

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-term Examination, 2023-24

Course Code: CYC01

Course Name: Engineering Chemistry

Question Paper No.: NITD/CYC01/01

Full Marks: 25

Time: 90 Minutes

Instructions:

1. Answer all questions
2. All the parts of a question must be written in same place. Otherwise, those answers will not be evaluated if written randomly.

Question No.	Body of the Question	Marks	Mappe d CO
1	(a) Explain the differences with suitable examples: (i) Ionization isomerism and Hydrate isomerism; (ii) Geometrical isomerism and Optical isomerism. (b) Calculate the CFSE value by showing the splitting under octahedral ligand field for the following ions: d^5 , d^7 and d^9	4+5= 9	CO3
2	(a) Derive the expression of work done of an n mole of ideal gas in (i) Reversible isothermal expansion, (ii) Irreversible expansion and (iii) Reversible adiabatic expansion. (b) What are the expressions of C_p and C_v in terms of enthalpy (H) and internal energy (U) respectively? Physically explain why C_p is greater than C_v . (c) Under what condition, heat change and enthalpy change will be equal?	4+3+1=8	CO4
3	(a) Give a brief discussion on the principle of IR spectroscopy. Based on this principle explain why CO_2 molecule is IR active but N_2 molecule is IR inactive. (b) How would you differentiate between the following molecules based on spectroscopic techniques? (i) cyclopentanone and pentanol (ii) 1,3-butadiene and 1,4-pentadiene	3+2+3=8	CO2

COs: CO1: Students will get the knowledge of fundamentals as well industrial applications of polymer, petroleum products, organometallic compounds and others; CO2: Students will be able to elucidate the structure of different organic compounds and to analyze the structure-property correlation; CO3: Students will be aware on the role played by different metals in biological systems and also the ecological impact of metals; CO4: Students will be able to understand and analyze Thermodynamical, kinetic as well as electrochemical aspects of chemical systems and apply the understanding in the technical field.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-Term Examination, 2023-24

Course Code: CYC301

Full Marks: 25

Course Name: State of Matter and Chemical Thermodynamics

Time: 90 Minutes

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	<p>(a) Estimate $\overline{C_p} - \overline{C_v}$ for CCl_4 at 25°C when $\overline{C_p} = 132 \text{ J K}^{-1} \text{ mol}^{-1}$, given, at this temperature density of CCl_4 is 1.59 g cc^{-1}. Its expansion coefficient is $1.24 \times 10^{-3} \text{ K}^{-1}$, and isothermal compressibility is $9.05 \times 10^{-5} \text{ atm}^{-1}$.</p> <p>(b) Why $\overline{C_p}$ is greater than $\overline{C_v}$? explain critically.</p> <p>(c) On which factor does the internal pressure for a van der Waals gas depend?</p>	<p>3</p> <p>+2 +2=7</p>	CO1, CO4
2	<p>(a) Under which condition the heat change and the enthalpy change will be the same?</p> <p>(b) Show that for irreversible expansion followed by irreversible compression, overall work done is positive. What is its significance?</p> <p>(c) For hydrogen gas, the inversion temperature is much below the normal room temperature, whereas that for nitrogen gas is much higher than the normal room temperature. Explain its significance.</p>	<p>2+2+2 =6</p>	CO1
3	<p>If the probability of finding gas molecules having speed(c) with in the range c and c+dc in 3D is given by</p> $p(c)dc = 4\pi \left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} c^2 e^{-\frac{mc^2}{2kT}} dc,$ <p>(a) Show the effect of temperature on the p(c) vs c curve for a particular gas at two temperatures T_1 and T_2 where $T_1 > T_2$.</p> <p>(b) Plot the same curve for two ideal gases He and Ne, at a particular temperature.</p> <p>(c) Calculate max probable speed, c_{mp}.</p> <p>(d) Calculate average speed, $\langle c \rangle$.</p> <p>(e) Show that the fraction of molecules of an ideal gas moving with speed between c_{mp} and $(c_{mp} + 0.0001 c_{mp})$ is $\left(\frac{4 \times 0.0001}{\sqrt{\pi} e}\right)$, which is constant for any gas at any temperature. [c_{mp} is the most probable speed.].</p>	<p>1+1+2+ 2+3=9</p>	CO2
4	Using classical equi-partition principle calculate the theoretical value of Molar heat capacity at constant volume, $\overline{C_v}$ for CO_2 considering ideal gas behaviour.	3	CO2

Course Outcomes

CO1: Foundation in chemical thermodynamics.

CO2: Understand the fundamental properties of different states of matter.

