Meerut Institute of Engineering & Technology, Meerut

CO-Wise AKTU Question Bank

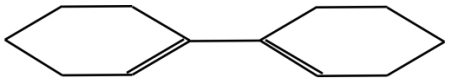
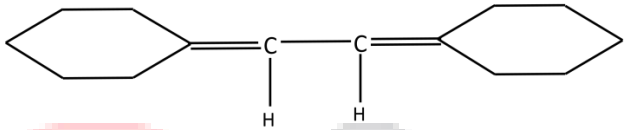
Course: B.Tech **Subject Name: Engineering Chemistry** **Subject Code: BAS102/202** **Semester: I/II**

CO No.	Lect. No.	Syllabus Topic (As Per LP)	Ques. No.	Question Statement (As Per AKTU)	Session
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**1**	Discuss the postulates of Molecular Orbital Theory OR Outline the salient features of MOT on the basis of LCAO principle.	(2016-2017) (2018-2019)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**2**	Explain BMO and ABMO and differentiate between them.	(2018-2019)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**3**	On the basis of MO theory explain why hydrogen forms diatomic molecule while helium remains monoatomic	(2014-2015)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**4**	Explain why bond energy of N_2 is greater than bond energy of O_2?	(2015-2016)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**5**	Calculate the bond order, magnetic behavior and order of stability of: (a) N_2, N_2^-, N_2^+, and O_2^+ (b)NO, NO^-, NO^+	(2015-2016) (2016-2017) (2017-2018)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**6**	Arrange the following in the increasing order of their bond energy and bond length: a) O_2, O_2^{2+}, O_2^{2-} b) N_2, N_2^- and N_2^{2-}	(2017-2018) (2018-2019) (2019-2020) (2020-2021)
CO1	**L1**	Molecular orbital theory and its application to homo diatomic molecules.	**7**	On the basis of molecular orbital theory explain why $N_2$is diamagnetic and O_2 is paramagnetic? Calculate their bond orders and write their magnetic behavior.	(2016-2017) (2017-2018) (2018-2019) (2020-2021)
CO1	**L2**	Molecular orbital theory and its application to hetero diatomic molecules.	**8**	With the help of molecular orbital diagram explain the formation of NO and CO. Also calculate their bond order and predict their magnetic behavior?	(2015-2016) (2018-2019) (2019-2020)

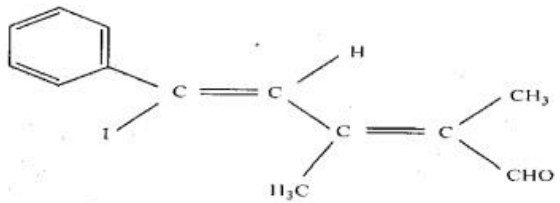
CO1	**L2**	Molecular orbital theory and its application to hetero diatomic molecules.	**9**	Draw the molecular orbital diagrams of: N_2, O_2, NO, CO, HF. Calculate their bond orders and also comment on their magnetic behavior giving reasons for their magnetic behavior.	(2018-2019) (2019-2020) (2022-2023)
CO1	**L3**	Liquid crystals, their classification, properties and applications. Industrially important materials used as liquid crystals.	**10**	What is Liquid crystalline state? Describe the various types of liquid crystals. Define the term pitch. What is its significance? Give the applications of liquid crystals **OR** What do you mean by mesomorphic state? Discuss its classification on basis of temperature and give their important applications Differentiate between nematic and smectic liquid crystals. **OR** What are liquid crystals? What are their essential characteristics? Give their classification and application. **OR** Illustrate the concept of liquid crystals. Classify them on the basis of temperature and mention their important applications.	(2014-2015) (2016-2017) (2017-2018) (2018-2019) (2019-2020) (2020-2021) (2021-2022) (2022-2023)
CO1	**L4**	Nanomaterials: Graphite and fullerenes.	**11**	Give the structure, properties and uses of graphite. Explain the reason for its electrical and lubricating properties **OR** With the help of neat diagram describe the structure of graphite. Also give at-least five applications of graphite.	(2014-2015) (2016-2017) (2017-2018) (2021-2022) (2022-2023)
CO1	**L4**	Nanomaterials: Graphite and fullerenes.	**12**	Discuss the preparation properties and application of an allotrope of carbon having truncated icosahedrons geometry.	(2014-2015) (2015-2016) (2016-2017) (2019-2020) (2020-2021) (2022-2023)
CO1	**L4**	Carbon Nano Tubes (CNT)	**13**	What are CNT? Write their types, preparation and application	(2022-2023)
CO1	**L4**	Concepts, Properties & Applications of Nano-Science & Nano-materials	**14**	Define nanomaterials and nanotechnology. Give the approaches used for the preparation of nanomaterials. Give applications of nanomaterials in electronics and medicines.	(2017-2018) (2018-2019) (2019-2020) (2020-2021)

