of hydrogen atom. Lande’s splitting factor and its significance. ESR spectra of organic radicals like methyl, ethyl, isopropyl, benzene (anion and cation radicals), 1,4-benzosemiquinone and naphthalene anion.

**Recommended Books:**

5. Spectroscopy organic compounds-P. S. Kalsi (New Age International).
6. Organic Spectroscopy-Jag Mohan (Narosa)
15. Applications of spectroscopy-J. Dyer.