R3533

Sub. Code
536301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Chemistry

ADVANCED INORGANIC CHEMISTRY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct answer.

1. In transition metal-arene complexes, the carbone atom is (CO1, K2)

   (a) sp^2 (b) sp^3

   (c) sp (d) dsp^2

2. The allyl ligand behaves as (CO1, K2)

   (a) one e-donor (b) 3e-donor

   (c) both (a) and (b) (d) 3e-aceped

3. Wilkinson's catalyst is used for: (CO2, K4)

   (a) Hydrogenation

   (b) Epoxidation

   (c) Polymerization

   (d) Metathesis reaction

4. The oxidative addition and reductive elimination are favoured by: (CO2, K4)

(a) Electron rich metal centre

(b) Electron deficient metal centre

(c) Electron deficient and electron rich metal centers respectively

(d) Electron rich and electron deficient metal centers respectively

5. The ground state term for $t^2g^6eg^2$ in octahedral filed is (CO3, K3)

(a) ^3A_2g (b) ^3E_g

(c) ^4T_1g (d) ^2A_1g

6. Paramagnetic susceptibility of the order of 10-6 cm-3 mol-1 observed for $KMnO_4$ is due to (CO3, K3)

(a) random spin alignment

(b) antiferromagnetic exchange interaction

(c) paramagnetic impurity

(d) temperature indepent paramagnetic

7. In biological system, the metal ion involved in electron transport are (CO4, K4)

(a) Na^+ and K^+

(b) Zn^{2+} and Mg^{2+}

(c) Ca^{2+} and Mg^{2+}

(d) Cu^{2+} and Fe^{2+}

8. The minerals involved in splitting reaction during, photosynthesis is (CO4, K4)

(a) Potassium and manganese

(b) Magnesium and chlorine

(c) Potassium and chlorine

(d) Manganese and chlorine

9. Nitrogenase contains : (CO5, K5)

(a) An Fe-protein and an FeMo-protein that operate in conjunction with each other

(b) An FeMo-protein in which the active site consists of a single [3FeMo-4S] cluster

(c) An FeMo-protein in which the P-cluster is in an irreversibly reduced state

(d) An Fe-only containing protein in which the P-cluster is the active site

10. Carboxypeptidase contains. (CO5, K5)

(a) Zn(II) and hydrolysis CO_2

(b) Zn(II) and hydrolysis peptide bonds

(c) Mg(II) and hydrolysis CO_2

(d) Mg(II) and hydrolysis peptide bonds

Part B ($5 \times 5 = 25$)

Answer **all** questions not more than 500 words each.

11. (a) Describe the structure and reactivity of Rh and Ru based carbene complexes with examples. (CO1, K2)

Or

(b) Explain the reaction and mechanism of simple and cross metathesis reactions with suitable examples. (CO1, K2)

12. (a) Analyze any three Fluxional behaviors of Organometallics compounds with examples. (CO2, K4)

Or

(b) Outline about Wacker process with suitable catalytic reaction. (CO2, K4)

13. (a) In the electronic spectrum of $[CrF_6]^{3-}$ three absorption bands are observed at 14900, 22700 and 34400 cm^{-1}. Calculate the value of Δo and B' for $[CrF_6]^{3-}$. (CO3, K3)

Or

(b) How would you demonstrate the orgel diagram of $[Ni\ (H_2O)_6]^{2+}$ high spin complex. (CO3, K3)

14. (a) Select a bychelation ligands used to metal detoxification in biological system. (CO4, K4)

Or

(b) Analyze how these Mn ion role in photosystem II. (CO4, K4)

15. (a) Illustrate the structure and functions of myoglobin. (CO5, K5)

Or

(b) Discuss details about non-heme proteins with suitable examples. (CO5, K5)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Discuss details about structure and bonding of ferrocene. (CO1, K2)

Or

(b) Predict the structure and bonding of acetylene complexes. (CO1, K2)

17. (a) Demonstrate the conversion of alkenes into Alkane using Wilkinson catalyst with mechanism.(CO2, K4)

Or

(b) Illustrate the reaction and mechanism of Ziegler-Natta polymerization reactions with suitable examples. (CO2, K4)

18. (a) Construct the orgel diagram of $[V(H_2O)_6]^{3+}$ complex. (CO3, K3)

Or

(b) Measure the magnetic properties of complexes using Gouybalance and SQUID magntometry techniques. (CO3, K3)