					(2022-2023)
CO1	**L4**	Concepts, Properties & Applications of Nano-Science & Nano-materials	**15**	What are nano materials? How they are different from bulk materials?	(2021-2022)
CO1	**L4**	Concepts, Properties & Applications of Nano-Science & Nano-materials	**16**	How the physical and chemical properties of nanomaterials vary with size? Write important applications of nanomaterials. **OR** Give the applications of nanomaterials in electronics and medicines.	(2022-2023)
CO1	**L6**	Green Chemistry: Introduction, 12 principles and importance of green Synthesis, Green Chemicals	**17**	Write 12 principal of Green chemistry?	(2022-2023)
CO1	**L5**	Synthesis of typical organic compounds by conventional and Green route (Adipic acid and Paracetamol), Environmental impact of Green chemistry on society	**18**	Describe conventional and non-conventional green synthesis of Paracetamol & Adipic Acid?	(2022-2023)
CO2	**L7**	Beer Lamberts Law and its numerical. U.V. and Visible spectroscopy: Electronic transitions	**1**	What is Beer-Lambert law in UV-Visible absorption spectroscopy? A compound having concentration 10^{-3} g/l resulted absorbance value 0.20 at λ_{max} =510 nm using 1.0 cm cell. Calculate its absorptivity and molar absorptivity values. Molecular weight of compound is 400.	(2015-2016) (2016-2017) (2018-2019)
CO2	**L8**	Beer Lamberts Law and its numerical. U.V. and Visible spectroscopy: Electronic transitions	**2**	A solution shows a transmittance of 20%, when kept in a cell of 2.5 cm thickness. Calculate its concentration if the molar absorption coefficient is 12000 $dm^3mol^{-1}cm^{-1}$.	(2021-2022)
CO2	**L8**	Beer Lamberts Law and its numerical. U.V. and Visible spectroscopy: Electronic transitions	**3**	State and drive the Lambert beer's law. The percentage transmittance of an aqueous solution of unknown compound is 20% at 25 ºC and 300 nm for 2 $x10^{-5}$ M solution in a 4 cm cell calculate the observance and the molar extinction coefficient.	(2019-2020)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**4**	Define the terms Bathochromic and Hypsochromic shifts.	(2014-2015)

CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**5**	What are chromophores and auxochromes? How do auxochromes increase the colouring power of chromophores? A di-ene has λ_{max} at 175 nm in its UV spectrum. What inference can be drawn from this data?	(2014-2015) (2015-2016) (2016-2017)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**6**	Give the basic principle of UV- spectroscopy. Explain various types of electronic transition. Predict electronic transition in CH_3CHO	(2014-2015) (2016-2017) (2018-2019) (2020-2021)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**7**	Give the possible electronic transitions (UV spectra) in- $CH_3CH_2CH_3$, $CH_3CH=CH_2$, $CH_3CH=O$ and CH_3-CH=CH-CH=CH-CH_3	(2020-2021)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**8**	Explain the absorption and intensity shift in the UV spectroscopy and support with examples. Illustrate, the effect of polar and non-polar solvent on π- π* transition in acetone **Or** Explain the different types of electronic transitions involved in UV-Vis. Spectroscopy. Also explain the different types of absorption and intensity shifts taking place in UV-VIS spectroscopy	(2018-2019) (2019-2020) (2021-2022)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**9**	Why β carotene absorbs light in visible region?	(2016-2017)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**10**	Can ultra-violet spectral data be useful to distinguish between the following compounds? Give reasons. i) Ethyl benzene and styrene ii) CH_2=CH-CH_2-CH=CH_2 and CH_2=CH-CH=CH-CH_3	(2018-2019)
CO2	**L8**	auxochromes, chromophores and absorption shifts .factors causing shifts, application of U.V.-Visible spectroscopy	**11**	Explain, which one will exhibit higher value of λ_{max} in UV/Visible spectra of CH_3COCH_3 and CH_3=CHCOCH$_3$ Identify the chromophoric groups present in cyclopentene, toluene, butanone and methanethiol in UV spectroscopy.	(2018-2019) (2022-2023)
CO2	**L9**	Woodward Fieser Rule and calculation of λmax.	**12**	Give the structure of a di-ene having a molecular formula C_4H_6 which shows an intense peak at λ_{max} =217 nm in its UV spectrum.	(2014-2015)

CO2	**L9**	Woodward Fieser Rule and calculation of λmax.	**13**	Why the λ_{max} for the diene (I) is observed at a lower nm than (II)?  (I)  (II)	(2014-2015) (2022-2023)
CO2	**L10**	Elementary idea and simple applications of IR	**14**	Explain the principle of IR spectroscopy. For XY_2 bent molecule show various types of stretching and bending vibrations in IR spectroscopy. Discuss the significance of Finger print region. **OR** Define infrared spectroscopy? Describe the various molecular vibrations in the technique. What is finger print region and functional group region in IR spectroscopy? **OR** IR peaks is often characterized as molecular finger prints comment on it.	(2013-2014) (2014-2015) (2015-2016) (2016-2017) (2017-2018) (2018-2019) (2019-2020) (2021-2022) (2022-2023)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**15**	How many fundamental vibrational degrees of freedom are expected for the following molecules: CO_2, H_2O and C_2H_4?	(2020-2021)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**16**	Two isomers A and B of the molecular formula C_3H_6O gives IR absorption at 1650 cm^{-1} and 1710 cm^{-1} respectively. Assign structural formula to A and B isomers.	(2018-2019)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**17**	One of the fundamental vibrational modes of H_2O occurs at 3652 cm^{-1}.What would be the frequency of the corresponding vibration for D_2O	(2014-2015)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**18**	An organic compound having molecular formula C_7H_6O shows absorption peaks at 3010, 2700, 1600, 1580, 1520, 1480, and 1270 cm^{-1} in its IR spectrum. Suggest its structure.	(2015-2016)