CO3: Analyzing effect of various experimental parameters towards equilibrium condition of a chemical reaction/process

CO4: Numerical analysis on various thermodynamics properties

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-term Examination, 2023-24

Course Code: CYC-302

Course Name: Atomic Structure and Chemical Bonding

Full Marks: 25

Time: 90 Minutes

Instructions: Answer all questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Explain the nature of curve (E_v vs v) of black body radiation as explained by Planck. (b) Discuss the intensity of light based on wave theory and particle theory of light.	4+3 = 7	CO1
2	(a) Show the magnitude of kinetic energy of the electron in hydrogen atom is less than that of potential energy on the light of Bohr's theory. (b) What is matter wave?	4+2=6	CO1
3	(a) Write a note on violation of octet rule. (b) Write the advantages and disadvantages of Lewis theory of bonding with suitable examples. (c) How valance bond theory addresses the draw backs of Lewis theory of bonding.	2+(2+2)+2=8	CO7
4	(a) Which orbitals participate in the following hybridizations: dsp^2 and sp^3d^3 ? Give justification in favour of your answers. (b) What are the similarities and dissimilarities between d^2sp^3 and sp^3d^2 hybridizations?	2+2=4	CO7

COs:

- CO1: know the history of development of the subject with the contribution of the scientist.
- CO2: to be exposed with quantization of energy, momentum and space.
- CO7: orientation and shape of the atomic orbitals.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-Sem Examination, 2022-23

Course Code: CYC303

Full Marks: 25

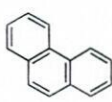
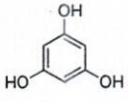
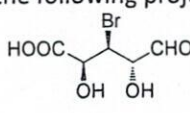
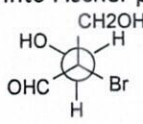
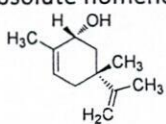
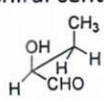
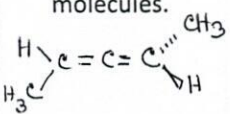
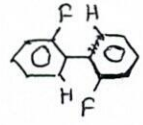
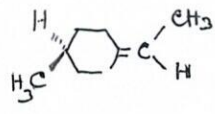
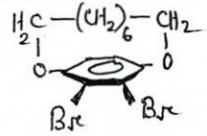
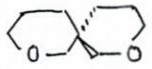
Course Name: Stereochemistry and Basic Principle of Organic Chemistry

Time: 90 Minutes

Question Paper No.: NITD/CYC303/1

Date of Exam: 13.09.23

Answer the following questions.

Q. No.	Body of the Question	Marks	Mapped CO
1	<p>(i) What do you mean by symmetry elements? Indicate the element(s) of symmetry present in the following molecules:</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>(ii) The presence and absence of a chiral centre is no criterion of chirality. Explain.</p> <p>(iii) Convert the following projections into Fischer projections.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>(iv) Assign absolute nomenclature to the chiral centre(s) present in the following molecules.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div>	[3+2+3+2=10]	CO1, CO2
2	<p>(i) Which of the following molecules are chiral? Assign R/S designations to the chiral molecules.</p> <div style="display: flex; justify-content: space-around; align-items: center;">     </div>  <p>(ii) What are the differences between observed optical rotation and specific optical rotation?</p> <p>(iii) Calculate the ee and the specific rotation of a mixture containing 10 g of (+)-2-butanol and 6 g of (-)-2-butanol. The specific rotation of enantiomerically pure (+)-2-butanol is +13.5°.</p> <p>(iv) What do you mean by atropisomerism?</p>	4+2+2+2=10	CO1, CO2
3	<p>(i) Write the underline principle of resolution of racemic modification.</p> <p>(ii) Indicate the most stable conformation of 1,2-dibromo ethane in methanol solution with justification.</p>	3+2 = 5	CO1, CO5

CO1: To Learn Basic Concept of stereochemistry

CO2: To Learn Molecular symmetry, Designation of chiral centre, axis and helices

CO5: To Learn Conformational analysis

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-term Examination, 2023-24

Course Code: CYC-331
 Course Name: Chemistry-II

Full Marks: 25
 Time: 90 Min

Instructions: Answer all questions. Calculator allowed. Materials to be supplied: Graph paper shall be supplied, if required.