19. (a) What is meant by active transport in Na/K pump? Give a diagrammatic representation of the process and explain the mechanism involved in it. (CO4, K4)

Or

(b) Illustrate in details about the MRI contrast agents with examples. (CO4, K4)

20. (a) Justify roll of Zn ion in active side in carboxypeptidase-A for hydrolysis reaction of amino acid. (CO5, K5)

Or

(b) Build the In-vivo and In-vitro nitrogen fixation reaction explain it. (CO5, K5)

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R3534

Sub. Code
536302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Chemistry

ADVANCED ORGANIC CHEMISTRY

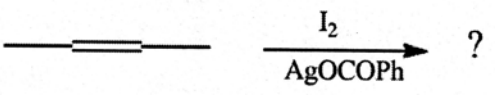
(CBCS – 2022 onwards)

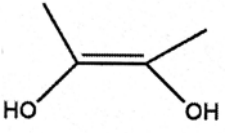
Time : 3 Hours Maximum : 75 Marks

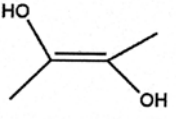
Part A (10 × 1 = 10)

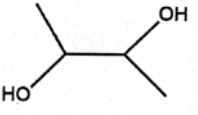
Answer **all** the following objective type questions by choosing the correct option.

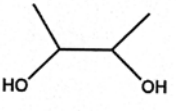
1. Identify the product of the following: (CO1, K3)



(a) 

(b) 

(c) 

(d) 

2. What is the product formed when styrene is subjected to ozonolysis? (CO1, K3)

(a) 1, 2-dihydroxy 2-phenylethane

(b) benzaldehyde and formaldehyde

(c) 2-phenyl ethanal

(d) acetophenone

3. Identify the product formed when acetone is subjected to the McMurry reaction. (CO2, K2)

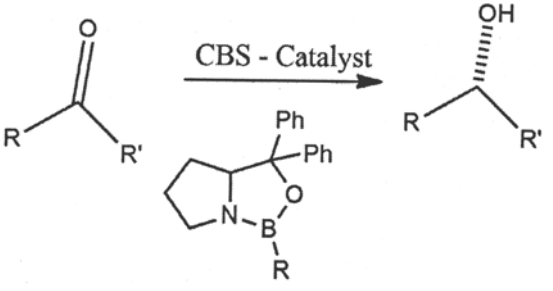
(a) 2-methylbutane

(b) 2-methylbutene

(c) 2, 3-dimethylbutane

(d) 2, 3-dimethylbutene

4. Identify the name of the reaction below: (CO2, K2)



(a) Birch reduction

(b) Wilkinson reaction

(c) Corey-Bakshi-Shibata reaction

(d) Luche reaction

5. Which one of the following compounds is used as a nucleophile in the Sakurai reaction? (CO3, K3)

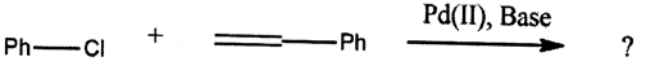
(a) Tetramethyl silane

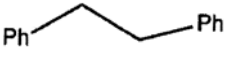
(b) Alkyl trimethylsilane

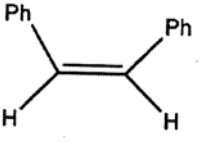
(c) Titanium tetrachloride

(d) Diethylether

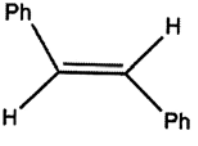
6. Complete the reaction below: (CO3, K3)



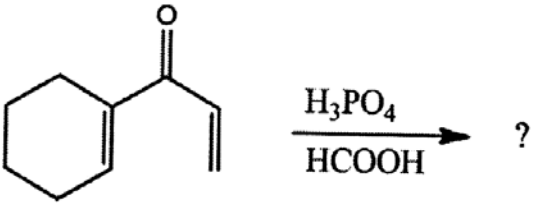
(a) 

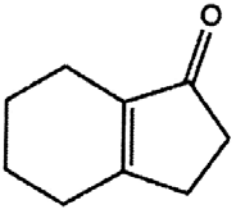
(b) 

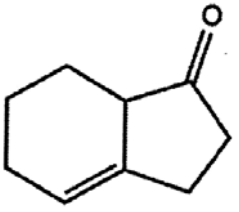
(c) 