CO2	**L10**	factors affecting IR vibrational modes & its numerical	**19**	How will you distinguish between the following pairs of compounds on the basis of infrared spectroscopy? 1) CH_3COOH and $CH_3COOC_2H_5$ 2) C_2H_5OH and $C_2H_5OC_2H_5$	(2015-2016)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**20**	Out of the following pair which one is expected to absorb at higher frequency for stretching vibration. Also state reason. i) HCHO, CH_3CHO ii) C=C, C≡C iii) O-H, C-C	(2018-2019)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**21**	On the basis of IR spectra, distinguish between intermolecular and intra-molecular hydrogen bonding.	(2020-2021)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**22**	Among H_2, HCl, CO_2, H_2O molecules identify which will be IR active and why? Explain different modes of vibrations observed in CO_2molecule.	(2018-2019)
CO2	**L10**	factors affecting IR vibrational modes & its numerical	**23**	A compound having molecular formula $C_2H_4O_2$ while studied for its IR analysis resulted the following peak in its spectrum: 2900-2950 cm^{-1}, 1710 cm^{-1} and 3500-3650 cm^{-1}. The compound also gave effervescence with Na_2CO_3.Suggest structure of the compound.	(2015-2016)
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and numerical, structural elucidation on the basis of IR & NMR spectroscopy	**24**	Why Tetra Methyl Silane is used as an internal indicator in NMR spectroscopy? Give the number of 1H NMR signals and their splitting pattern in the following compounds: (i) $(CH_3)3COCH_3$ (ii) $CH_3CH(Cl)CH_2Cl$ (iii) $CH_3CH_2CH_2OH$ (iv) $CH_3CHCHCHO$	(2016-2017)
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and numerical, structural elucidation on the basis of IR & NMR spectroscopy	**25**	.An aromatic compound (Molecular mass=135) give the following signals in NMR Spectrum. (i) Singlet (2.09 δ),3H (ii)A distorted singlet (3.09 δ),1H (iii)A multiplet(7.27 δ),3H (iv)A multiplet (7.75 δ),2H. Predict the structure of the compound.	(2017-2018)
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and	**26**	Why is TMS used as an internal standard in NMR spectroscopy? Two isomeric compounds A and B have molecular formula $C_{10}H_{14}$. The 1H NMR spectra of these isomers gave the following data:	(2022-2023)

		numerical, structural elucidation on the basis of IR & NMR spectroscopy		Isomer A: δ 1.30 (9H,s); δ 7.28 (5H, s) Isomer B: δ 0.88 (6H, d); δ 1, 86 (1H, m); δ 2.45 (2H, d); δ 7.12 (5H, s) Giving reasons assign the structures for the two isomers.	
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and numerical, structural elucidation on the basis of IR & NMR spectroscopy	**27**	What is the basic principle of 'H NMR spectroscopy? What is the significance of sp lifting, shielding and deshielding g? A compound having the molecular formula $C_{10}H_{14}$ gave the following1HNMRdata: δ 0.88 (6H, doublet), δ 1.86 (1H, multiplet), δ 2.45 (2H, doublet) and δ 7.12 (5H, singled). Giving reasons, assign the structure to the compound which is consistent with the above data.	(2014-2015)
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and numerical, structural elucidation on the basis of IR & NMR spectroscopy	**28**	Explain the term chemical shift along with shielding and deshielding. An organic compound with molecular formula C3H3Cl5 gave the following proton NMR data: (i) A triplet 4.52 δ 1H (ii) A doublet 6.07 δ 2H	(2017-2018)
CO2	**L11, L12**	NMR spectroscopy: principle , chemical shift, shielding and deshielding effect, NMR spectrum and application and numerical, structural elucidation on the basis of IR & NMR spectroscopy	**29**	What is shielding and deshielding in NMR spectroscopy? A compound having the molecular formula C_4H_9Br gave the following 1H NMR data: δ 1.04 (6H, doublet), δ 1.95 (1H, multiplet) and δ 3.33 (2H, doublet). Giving reasons, assign the structure to the compound which is consistent with the above data.	(2022-2023)
CO2	**L12**	Structural elucidation on the basis of IR & NMR spectroscopy	**30**	Predict the number of signal and their splitting pattern in 1H NMR spectra of $CH_3CCl_2CH_3$ and $CH_3OCH_2CH_3$	(2013-2014)
CO2	**L14**	Stereochemistry: Geometrical Isomerism, Chiral Drugs.	**31**	Give five examples of compounds showing optical isomerism without the presence of chiral carbon. What is E-Z configuration : Assign E or Z confirmation to the following and draw all its possible stereo isomers 	(2022-23)

