NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester Mid-term Examination, 2021-22

Course Code: CYC01 | Full Marks: 25

Course Name: Engineering Chemistry | Time: 90 Minutes

Question Paper No.: NITDGP/CYC01/01 | Date of Exam: 25/05/2022

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	(i) A car engine with a power output of 50 kW has a thermal efficiency of 25 percent. Determine the fuel consumption rate (kg per sec) of this car if the fuel has a heating value of 40,000 kJ/kg. (ii) Correlate the following observations with proper justification in terms of change in disorderness: a) For a spontaneous process entropy of the universe increases. b) Conversion of work into heat produced is spontaneous, but the reverse is not. (iii) The molar Gibbs free energy of a certain gas is given by $\bar{G} = RT\ lnP + a + bT$, where a and b are numerical constants. Show that the equation of state of the gas is given by: $\bar{V} = RT$. (Hint: Use the relation: dG=-SdT + V dP) (iv) Calculate the value of ΔG_f^0 for N_2O_4 (g) at 25 °C. Given that the reaction: $2N_2O_4$ $_{(g)} \rightleftharpoons 2N_2O_{(g)} + 3O_2$ $_{(g)}$ has $K = 0.00613$ and ΔG_f^0 of $N_2O_{(g)}$ = +104.20 kJ/mole and that of O_2 (g)) = 0.00 kJ/mole: ΔG_f^0 is the standard free energy of formation.	2+2+2+2 =8	CO1
2	(i) What is meant by annulation reaction? What is special about Robinson annulation reaction? Discuss the mechanism involved taking a suitable example. (ii) Write the general structure of Gillmann's reagent. What difference in product distribution would be observed when conjugated cyclohexenone and 2-bromo-3-methylbutane are separately treated with a Grignard reagent and a Gillman's reagent? How would you explain this difference?	[(1+1+2)+ (1+2+2) =9]	CO2
3	(i) How many types of isomerism are there in coordination chemistry? Explain each with suitable examples. (ii) Calculate the CFSE values for both high and low spin d^5 and d^7 systems in octahedral coordination geometry.	[5+3=8]	CO4

Course Outcomes

CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

EVEN SEMESTER END SEM EXAMINATION

Course Code: CYC401 **Full Marks: 30**

Course Name: Biochemistry: Structure and function **Time: 90 minutes**

Question Paper no. NITDGP/CYC401/1 Date: 25.04.2022

Instructions: *Answer all questions*

Question No.	Body of the Question	Marks	Mapped CO
1	(a) What are the differences between Transcription and Translation processes? (b) Draw the chemical structure of 5'-ATGC-3' strand. (Draw the structures of all components starting from 5'OH of 1st nucleotide) (c) What is Chargaff's rule? (d) Write down the different steps involved in chemical hydrolysis of a nucleic acid to its basic components.	3+2+2+3 =10	CO1 CO3
2	(a) What are the reasons behind specific A-T and G-C pairing? (b) Draw the hydrogen bonds between A-T and G-C base pairs. (c) What are Homoglycans and Heteroglycans? Give one example each. (d) What is Anomerism of Glucose? Draw the structures of two D-Glucose anomers. What is mutarotation?	2+2+3+3 =10	CO4 CO2 CO3
3	(a) What are disaccharide, oligosaccharide and polysaccharide? (b) Draw the structure of Lactose. Comment on the nature of its glycosidic bond. (c) What is invert sugar? Comment on the inversion process involved in the invert sugar preparation. (d) What are biomedical importance of Glucose?	3+2+3+2 =10	CO2 C04 CO1

COs:

CO1: Understanding the Chemistry behind biological processes

CO2: Development of basic knowledge of cell structure and function

CO3: Learning of different chemical aspects of biomolecules such as Carbohydrates, Lipids, Proteins, Nucleic acids

CO4: Generation of concepts on molecular mechanics amongst biomolecules as a stepping-stone towards Biophysical Chemistry.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

EVEN SEMESTER END SEM EXAMINATION

Course Code: CYC402 **Full Marks: 30**

Course Name: Phase-equilibrium, chemical kinetics and catalysis **Time: 90 minutes**