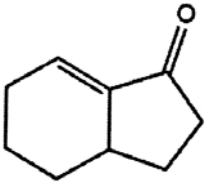
(d) 

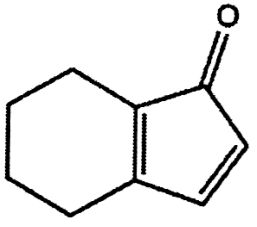
7. Find the product of the following reaction. (CO4, K2)



(a) 

(b) 

(c) 

(d) 

8. Pauson-Khand reaction is a _____ cycloaddition reaction. (CO4, K2)

(a) 2 + 2

(b) 2 + 2 + 2

(c) 2 + 2 + 1

(d) 4 + 2

9. The ideal synthetic equivalent of synthons for the disconnection of benzyl benzoate is (CO5, K3)

(a) $PhCl + PhCOOCH_2OH$

(b) $PhCH_2COOH + PhOH$

(c) $PhCH_2COCl + PhOH$

(d) $PhCH_2OH + PhCOCl$

10. Which one of the following compounds is used to protect the carbonyl group? (CO5, K2)

(a) Phthalic anhydride

(b) 1, 3-dithiane

(c) Trialkyl ether

(d) DCC

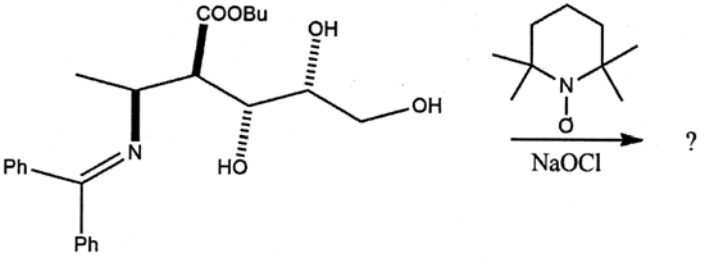
Part B $(5 \times 5 = 25)$

Answer **all** the questions not more than 500 words each.

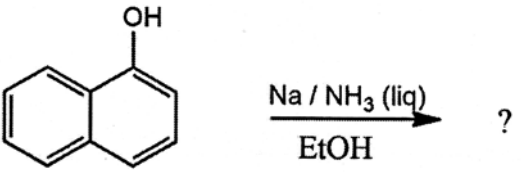
11. (a) What happens when methyl octane 1, 3-dienoate reacts with aqueous palladium chloride? Deduce the mechanism behind it. (CO1, K4)

Or

(b) Complete the reaction below with a suitable mechanism: (CO1, K3)



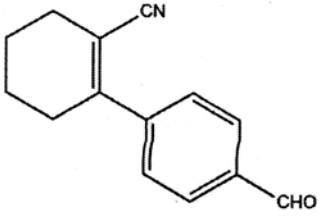
12. (a) Accomplish the following reaction with a suitable mechanism and trace out the name of the reaction: (CO2, K4)



Or

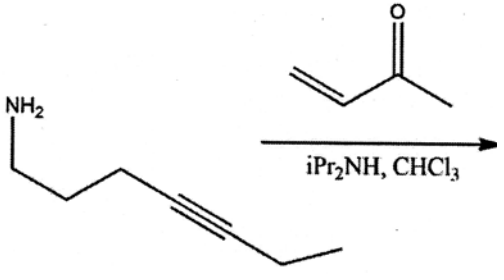
(b) Find the product formed when react with sodium borohydride in the presence as well as the absence of $CeCl_3$ and predict the mechanism behind it. (CO2, K4)

13. (a) How can you prepare the following compound with the aid of the Stille reaction and predict its mechanism? (CO3, K4)



Or

(b) Complete the following with a suitable mechanism: (CO3, K5)



14. (a) What happens when 2-butyne reacts with propene in the presence of $Co_2(CO)8$ and arrives at the mechanism behind it? (CO4, K4)

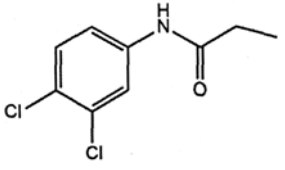
Or

(b) How can you make different cyclic compounds from-Chlorosulfones react with t-BuOK with suitable examples and predict their mechanism? (CO4, K5)

15. (a) Deduce the retro synthesis of 2-methylhexan-2-ol with the help of a one-group C-C disconnection strategy. (CO5, K4)

Or

(b) Make a retro analysis and synthesis of the following compound with the help of one group C-X disconnection strategy. (CO5, K5)

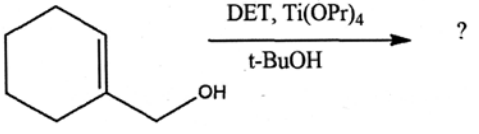


Part C (5 × 8 = 40)

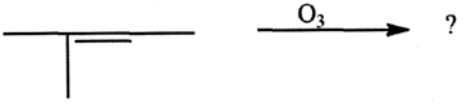
Answer **all** the questions not more than 1000 words each.