CO2	**L13**	Stereochemistry: Optical isomerism in compounds without chiral carbon	**32**	Discuss the stereochemistry of tartaric acid. What will happen when one of the OH group of tartaric acid will be replaced by NH_2	(2014-2015)
CO2	**L13,14**	Stereochemistry: Geometrical Isomerism. Geometrical Isomerism	**33**	Asymmetrically substituted compounds having even number of cumulative bonds exhibit optical isomerism whereas compounds having odd number of cumulative double bonds exhibit geometrical isomerism. Explain giving by proper reason.	(2022-2023)
CO2	**L14**	Stereochemistry: Geometrical Isomerism, Chiral Drugs.	**34**	What are Chiral Drugs? Give examples of Chiral Drugs	(2022-2023)
	L14	Stereochemistry: Geometrical Isomerism, Chiral Drugs.	**35**	What is Atropisomerism? Give five examples of compounds showing optical isomerism in the absence of chiral carbon.	(2022-2023)
CO3	**L15**	Electrochemistry: Electrochemical and electrolytic cells, Electrochemical series and its uses.	**1**	Discuss the principle and working of a galvanic cell.	(2016-2017) (2017-2018)
	L15	Electrochemistry: Electrochemical and electrolytic cells, Electrochemical series and its uses.	**2**	What is electrochemical series? What is the potential of a half-cell consisting of zinc electrode in 0.01M $ZnSO_4$ solution at 25°C. E= 0.736V.	(2022-2023)
CO3	**L16**	Derivation of Nernst equation, numerical and applications of Nernst equation.	**3**	Calculate the cell potential the given cell at 25°C (R= 8.31 $JL^{-1}mol^{-1}$, F= 96500C mol^{-1} Ni(s) / Ni^{+2} (0.01 mol) // Cu^{+2} (0.1 mol)/Cu+(S) Given: $E°_{Cu+2/Cu}$= 0.34 V; $E°_{Ni+2/Ni}$= - 0.25 V	(2018-2019)
CO3	**L16**	Derivation of Nernst equation, numerical and applications of Nernst equation.	**4**	Calculate the cell potential at 298 K for cell reaction: Al^{+3} + Fe $\rightarrow Fe^{+3}$ + Al ; $E°_{Cell}$= - 1.62 V	(2018-2019) (2021-2023)
CO3	**L16**	Derivation of Nernst equation, numerical and applications of Nernst equation.	**5**	Derive Nernst equation. Give significance of Nernst equation. Consider a cell reaction: Zn / Zn^{2+} [0.1M] ||Cu^{2+} [0.2M] / Cu Standard reduction potential of Zn^{2+} and Cu^{2+} are -0.76V and0.34V respectively. Write half-cell reactions, complete cell reaction and calculate EMF of the cell.	(2018-2019) (2020-2021) (2020-2021)
CO3	**L16**	Derivation of Nernst equation, numerical and applications of Nernst equation.	**6**	The EMF of a cell measured by means of a hydrogen electrode against a saturated calomel electrode at 298 K is 0.4 188 V if the pressure of the H_2 was maintained at 1 atm calculate the pH of the unknown solution given potential of reference electrode is 0.2415 V.	(2019-2020)

CO3	**L17**	Gibbs Helmholtz equation, Relation of EMF with thermodynamic functions (ΔH, ΔS and ΔF) and numerical.	**7**	The voltage of the cell $Pb/PbSO_4/Na_2SO_4/Hg$ is 0.9647 V at 25°C. The temperature is 1.74×10^{-4} VK^{-1}. Calculate the values of ΔG, ΔS and ΔH.	(2018-2019)
CO3	**L17**	Gibbs Helmholtz equation, Relation of EMF with thermodynamic functions (ΔH, ΔS and ΔF) and numerical.	**8**	The e.m.f. of the cell:$Cd\|CdCl_2,2.5H_2O$(Saturated)$\|\|AgCl(s)\|Ag$ involving following reaction: $Cd(s) + 2AgCl(s)aq \rightarrow CdCl_2.5H_2O$(Saturated) + 2Ag(s) is 0.6753V and 0.6915Vat 25 0C and O 0C. Calculate Δ H, ΔG and ΔS at 25 0C.	(2020-2021)
CO3	**L18**	Batteries, their types, construction and working of lead acid storage battery.	**9**	Explain the construction and working of Lead acid storage battery. **OR** Discuss the construction and chemistry of charging/ discharging of lead acid battery. **OR** Give reactions of lead-acid storage cell when it behaves like a galvanic cell.	(2017-2018) (2018-2019) (2019-2020) (2022-2023)
CO3	**L19**	Working and reaction of Leclanche cell	**10**	Give the working and reaction of Leclanche cell.	
CO3	**L20**	Corrosion: Types of corrosion, its causes.	**11**	Explain the corrosion phenomena involving oxide film growth law.	(2015-2016)
CO3	**L20**	Corrosion: Types of corrosion, its causes.	**12**	Discuss the electrochemical theory of corrosion with the help of oxygen absorption and hydrogen evolution mechanism along with equations. What effect will increased oxygen supply have on such corrosion?	(2016-2017) (2017-2018) (2018-2019) (2019-2020) (2022-2023)
CO3	**L20**	Corrosion: Types of corrosion, its causes.	**13**	Why is a block of magnesium attached through an insulated metallic wire to the hull of the ship?	(2014-2015)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**14**	How does a cathodic metallic coating help in protection against corrosion?	(2014-2015)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**15**	How can corrosion be minimized by proper design?	(2014-2015) (2016-2017) (2022-2023)

CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**16**	What are corrosion inhibitors? Explain with examples how anodic and cathodic inhibitor provides protection against corrosion.	(2015-2016)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**17**	Why is a block of magnesium attached through an insulated metallic wire to an underground iron pipeline?	(2016-2017) (2018-2019) (2022-2023)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**18**	Explain why a pure metal rod half immersed vertically in water starts corroding at the bottom? **OR** What will happen if a Zinc rod is vertically half submerged under water?	(2017-2018) (2022-2023)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**19**	Explain why sheets of Zinc metal are hung around the ship hull of ocean going ships.	(2017-2018)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**20**	Comment on the use of Aluminum in place of Zinc for Cathodic protection of iron from rusting.	(2018-2019)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**21**	How corrosion can be prevented by sacrificial anodic protection and impressed current cathodic protection.	(2015-2016) (2016-2017) (2017-2018) (2018-2019) (2019-2020)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**22**	Why does part of a nail inside the wood undergoes corrosion easily?	(2019-2020)
CO3	**L21**	Factors affecting corrosion, Electrochemical theory of corrosion. Preventive measures of corrosion.	**23**	How much rust ($Fe_2O_3.6H_2O$) can be produced by 3gm of iron?	(2020-2021)
CO3	**L21**	Preventive measures of corrosion.	**24**	Discuss the differences between anodic and cathodic metallic coatings. Explain the process of Galvanizing and Electroplating. What will happen if an iron ship travelling in sea is attached through an insulated metallic wire to a small sheet of magnesium?	(2022-2023)