Question Paper no. NITDGP/CYC402/1 Date: 26.04.2022

Instructions: *Answer all questions*

Question No.	Body of the Question	Marks	Mapped CO
1	a) For an autocatalytic reaction, $A \xrightarrow{k} B$, show that the rate of the reaction will be maximum when the extent of reaction, $x_{max} = \frac{[A]_0 - [B]_0}{2}$ where, $[A]_0$ and $[B]_0$ are initial concentrations. b) Consider a reaction: $A^{Z_A} + B^{Z_B} + C^{Z_C} \leftrightarrow X^{Z_A+Z_B+Z_C}$ $X^{Z_A+Z_B+Z_C} \rightarrow Product$ Where Z_A is the charge of the ion A and so on; X is the transition state. Using Debye-Hückel limiting law: show that $logk = logk_0 + 2A_0(Z_AZ_B + Z_BZ_C + Z_CZ_A)\sqrt{I}$ where, A_0 is the Debye-Hückel constant, I is the ionic strength of the solution.	4+3=7	CO2, CO4
2	a) Consider the following parallel reaction: $A \xrightarrow{k_1} Y$; $A \xrightarrow{k_2} Z$; where k_1 and k_2 are the reaction constants for the formation of Y and Z, respectively. In an experiment it was found that 60% decomposition of A takes place in 20 mins and analysis of product showed that 75% of Y and 25% Z are present. Calculate k_1 and k_2. b) What is entropy of activation? Entropy of activation for a unimolecular reaction is usually less compared to bimolecular reaction. Explain critically.	4+3=7	CO2, CO4
3	a) If the reactants are of same charge, rate of the reaction increases with increase in ionic strength. Explain the observation from the viewpoint of change in activation energy of the transition state by the added ions. b) Compare the rate of dissociation of C-H and C-D bonds. How we can apply the observation that rates of above reactions are different.	2+4=6	CO2
4	a) Define critical solution temperature of two partially miscible liquids. b) Write one example of each for systems having upper, lower and both upper and lower critical solution temperature, respectively.	1+3=4	CO1
5	a) Discuss the Nernst distribution law of a solute between two immiscible liquids. What modifications need to be made if the solutes undergo any association in the solution. b) At 303K, the vapour pressure of pure toluene and pure benzene are 36.7 and 118.2 Torr, respectively and the two solutions form a nearly ideal solution. For a solution containing 50 mass % of toluene, calculate the total vapour pressure and the amount of fraction of each compound in the vapour phase. Given molecular weights of benzene and toluene are 78 and 92 g mol^{-1}, respectively.	3+3=6	CO1

COs: • CO1: Concept of phase rule and phase diagram of multi-component system; • CO2: Understand the fundamentals of chemical kinetics and corresponding theoretical treatment; CO3: Concept of catalysts towards reaction rate and its applications; • CO4: Numerical analysis of the effect of various parameters on reaction kinetics

NITDGP/Int. MSc/Reg/Even/2021-22

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: CYC-403 Full Marks: 30

Course Name: Chemistry of Elements and Radioactivity Time: 90 Minutes

Question Paper No.: NITDGP/CYC403/3 Date of Exam: 27/04/2022

Instructions: Answer all the questions.

Question No.	Body of the Question	Marks	Mapped CO
1	For a radioactive disintegration process show that the half-life time, $t_{1/2} = 0.693/\lambda = 0.693\ t_{av}$, ($\lambda$ = disintegration constant and t_{av} = average life time of that radioactive nuclide).	5	CO4
2	An Uranium mineral contains 15 gm ^{206}Pb of each 100 gm ^{236}U. Calculate the age of that mineral ($t_{1/2} = 4.5 \times 10^9$ years for ^{236}U is given)	5	CO5
3	The radioactive element ^{60}Co ($t_{1/2}$ = 30 days) decays 90% through β^+ emission and rest by K electron capturing. Calculate the decay constant of the individual path	5	CO6
4	Write down the electronic configuration of IVA, VA and VIA group elements	3	CO1
5	Mention some common properties of 'd' block elements	3	CO2
6	Briefly mention the chemical behaviour of Group IVA elements like Ti, Zr and Hf	3	CO2
7	Discuss the stability of oxidation states of f-block elements	3	CO3
8	Describe the various lanthanides complexes with polydentate ligands.	3	CO3