16. (a) Convert the following with a suitable mechanism: (CO1, K4)

(i)



(ii)



Or

(b) How can you prepare the following and arrive at their mechanism? (CO1, K5)

(i) Juglone with the help of Fremy's salt

(ii) 6-methyltetrahydropyren-2-one

17. (a) What happens when the following substrates react with aluminium isopropoxide in the presence of isopropyl alcohol and predict the mechanism? (CO2, K4)

(i) acetophenone

(ii) trichloropropanone

(iii) crotanaldehyde

(iv) oestrone

(v) o-nitrobenzaldehyde

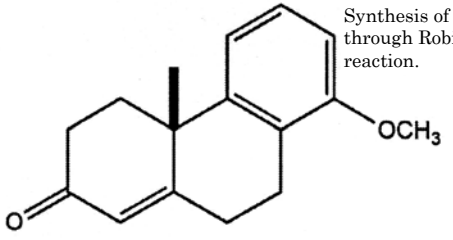
Or

(b) Write down the synthetic applications and mechanism of L-Selectride and K-Selectride reagents. How was its superior reduction behaviour than that of conventional reducing hydride? (CO2, K5)

18. (a) How can you make the following compounds and predict their mechanism? (CO3, K4)

(i) N-Ethyl aniline By Buchwald-Hartwig reaction.

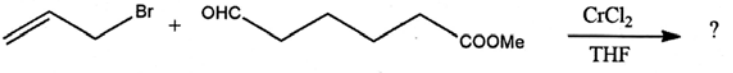
(ii) Synthesis of this compound through Robinson annulation reaction.



Or

(b) (i) Discuss the synthetic applications and mechanism of Negishi and Sonogashira reactions. (6)

(ii) Complete the following reaction: (2)



(CO3, K5)

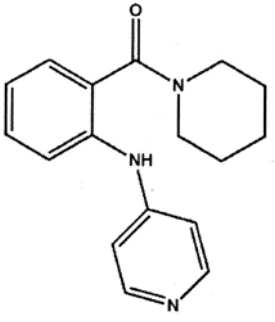
19. (a) How can you make different cyclic compounds with the help of cation-olefin cyclisation technique? Predict the mechanism behind it. (CO4, K4)

Or

(b) (i) Explain the interconversion of ring systems with suitable examples. (5 + 3)

(ii) How can you make a 3-membered ring from acyclic compounds with suitable examples? (CO4, K4)

20. (a) (i) Retrosynthesis of the following structure with the utility of the FGI strategy. (5 + 3)



(ii) Write down the retrosynthesis of retinol. (CO5, K4)

Or

(b) Describe the retrosynthesis of various organic compounds by different two group C-C disconnections approaches. (CO5, K5)

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R3535

Sub. Code
536303

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Chemistry

ADVANCED PHYSICAL CHEMISTRY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which one is called adiabalic approximation (CO1, K2)
   (a) Slatter (b) Born-openheimer
   (c) HF (d) None

2. $2P_{3/2}$ is the ground state of (CO1, K2)
   (a) H (b) B
   (c) Li (d) F

3. The molecule microwave inactive (CO2, K3)
   (a) N_2 (b) C_2H_2
   (c) HCl (d) H_2O

4. LASERS the mechanism is (CO2, K3)
   (a) Ground state population
   (b) Excited state population
   (c) Light absorption
   (d) Light emission

5. Which one is a reference electrode. (CO3, K2)

(a) Glascy carbon (b) Platinum

(c) Hydrogen (d) Copper

6. Tatel equation relates rate of an electrochemical reaction to the _____ (CO3, K2)

(a) Chorae (b) Over potential

(c) Mass (d) Polarizibility

7. Calculate the temperature at which the average velocity of oxygen equal to hydrogen at 20K (CO4, K2)

(a) 320K (b) 420K

(c) 310K (d) 410K

8. Which theory account roles of collisional activation and unimolecular dissociation are energy dependent (CO4, K2)

(a) RRK (b) Lindeman

(c) RRKM (d) Hinshelwood

9. The miller indices of the diagonal plane of a cube are (CO5, K5)

(a) 110 (b) 111

(c) 100 (d) 000

10. Which one is a semi conductor? (CO5, K5)

(a) Si (b) Ge

(c) TiO_2 (d) All

Part B

$(5 \times 5 = 25)$

Answer **all** the questions not more than 500 words each.