CO3	**L23**	Chemistry of Engineering Materials: Cement; Constituents, manufacturing, hardening and setting, deterioration of cement, Plaster of Paris	**25**	Give the manufacturing of cement with the reaction involved in setting, hardening and decay? **OR** Explain the setting and hardening of cement with relevant chemical reactions involved in the process.	(2015-2016) (2016-2017) (2022-2023)
CO4	**L24**	How to calculate hardness and alkalinity, internal treatment methods.	**1**	Discuss the different methods of internal treatment for boiler feed water.	(2014-2015)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**2**	What is permanent and temporary hardness? Write the constituent responsible for them and how can they be removed?	(2014-2015) (2015-2016)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**3**	Describe sludge and scales. **OR** Explain the process of scale and sludge formation in boilers. How can this be prevented? Discuss five disadvantages of scales and sludge formation in boilers respectively. **OR** Distinguish between scales and sludge.	(2014-2015) (2016-2017) (2018-2019) (2022-2023)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**4**	What is potable water? What are its chemical requirements?	(2016-2017)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**5**	What is calgon conditioning? Explain. Why is calgon conditioning better than phosphate conditioning? **OR** Show with the help of reaction, how scale formation can be prevented by Calgon conditioning.	(2015-2016) (2016-2017)(2017-2018) (2018-2019)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**6**	Define Hardness. Why is it conventional to express hardness in terms of $CaCO_3$ at the international level? Write other units also. How are they inter-related? **OR** Why hardness of water is expressed in terms of $CaCO_3$ equivalents.	(2015-2016) (2018-2019)

CO4	**L25**	Hardness, its units and types, associated boiler trouble	**7**	A sample of water was found to contain 40.5 mg/L $Ca(HCO_3)_2$, 46.5 mg/L $Mg(HCO_3)_2$, 32.1mg/L $CaSO_4$, 27.6 mg/L $MgSO_4$, 22.45 mg/L $CaCl_2$, 19.0 mg/L $MgCl_2$ and 4.8 mg/L NaCl. Calculate the temporary and permanent hardness of water sample.	(2016-2017)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**8**	100 ml of water sample has hardness equivalent to 12.5 ml of 0.08 N $MgSO_4$ solutions. Calculate the hardness of this water sample.	(2017-2018)
CO4	**L25**	Hardness, its units and types, associated boiler trouble	**9**	A water sample contains 10 ppm of $CaCl_2$ 3.2 mg / liters of NaCl, 21.1 ^{0}Fr of Al_2O_3. Calculate total hardness of water.	(2019-2020)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**10**	Explain reverse osmosis process.	(2014-2015) (2016-2017) (2018-2019)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**11**	What are ion-exchange resins? How will you purify water by using the resins? Calculate the lime and soda needed for softening 50,000 L of water containing The following salts. $CaSO_4$=l3.6mg/L; $MgCl_2$=9.5 mg/L; $Mg(HCO_3)_2$=7.3 mg/L; $Ca(HCO_3)_2$= l6.2 mg/L. Given that the molar mass of Ca $(HCO_3)_2$ is 162 and that of $MgCl_2$ is 95. **OR** What are ion exchange resins? With the help of neat sketch, discuss ion exchange process for water softening. Compare its merit over zeolite process.	(2014-2015) (2016-2017) (2018-2019) (2019-2022)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**12**	The hardness of 10,000 L of sample of water was completely removed by passing it through a zeolite softener. The zeolite softener then required 200 L of NaCl solution containing 150 gm/L of NaCl for regeneration. Find out the hardness of water sample	(2014-2015) (2017-2018) (2022-2023)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**13**	What do you mean by term Permutit? Explain zeolite process for water softening. **OR** Explain the Zeolite process of water softening. What are the disadvantages and limitations of this process?	(2014-2015) (2015-2016) (2017-2018) (2018-2019) (2022-2023)

CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**14**	A zeolite softener was 90% exhausted by removing the hardness completely when 10,000 liters of hard water sample passed through it. The exhausted zeolite bed required 200 liters of 3% of NaCl solution for its complete regeneration. Calculate the hardness of water solution.	(2016-2017) (2017-2018) (2021-2022)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**15**	A zeolite softener was regenerated by passing 50 ltrs of NaCl solution having strength of 14.625 g/l of NaCl. Calculate the hardness of water if 10000 ltrs of hard water was softened by using this zeolite.	(2021-2022)
CO4	**L26-L27**	Zeolite Process, Ion exchange resins, numericals on zeolite process. Reverse osmosis	**16**	Why zeolite softener is not recommended for obtaining feed water for high pressure boilers?	(2017-2018)
CO4	**L28-L29**	Lime soda process and its numericals.	**17**	What is the basic principle of Lime Soda process? A water sample, using $FeSO_4.7H_2O$ as a coagulant at the rate of 139 ppm gave the following results on analysis: Ca^{+2}= 160 ppm, CO_2= 88 ppm, Mg^{2+}=72ppm, HCO_3^- = 488ppm Calculate the lime and soda required to soften 1,00,00 liters of water.	(2014-2015) (2015-2016) (2017-2018)
CO4	**L28-L29**	Lime soda process and its numericals.	**18**	Water sample contains the following impunities Ca^{+2}=20ppm, Mg^{2+}=l 8 ppm, HCO_3^- = 183 ppm and SO_4^{2-} = 24 ppm. Calculate the amount of lime and soda needed for softening.	(2015-2016)
CO4	**L28-L29**	Lime soda process and its numericals.	**19**	A sample of water contains the following impurities: Ca^{2+}=20ppm, Mg^{2+}=18ppm, HCO_3^-=183ppm and SO_4^{2-} =24ppm. Calculate the lime and soda needed for softening.	(2017-2018)
CO4	**L28-L29**	Lime soda process and its numericals.	**20**	Why does magnesium bicarbonate require double amount of lime for softening in comparison to calcium bicarbonate?	(2017-2018) (2018-2019)
CO4	**L28-L29**	Lime soda process and its numericals.	**21**	Differentiate between lime soda process and ion exchange process. Calculate the amount of lime and soda required for softening 30000 liters of water, using 20 ppm of sodium aluminates as coagulant. Impurities in water are as follows: Ca^{2+} =160 ppm, Mg^{2+} = 96 ppm, dissolved CO_2 = 34 ppm and HCO_3^- = 403 ppm.	(2017-2018) (2019-2020)