Q No	Body of the Question	Marks	Mapped CO
1	(a) Draw the structures of all configurational isomers of aldopentose in Fischer projection. (b) Draw the C-2 and C-3 epimers of aldohexose. (c) When a single anomer, β -D-glucopyranose, is treated with EtOH in presence of HCl both α -D-glucopyranoside and β -D-glucopyranoside are obtained. Explain the fact with probable mechanism.	2+2+4 = 8	CO4
2	(a) Write the basic principles of complexometric titration. (b) Draw the structure of Tris(8-hydroxyquinolino)aluminium(III) or Alq ₃ and Ca-EDTA complexes. (c) Give one example of a coordination compounds in biological systems? What is the role of 'British anti-Lewisite' in biological systems? (d) How UV-visible spectroscopic method can be applied to determine the concentration of a coloured solution of an analyte?	2+2+(1+1)+2=8	CO1
3	(a) What do you understand by Molar and Partial Molar quantity of an extensive property? Give example. (b) For a system of variable compositions, prove that the chemical potential of the i-th species can be written as: $\mu_i = \left(\frac{\partial H}{\partial n_i}\right)_{S,P,n_{j \neq i}} = \left(\frac{\partial U}{\partial n_i}\right)_{S,V,n_{j \neq i}} = \left(\frac{\partial A}{\partial n_i}\right)_{S,V,n_{j \neq i}}$, where terms involved here have their usual meaning. (c) Write down the thermodynamic criteria of an ideal solution. Show that for a binary ideal gas mixture entropy of mixing, ΔS_{mix} is maximum at $x_1 = x_2 = \frac{1}{2}$, where x_1, x_2 refers to the mole fractions of component 1 and component 2, respectively in the mixture. (d) 1 mole He, 3 moles of Ne and 2 moles of Ar gases are mixed at the same temperature and pressure. Assuming Ideal gas behaviour, calculate $\Delta G_{mix}/RT$.	1+(1+1+1)+(1+2)+2=9	CO3

COs: • CO1: To learn advanced analytical techniques useful for chemical engineering. • CO2: To learn the few catalytic process commonly used in industrial applications. • CO3: To learn thermodynamics of solutions and understanding of phase diagrams of single and multicomponent systems. • CO4: To learn fundamentals of fats, oils and carbohydrate chemistry together with basics of large scale organic synthesis.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Odd Semester Mid-Term Examination, 2023-24**

Course Code: CYC501

Full Marks: 25

Course Name: Fundamentals of Electrochemistry and Surface Chemistry

Time: 90 Minutes

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Discuss the Faraday's laws of electrolysis. (b) Derive a quantitative relationship between the mass of the species (m) deposited/liberated on passing current (I) for a certain period of time (t) involved in the reduction/oxidation reaction at the electrode. (c) Write the Cathodic and Anodic reactions that will take place during the electrolysis of aqueous solution of NaCl using inert electrodes (Pt).	2 +2 +2 =6	CO1
2	(a) State Kohlrausch's law of independent migration of ions. (b) Based on Kohlrausch's law, discuss how the molar conductivity of a weak electrolyte like calcium phosphate can be determined at infinite dilution. (c) 'Transport numbers of ions are directly proportional to their speeds' – discuss critically with mathematical arguments.	2+2+2 =6	CO2
3	(a) Define buffer capacity. In what pH range an aqueous Acetic acid-sodium acetate buffer can be best used. Explain with detailed mathematical treatment. (b) Calculate the pH of a solution prepared by mixing 2 ml of a strong acid solution pH=3 and 3ml of a strong base of pH=10?	4+ 2=6	CO2
4	(a) Calculate the work required to stretch a soap film so that its area increases by 5.0 cm^2 . The surface tension of the air-soap solution interface is 30 mN m^{-1} . (b) The total concentration of the surfactant is 'c' and the change in surface tension of the solvent is $(\gamma_0 - \gamma)$ – where γ_0 is the surface tension of the pure solvent. For aliphatic acids this relationship is $\gamma_0 - \gamma = a \log(1 + bc)$. The constants a and b are determined by the acid. For Propanoic acid $a = 0.0298 \text{ N/mn}$ and $b = 6.07 \text{ L/mol}$. What is the surface tension of a 0.1M solution of Propanoic acid? Also, calculate the surface excess Γ for a 0.1M solution of Propanoic acid using Gibbs adsorption equation. Given γ_0 of pure water 0.0727 N/m . Temp: 298K.	2+5 =7	CO4

Course Outcomes

- CO1: Application of conductometric measurement
 CO2: Understanding the dissociation of electrolytes in solution and its application
 CO3: Electrochemical cell: principle and application
 CO4: Understanding the adsorption process
 CO5: Fundamentals and application of micellar and colloid system

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-term Examination, 2023-24

Course Code: CYC502
Course Name: Chemistry in Solution and Solid State Chemistry

Full Marks: 25
Time: 90 Minutes

Instructions:

1. Answer all questions.
2. All the parts of a question must be written in same place. Otherwise, those answers will not be evaluated if written randomly.