11. (a) Explain Paulis exclusion Principle. (CO1, K2)

Or

(b) Illustrate Potential energy surface. (CO1, K2)

12. (a) Outline the origin of line width in molecular spectra. (CO2, K3)

Or

(b) Explain normal mode analysis. (CO2, K3)

13. (a) Construct the electrical double layer. explain. (CO3, K2)

Or

(b) Classify different electrochemical cells. (CO3, K2)

14. (a) How entropy is visualized in statistical point of view? Justify. (CO4, K2)

Or

(b) Interpret transition state theory. (CO4, K2)

15. (a) Develop the concept of miller indices. (CO5, K5)

Or

(b) Identify the applications of Solid state laser. (CO5, K5)

Part C ($5 \times 8 = 40$)

Answer **all** the questions not more than 1000 words each.

16. (a) Solve Schordinger Wave equation for the atom. (CO1, K2)

Or

(b) Outline Lcto-Mo approach. (CO1, K2)

17. (a) Compare LASERS and MASERS. Outline the application of both. (CO2, K3)

Or

(b) Explain Raman Scattering. How it differs from IR absorption (CO2, K3)

18. (a) Construct Stem model for electrical double layer. (CO3, K2)

Or

(b) Identify various electrodes. (CO3, K2)

19. (a) Assess Fermi-Dirac Statistics. (CO4, K2)

Or

(b) Prove the applicability of RRKM over RRK theory. (CO4, K2)

20. (a) Predict the role of XRD in Solid State chemistry. (CO5, K5)

Or

(b) Develop the properties of Solids. (CO5, K5)

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R3536

Sub. Code
536053

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Chemistry

Elective – SPECTROSCOPY METHODS OF ANALYSIS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective type questions by choosing the correct option.

1. In Woodward-Fieser rules, what does an exocyclic double bond typically add to the λ max? (CO1, K2)

   (a) 0 nm (b) 5 nm

   (c) 10 nm (d) 15 nm

2. What is not a typical application of FTIR spectroscopy? (CO1, K1)

   (a) Identifying functional groups in a molecule

   (b) Determining the concentration of a substance

   (c) Studying the kinetics of a chemical reaction

   (d) Determining the purity of a sample

3. The coupling constant (J) in NMR is expressed in which unit? (CO2, K1)

   (a) Hz (b) ppm

   (c) Tesla (d) MHz

4. In ^{1}H NMR, a doublet of doublets arises when (CO2, K2)

(a) A proton couples to two nonequivalent neighboring protons

(b) A proton couples to two equivalent neighboring protons

(c) A proton couples only to a single proton

(d) There is no coupling (full decoupling)

5. In a COSY (Correlation Spectroscopy) experiment, cross peaks arise due to (CO3, K2)

(a) Direct coupling of nuclei

(b) Long-range dipole-dipole relaxation

(c) Chemical exchange

(d) Difference in chemical shifts

6. In EPR spectroscopy, the hyperfine splitting pattern of a Cu(II) complex (I = 3/2) will generally show (CO3, K1)

(a) 2 lines (b) 3 lines

(c) 4 lines (d) 6 lines

7. In mass spectrometry, the McLafferty rearrangement involves (CO4, K2)

(a) Cleavage of a C – C bond next to a heteroatom

(b) Rearrangement of a hydrogen via a six-membered transition state

(c) Isotopic peak splitting

(d) Ionization of the molecular ion

8. The isomer shift in Mössbauer spectroscopy arises mainly due to (CO4, K2)

(a) Nuclear Zeeman effect

(b) Electron density at the nucleus

(c) Magnetic dipole-dipole interactions

(d) Quadrupole moment

9. The main principle behind fluorescence spectroscopy is (CO5, K1)

(a) Emission of light after absorption of thermal energy

(b) Emission of light after absorption of electromagnetic radiation

(c) Emission of light due to chemical reaction

(d) Scattering of incident radiation

10. In Raman spectroscopy, the Raman shift is expressed in (CO5, K1)

(a) nm (b) Hz

(c) cm^{-1} (d) ppm

Part B ($5 \times 5 = 25$)

Answer **all** questions not more than 500 words each.