CO4	**L28-L29**	Lime soda process and its numericals.	**22**	Calculate the quantities of lime (74%) and soda (94%) required for cold softening of 125,000 L of water with the following analysis, using 10 ppm of $NaAlO_2$ as coagulant. Analysis of raw water: Ca^{+2}= 160 ppm, Mg^{+2}= 48 ppm, CO_2= 66 ppm, HCO_3^- = 264 ppm, H^+= 20 ppm, NaCl= 4.7 ppm. Analysis of treated water: CO_3^{-2}= 45 ppm, OH^- = 68 ppm.	(2018-2019)
CO4	**L28-L29**	Lime soda process and its numericals.	**23**	A sample of water gave the following data on analysis: Ca^{+2}= 20 ppm, Mg^{+2}= 25 ppm, CO_2= 30 ppm, HCO_3^- = 150 ppm, K^+= 10 ppm. Calculate the amount of lime (87%) and soda (91% pure) required to soften 10^6 L of water	(2018-2019)
CO4	**L28-L29**	Lime soda process and its numericals.	**24**	Calculate the amount of lime and soda required for the treatment of 10,000 L of water whose analysis is as follows (in mg/L): $Mg(HCO_3)_2$= 73; $CaSO_4$= 102; $MgCl_2$= 95; $MgSO_4$= 24, $Ca(HCO_3)_2$= 121.5; NaCl= 55.	(2022-2023)
CO4	**L28-L29**	Lime soda process and its numericals.	**25**	Calculate the amount of lime and soda required for the treatment of 20000 lts. of water whose analysis is as follows: $Ca(HCO_3)_2$ = 40.5; $Mg(HCO_3)_2$ =36.5 ppm; $MgSO_4$= 30 ppm; $CaCl_2$= 27.75 ppm.	(2021-2022)
CO4	**L28-L29**	Lime soda process and its numericals.	**26**	Calculate the quantities of lime and soda required for cold softening of 125,000 L of water with the following analysis, using 10 ppm of $NaAlO_2$ as coagulant. Analysis of raw water: Ca^{+2}= 160 ppm, Mg^{+2}= 48 ppm, CO_2= 66 ppm, HCO_3^- = 264 ppm, H^+= 20 ppm, NaCl= 4.7 ppm. Analysis of treated water: CO_3^{-2}= 45 ppm, OH^- = 68 ppm.	(2019-2020)
CO4	**L30**	Fuels and their classification, comparision of solid, liquid and gaseous fuels, characteristics of good fuels.	**27**	Why should an ideal fuel have moderate ignition temperature?	(2014-15)
CO4	**L30**	Fuels and their classification, comparision of solid, liquid and gaseous fuels, characteristics of good fuels.	**28**	How does Gross calorific value differ from Net calorific value? Explain when will the value of GCV=NCV?	(2017-2018) (2022-2023)

CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**29**	Calculate GCV of the coal sample having C=80%, H = 9%, O=4%, N=1.5%, S=2.5% and Ash = 3%.	(2014-2015) (2017-2018) (2018-2019)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**30**	Why should an ideal fuel have moderate ignition temperature?	(2014-15)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**31**	Calculate the gross and net calorific values of a coal sample containing 84% of Carbon, 1.5% sulphur, 6% nitrogen, 5.5% hydrogen and 8.4% oxygen. The Calorific values of carbon, hydrogen, sulphur are 8080 Kcal/Kg, 34500 Kcal/Kg and 2240 Kcal/Kg respectively, and latent heat of steam is 587 Cal/g.	(2014-2015) (2022-2023)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**32**	What is meant by calorific value of a fuel? What are its units? or Define Gross Calorific Value and Net Calorific Value?	(2015-2016) (2016-2017) (2017-2018)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**33**	In an experiment in a bomb calorimeter, a solid fuel of 0.90 g is burnt. It is observed that increase of temperature is 3.8°C of 4000 g of water. The fuel contains 1% of H. calculate the H.C.V. and L.C.V. value (Water equivalent of calorimeter 385g, latent heat of steam=587 cal/g).	(2015-2016)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**34**	How the calorific value of a solid fuel is determined using bomb calorimeter? Draw a neat diagram of bomb calorimeter. **OR** Explain with the help of neat labeled diagram the working of Bomb calorimeter.	(2015-2016) (2017-2018) (2019-2020) (2021-2022) (2022-2023)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**35**	Sample of coal contain C=93%, H=6% and ash=l%. The following data was obtained when the above coal was tested in bomb calorimeter. 1. Wt. of coal burnt=0.92 g 2. Wt. of water taken=2200g. 3. Water equivalent of bomb calorimeter=550g 4. Rise in temperature=2.42°C 5. Fuse wire correction= 10.0 cal 6. Acid correction= 50.0 cal.	(2015-2016)