Question No.	Body of the Question	Marks	Mapped CO
1	What are differences between Arrhenius concept and solvent system concept? Explain with examples.	3+3=6	CO1
2	What are the important features of Lewis concept? Describe with suitable examples. Explain the limitations of this concept.	4+2=6	CO2
3	Explain the following statements (a) "the melting point of NaCl is around 800 °C whereas the melting point of MgO is around 2800 °C" (b) "the melting point of CaCl ₂ is around 770 °C whereas the melting point of AlCl ₃ is around 194 °C" (c) Write the limitations of Born-Haber cycle.	2+2+2=6	CO5,CO6
4	(a) Show that ionic lattices are more stable than isolated ion pairs. (b) Write a note on Madelung constant. (c) Write the mathematical formula of Kapustinskii equation.	4+2+1=7	CO7

COs:

- CO1: understand different concepts of acids and bases
- CO2: know about the thermodynamic aspects of Lewis acid and base interaction
- CO3: understand the concept of redox reaction, standard redox potential
- CO4: have concept of effect of concentration and pH on redox reaction
- CO5: know basic idea of Inorganic solid and crystal
- CO6: know the thermodynamics and energetics of stability of solid
- CO7: Born Lande equation and Kapustinskii equation,
- CO8: crystal system and different types of unit cells and crystals in inorganic solid
- CO9: defect of crystal and the associated property

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-term Examination, 2023-24

Course Code: CYC503

Course Name: Chemistry of Heterocyclic Compounds and Natural Products

Question Paper No.: NITD/CYC503/01

Full Marks: 25

Time: 90 Minutes

Instructions:

1. Answer all the questions
2. All the parts of a question must be written in same place. Otherwise, those answers will not be evaluated if written randomly.

Question No.	Body of the Question	Marks	Mapped CO
1.	Write the IUPAC names of: (a) Imidazole (b) Pyrimidine (c) Pyrazine (d) Isoquinoline	[4]	CO1
2.	Why is study of heterocyclic chemistry important?	[1]	CO1
3.	Name two quinoline alkaloids.	[2]	CO1 & CO3
4.	Compare the aromaticity of pyrrole, furan and thiophene with benzene with proper explanation.	[2]	CO1
5.	Compare the basicity of pyrrole with pyrrolidine.	[2]	CO1
6.	What will happen on lithiation of pyrrole?	[2]	CO2
7.	Write the mechanism of Fischer indole synthesis.	[3]	CO2
8.	How will you nitrate pyrrole and thiophene? What causes the difference?	[3]	CO2
9.	At what positions electrophilic substitution of pyrrole and pyridine will take place? Explain.	[4]	CO2
10.	Draw any scheme of synthesis for adenine.	[2]	CO3

- CO1: Nomenclature, aromaticity acidity-basicity of heterocyclic compounds
- CO2: Synthesis and reactions of heterocyclic compounds
- CO3: Study of heterocycles with two or more hetero atoms including purine & pyrimidine
- CO4: Classification, general reactions of alkaloids aiding their isolation, purification and structure determination
- CO5: Structure determination, synthesis and reactions of simple alkaloids

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-Term Examination, 2023-24

Course Code: CYC504

Full Marks: 25

Course Name: Industrial Chemistry

Time: 90 Minutes

Instructions: Answer all the questions.**Materials to be supplied:** Not Applicable.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) How to determine the percentage (%) of carbon (C) and hydrogen (H) in a coal sample? Describe the procedure with proper chemical reactions.	2+2	CO3
	(b) What is the major constituent of LPG? How the leakage in LPG cylinder is detected?	1+1	CO2
	(c) What is cenatne number? Explain.	2	CO1
	(d) What is power alcohol?	2	CO2
2	(a) Explain the terms atactic, syndiotactic and isotactic as applied polymer structures using suitable example.	3	CO2
	(b) Write the stepwise formation of PVC from its concerned monomer via free radical mechanism using benzoylperoxide as the radical initiator.	5	CO3
	(c) What is number average molecular weight?	2	CO1
3	(a) What is the difference between thermoplastic and thermosetting polymers?	3	CO4
	(b) What is calorific value of a fuel? What is its unit? Between GCV and NCV which on is greater in value?	2	CO1

Course Outcomes

CO1: Understanding the applications of chemistry in the industrial set-up

CO2: Development of basic knowledge of industrial application

CO3: Learning of different chemical tools which are useful and valued in industry