11. (a) (i) Why are the intensities of $\pi - \pi^*$ transitions 10 to 100 times stronger than $n - \pi^*$ transitions?

(ii) Why is the hydroxy group considered an auxochrome rather than an achromophore? (2.5 + 2.5) (CO1, K2)

Or

(b) Discuss with suitable examples, the inductive, resonance, and ring size effect in carbonyl stretching frequency. (CO1, K4)

12. (a) What property of specific atomic nuclei is involved in the NMR phenomenon? And ^{13}C is NMR active, while ^{12}C is not. Explain. (2.5+2.5) (CO2, K2)

Or

(b) The resonance frequency of a proton in a 7.05 T magnetic field is observed at 300 MHz. Calculate the gyromagnetic ratio $(\gamma/2\pi)$ of the proton. (CO2, K3)

13. (a) Explain the principles of NOESY (Nuclear Overhauser Effect Spectroscopy) and its use in structural elucidation of organic molecules. (CO3, K3)

Or

(b) Discuss g-anisotropy in EPR spectroscopy with an example. (CO3, K3)

14. (a) Explain the role of ESI-MS and MALDI-MS in the analysis of biomolecules. (CO4, K4)

Or

(b) Write a short note on hyperfine interactions observed in Mössbauer spectroscopy. (CO4, K3)

15. (a) Explain the working principle of a fluorescence spectrometer and discuss its application in analytical chemistry. (CO5, K3)

Or

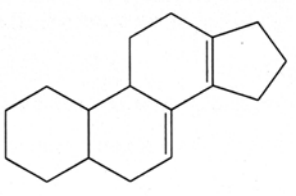
(b) What are the advantages of using FTIR spectroscopy over conventional IR spectroscopy? (CO5, K4)

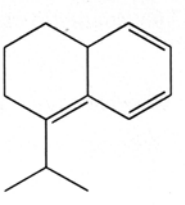
Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) (i) State Woodward-Fieser rules for calculating λ_{max} values of conjugated dienes.

(ii) Applying Woodward-Fieser rules, calculate the value of absorption maxima for the following compounds. (CO1, K3)





Or

(b) How would you distinguish between the compounds in each pair by infrared spectral studies? (CO1, K4)

(i) Phenol and cyclohexanol

(ii) Acetaldehyde and acetone

(iii) Cis and Trans 2-butene

(iv) Ethylbenzene and O-xylene

17. (a) (i) Describe the applications of ^{13}C NMR spectroscopy in organometallic chemistry.

(ii) Explain how broadband and off-resonance decoupling methods simplify spectra.

(CO2, K4)

Or

(b) Derive the Karplus equation and explain how vicinal coupling constants can be correlated with dihedral angles. Give an example calculation for a coupling constant when $\theta = 60°$. (CO2, K3)

18. (a) Derive the selection rules for EPR transitions. Calculate the resonance field (B_0) for a free electron at a microwave frequency of 9.5 GHz (g = 2.0023). (Given : $\beta e = 9.274 \times 10^{-24}$ J/T; h = 6.626×10^{-34} Js).

(CO3, K3)

Or

(b) Describe the principle and application of the HMBC experiment in 2D NMR. How does it differ from COSY? (CO3, K4)

19. (a) In a mass spectrum, a molecular ion peak is observed at m/z = 100, with an isotope peak at m/z = 101 having an intensity = 5% of the molecular ion. Calculate the approximate number of carbon atoms present in the compound. (Natural abundance of $^{13}C \approx 1.1\%$ per carbon atom).
(CO4, K3)

Or

(b) Discuss the quadrupole splitting in Mossbauer spectroscopy. Explain how it helps in distinguishing oxidation states of Fe in complexes. (CO4, K3)

20. (a) Discuss the instrumentation and applications of Raman spectroscopy. How does it complement IR spectroscopy in molecular structure determination?
(CO5, K4)

Or

(b) In a UV-Visible spectroscopic experiment, a compound shows an absorbance of 0.60 at $\lambda = 280$ nm using a 1 cm cuvette. If the molar absorptivity is 12,000 L mol^{-1} cm^{-1}, Calculate the concentration (in mol L^{-1}) of the solution. (CO5, K3)