				Calculate gross and net calorific value of the coal assuming the latent Heat of condensation of steam as 580cal/g.	
		Theoretical and experimental determination of GCV & NCV	**36**	A 0.85 g sample of solid fuel was completely combusted in excess of oxygen using bomb calorimeter. The rise in temperature of water in calorimeter was 28°C. Calculate the HCV of the fuel, if water taken in calorimeter is 2000g and water equivalent of calorimeter is 2200g. Also calculate the LCV of the fuel. (% Hydrogen in the fuel= 2.5)	(2022-2023)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**37**	A sample of coal contains C = 70%, 0 = 20%, H = 8%, S =1 %, N = 0.5%, ash= 0.5% Calculate GCV and NCV of coal	(2016-2017) (2019-2020)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**38**	The percentage composition of coal sample is: C = 85%, H = 5%, 0 = 6%, N=4%, S = 2% ash= 5% and moisture= 3%. Calculate GCV and NCV.	(2016-2017)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**39**	A sample of coal contains 60% Carbon, 33% Oxygen, 6.0% Hydrogen, 0.5%, Sulphur, 0.2% Nitrogen and 0.3% Ash. Calculate GCV and NCV of coal.	(2017-2018)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**40**	Calculate GCV of the coal sample having C=80%, H = 9%, O=4%, N=1.5%, S=2.5% and Ash = 3%.	(2019-2020)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**41**	A coal sample has following analysis by weight: C= 90%, O= 3%, S= 0.5%, N=0.5% and ash= 2.5. Net calorific value of the coal was found to be 8490.5 Kcal/Kg. Calculate the percentage of hydrogen and gross calorific value	(2018-2019)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**42**	A coal has the following composition by weight C=92% ,O=2.0% ,S=0.5% ,N=0.5% and ash =2.5% Net calorific value of the coal was found to be 9,430 kcal/Kg, Calculate the percentage of hydrogen and gross calorific value of coal?	(2021-2022)
CO4	**L31**	Theoretical and experimental determination of GCV & NCV	**43**	A sample of coal contain C= 80 %, H= 15%, and ash= 5%. The following data were obtained when above coal was tested in bomb calorimeter: Weight of coal burnt= 0.98 g Weight of water taken= 1000 g Water equivalent of bomb and calorimeter= 2500 g Rise in temperature= 2.5°C, Fuse wire correction= 8 cal, Acid correction= 50 cal., Cooling correction= 0.02°C. Assuming that the	(2019-2020) (2021-2023)

				latent heat of condensation is 580 cal/gm, calculate net and gross calorific values of coal.	
CO4	**L32**	Coal and its classification, Proximate and ultimate analysis of coal.	**44**	What is rank of coal? Describe proximate and ultimate analysis of coal and its usefulness.	(2016-2017) (2017-2018) (2022-2023)
CO4	**L32**	Coal and its classification, Proximate and ultimate analysis of coal.	**45**	4.2 g of a sample of coal was Kjeldahalized and evolved ammonia gas was absorbed in 30 ml of 0.1N H_2SO_4. After absorption excess acid required 5 ml of 0.1N NaOH for neutralization. Calculate the % of nitrogen in coal sample.	(2021-2022)
CO4	**L32**	Coal and its classification, Proximate and ultimate analysis of coal.	**46**	0.4 gm of a coal sample was used in bomb calorimeter for the determination of calorific value .The ash formed in the bomb calorimeter was extracted with acid and the acid extracted was heated with $BaCl_2$ solution and a precipitate of $BaSO_4$ was formed .The precipitate was filtered dried and weighted. The weighted of precipitate was to 0.04 gm Calculate the percentage of sulphur in the sample?	(2021-2022)
CO4	**L34**	Air Combustion & Numerical	**47**	A sample of fuel having following percentage composition C= 70%, H= 6%, N= 3%, S= 3%, ash= 6% and moisture 8%. Calculate the quantity of air required for complete combustion of 1 Kg of fuel.	(2022-2023)
CO4	**L34**	Air Combustion & Numerical	**48**	Calculate the mass of air needed for complete combustion of 5.0 kg of coal containing 80% carbon 15% hydrogen and rest Oxygen.	(2015-2016)
CO4	**L34**	Air Combustion & Numerical	**49**	Calculate the minimum weight of air required for complete combustion of 1kg of fuel containing C = 90%, H = 3.5%, O = 3.0%, S = 0.5%, H_2O = 1%, N = 0.5% and ash = rest.	(2017-2018), (2022-2023)
CO4	**L35**	Chemistry of Biogas production from organic waste materials and their environmental impact on society	**50**	Give the construction and working of biogas plant. **OR** Explain the stages involved in the production of biogas from cattle dung. Compare the impact of use of biogas and coal on the environment.	(2022-2023)
CO5	**L36**	Basic definitions, characteristics of polymers,	**1**	What is the necessary condition for a monomer to undergo condensation polymerization?	(2014-2015)