CO4: Generation of knowledge to bridge the gap between education and industrial application so the students might be confident to apply for industrial career

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Odd Semester Mid-term Examination, 2023-24

Course Code: CYC703

Full Marks: 25

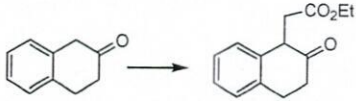
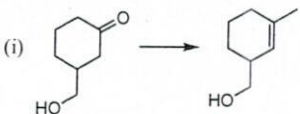
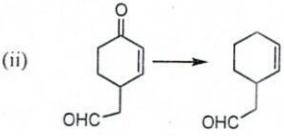
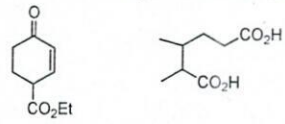
Course Name: Concept of Organic Synthesis and Asymmetric Synthesis

Time: 90 Minutes

Question Paper No.: NITD/CYC703/1

Date of Exam: 13.09.23

Answer the following questions.

Q. No.	Body of the Question	Marks	Mapped CO
1	(i) Write short notes on (i) Chemo-selective reaction (ii) Regio-selective reactions. (ii) 'Robinson annulation is a combined reaction of Michael reaction and aldol condensation reaction'. Explain the statement including mechanism. Show the difference in reactivity of Grignard reagent and Gillmann's reagent.	[(3+3)+4=10]	CO1, CO2
2	(i) Write the condition for making enamines. How the following conversion can be accomplished using enamine method?  (ii) Carry out the following conversions. (i)  (ii)  (iii) Show the schemes for the syntheses of the following compounds. 	[(1+1)+(2+2)+(2+2)=10]	CO1, CO2
3	(i) Mention a few methods of Carbon-carbon bond formation reactions. (ii) Reduction using LiAlH_4 requires ethereal solvent but reduction using NaBH_4 requires polar hydroxylic solvent. Explain	[3+2=10]	CO1, CO3

- CO1: A complete knowledge on tactics, strategy and control for the synthesis of organic compounds has been elaborately discussed using some specific reagents for particular compound synthesis. CO2: To Learn various aspect of Elimination reactions.
- CO2: To know how the better yield of product could be obtained, their tactics, strategy and control has been highlighted.
- CO3: Role of specific reagents with related mechanism in their transformation and mechanistic path from substrate to products is included for their step by step reactions. CO5: To Learn the fundamentals of nucleophilic and electrophilic substitution reactions.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-Term Examination, 2023-24

Course Code: CYC704

Course Name: Mathematical and Computational Chemistry

Full Marks: 25

Time: 90 Minutes

Instructions: Answer all the questions.

Given: $\int_0^{\infty} e^{-ax^2} dx = \left(\frac{\pi}{4a}\right)^{1/4}$

Question No.	Body of the Question	Marks	Mapped CO
1	<p>(a) Given $z = 1 + i$; Represent this complex number as a point in the two dimensional coordinate system. Determine the magnitude z and the phase angle θ of z.</p> <p>(b) Show that $\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2}$</p>	4+2	CO1
2	<p>Consider a uniform string stretched between two fixed points at 0 and l is plucked. Let $u(x, t)$ be the displacement of the string and it satisfies the equation $\frac{\partial^2 u}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 u}{\partial t^2}$, where, v is the speed the disturbance moves along the string.</p> <p>Derive a general solution of this equation using method of separation of variables.</p>	6	CO4
3	<p>The Planck's distribution law for an ideal black body radiation is given by:</p> $d\rho(\lambda, T) = \rho_\lambda(T) d\lambda = \frac{8\pi hc}{\lambda^5} \frac{d\lambda}{\exp\left(\frac{hc}{\lambda k_B T} - 1\right)}$ <p>What will be the behaviour of the energy density at very low and very high values of λ? Justify your answer mathematically.</p>	3+2	CO4
4	<p>Write in brief the basic principles of <i>ab initio</i>, density functional theory, semi-empirical and molecular dynamic simulation methodologies to calculate different thermodynamic properties of a molecule.</p>	2+2+ 2+2	CO2

Course Outcomes

- CO1: Foundation in basic mathematical techniques that are commonly used in chemistry.
- CO2: Learn the art of scientific programming to solve chemical problems.
- CO3: Write simple programs for matrix diagonalisation, solve numerical differentiation, integration and elementary differential equations.
- CO4: Apply computational methods to complex problems of group theory, quantum chemistry, molecular spectroscopy, chemical kinetics and other topics.
- CO5: Introduction to computational chemistry software packages for quantum mechanical and macromolecular modelling.