CO5	**L37**	Weight average and number average molecular weights, Classification of polymers.	**2**	In a particular sample of polymer 100 molecules have a molecular mass 10^3 each, 200 molecules have molecular mass 10^4 each and 200 molecules have molecular mass 10^5 each. Calculate the M_n and M_w.	(2014-2015)
CO5	**L38**	Mechanism of polymerization (free radical , cationic & anionic)	**3**	Give four examples of initiators used for free radical polymerization.	(2014-2015) (20222-2023)
CO5	**L36**	Basic definitions, characteristics of polymers,	**4**	Define chain growth polymers with examples.	(2014-2015)
CO5	**L36**	Basic definitions, characteristics of polymers,	**5**	What is meant by Tacticity? With suitable examples, explain Isotactic, Syndiotactic and Atactic polymers.	(2014-2015) (2016-2017)
CO5	**L36**	Basic definitions, characteristics of polymers,	**6**	Differentiate between (1) Thermoplastic and Thermosetting (2) Addition and Condensation polymerization	(2014-2015) (2015-2016) (2017-2018) (2022-2023)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**7**	Write various properties of polymers. Give various methods for determination of molecular weight of polymers.	(2014-2015)
CO5	**L36**	Basic definitions, characteristics of polymers,	**8**	What do you understand by the term functionality of a polymer?	(2017-2018)
CO5	**L36**	Basic definitions, characteristics of polymers,	**9**	Simple molecules do not polymerize. Justify	(2019-2020)
CO5	**L36**	Basic definitions, characteristics of polymers,	**10**	What are fibers and their important properties? Give different types of fibers with examples.	(2014-2015)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their	**11**	Write the preparation, properties and applications of: 1) Butyl rubber 2) HDPE 3)Nylon 6 4) Bakelite or Phenol formaldehyde resin	(2014-2015) (2015-2016) (2017-2018)

		environmental impact on society)			
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**12**	What is vulcanization? How does it improve the properties of raw rubber? **OR** Outline the process of vulcanization of rubber. Describe the preparation, important properties and important applications of butyl rubber.	(2014-2015) (2015-2016) (2019-2020) (2021-2022) (2022-2023)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**13**	Give the preparation of Teflon. Explain why Teflon is highly chemical resistant.	(2015-2016) (2020-2021)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**14**	What are copolymers? How does Buna-S differs from Buna- N	(2015-2016) (2017-2018)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**15**	Give the preparation, properties and uses of: (1) Bakelite (2) Nylon-6 (3) Nylon6,6 (4) Dacron (5) Buna-S (6) Buna-N (7)Neoprene (8)Kevlar(9) PMMA (10)Polyethylene (11) PVC	(2015-2016) (2016-2017) (2017-2018) (2018-2019) (2019-2020) (2020-2021) (2021-2022) (2022-2023)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**16**	Will you prefer to polymerize acrylonitrile under anionic or cationic conditions? Explain	(2017-2018)

CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**17**	Write the monomer of (1) Neoprene (2) Terylene (3) Buna-s (4) Polystyrene	(2018-2019)
CO5	**L39**	Preparations and applications of some industrially important polymers (Teflon, Lucite, Bakelite, Kelvar, Dacron, Thiokol, Nylon, Buna-N and Buna-S and their environmental impact on society)	**18**	Differentiate between elastomers and fibers? Give the preparation, properties and uses of Buna-S, Buna-N and Neoprene	(2018-2019)
CO5	**L40**	Conducting polymers and Biodegradable polymers: Preparation, Properties & Applications	**19**	How do natural biodegradable polymers undergo biodegradation?	(2014-2015) (2022-2023)
CO5	**L40**	Conducting polymers and Biodegradable polymers: Preparation, Properties & Applications	**20**	What are biodegradab1e polymers? Discuss their applications.	(2015-2016) (2016-2017) (2018-2019)
CO5	**L40**	Conducting polymers and Biodegradable polymers: Preparation, Properties & Applications.	**21**	What are conducting polymer? Classify conducting polymer and mention their important application. How can the conductivity of polymers be increased?	(2015-2016) (2016-2017) (2018-2019) (2019-2020) (2020-2021) (2022-2023)
CO5	**L41**	Blends & Composites: Properties & Applications	**22**	Write a note on: (1)Polymer Blend (2)Polymer composites	(2016-2017) (2018-2019) (2019-2020) (2020-2021)
CO5	**L42**	Organometallic compounds, their classification and general methods of preparations.	**23**	Write down the structure of Ziegler Natta catalyst. Discuss the mechanism of the preparation of polypropylene using Ziegler-Natta catalyst. Give the preparation and applications of PTFE and Butyl rubber.	(2014-2015) (2016-2017)
CO5	**L42**	Organometallic compounds, their classification and general methods of preparations.	**24**	What are organometallic compounds? Write their classification, preparation and applications.	(2017-2018)

CO5	**L43**	Grignard Reagent and its applications.	**25**	How is Grignard reagent prepared? Why dry ether solvent is important for the preparation of Grignard reagent? How will CH_3CH_2MgBr react with HCHO?	(2014-2015) (2016-2017) (2018-2019)
CO5	**L43**	Grignard Reagent and its applications.	**26**	Explain various methods of preparation of Grignard reagent and also write it's at least five applications	(2015-2016) (2016-2017) (2019-2020) (2020-2021)
CO5	**L43**	Grignard Reagent and its applications.	**27**	What are organometallic compounds? Explain various methods of preparation of Grignard reagent and also Write reaction of Grignard reagent with HCHO, R_2NH, CO_2, CH_3CH_2OH CH_3CHO, $(CH_3)_2CO$ and ester.	(2018-2019) (2021-2022)
CO5	**L43**	Grignard Reagent and its applications.	**28**	Explain with equations preparations of acid, ketone, alcohol, alkanes and Organometallic compound from Grignard reagent.	(2020-2021)
CO5	**L44**	$LiALH_4$ reagent and its applications.	**29**	Give the preparation of $LiAlH_4$. Predict the final product attained when $LiAlH_4$ reacts with (a) CH_3CHO (b) CH_3CN (c)$CH_3COOC_2H_5$(d) $CH_3COC_2H_5$(e)CH_3COOH (f)CH_3NH_3 (g) CH_3CHCH_2O (EPOXIDE)	2022-2023