Course Outcomes

- **CO1: Knowledge of periodic properties and their variation in period and group..**
- **CO2: General trends of elements and their compounds for s, p, d and f block elements.**
- **CO3: knowledge the structure and function of s, p, d and f block elements.**
- **CO4 : Concept of radioactive nuclei and their properties**
- **CO5 : Measurement of radioactivity**
- **CO6 : Various uses of radioactive elements**

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: CYC404 Full Marks: 30

Course Name: Organic Reaction Mechanism and Reactive Intermediates Time: 90 Minutes

Question Paper No.: NITD/CYC404/01 Date of Exam: 28.04.2022

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Ph_3CCHO does not undergo Cannizzaro reaction? Explain mechanistically. (b) What is directed aldol condensation reaction? What is the advantage of this reaction over normal aldol condensation reaction?	2+3=5	CO4
2	(a) What do you mean by persistent free radicals? Give two examples and explain their exceptional stability. (b) How many different types of carbenes are there depending on their spin states? Draw their orbital pictures and explain the bond angles found in these carbenes.	3+2=5	CO7
3	(a) Discuss the role of solvent and the metal used in pinacol formation from acetone (b) Show the mechanism of McMurry coupling reaction. What are the advantages of this reaction over Wittig reaction?	3+2=5	CO6+ CO4
4	(a) Hofmann, Lossen, Curtius and Smidt rearrangements proceeds via same intermediate. Show how this intermediate is formed in each case. (b) What happens when cyclohexanone is treated with hydroxyl amine followed by sulfuric acid?	4+1=5	CO1 + CO6
5	(a) Why ANTI elimination is preferred over SYN elimination? Give three reasons. (b) Florine is a halogen, yet $EtCH_2CH(F)CH_3$ gives Hofmann product. Why?	3+2=5	CO2
6	(a) What is the difference between order and molecularity? (b) Write the mechanism of a S_Ni reaction. (c) How the nature of the incoming nucleophiles influences the S_N1 reactions?	2+2+1=5	CO1 +CO5

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

EVEN SEMESTER END SEM EXAMINATION

Course Code: CYC601 **Full Marks: 30**

Course Name: Basics of photochemistry, spectroscopy, group theory and data analysis **Time: 90 minutes**

Question Paper no. NITDGP/CYC601/1 Date: 18.04.2022

Instructions: *Answer all questions*

Question No.	Body of the Question	Marks	Mapped CO
1	(a) State the two basic laws of photochemistry. (b) Define quantum yield of fluorescence. Why some times low quantum yield is observed than expected. (c) Why fluorescence is faster process than phosphorescence? Draw the jablonski diagram for different photophysical processess.	2+(1+2)+ (2+3)	CO1
2	(a) How can you distinguish between *prolate* and *oblate* symmetric top? Give one example for each. (b) What is rotational constant? On which factor it depends? Draw the permitted rotational energy levels with their energy values. (c) Taking staggered ethane as an example, show how many unique improper rotational symmetry operations can be generated.	(2+1)+ (1+1+2)+3	CO2+CO3
3	(a) Write the normal density function for a Gaussian distribution. Explain each term and graphically represent the same. (b) How does it differ from the Poisson's distribution? (c) The distance between two particles and their interaction energy are measured as per the following table: Calculate the nature of correlation between the distance and the interaction energy of the particles.	3+2+5	CO5

Observation	Distance	Interaction Energy
1	12	50
2	13	54
3	10	48
4	9	47
5	20	70
6	7	20
7	4	15
8	22	40
9	15	35
10	23	37

- **COs:** CO1: Physical understanding of photochemistry and photophysical processes. CO2: Fundamentals of different molecular spectroscopy. CO3: Introduction to symmetry and concept of point group. CO4: Application of spectroscopy and symmetry to unravel the molecular structure. CO5: Concept of data analysis and its applications.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

EVEN SEMESTER END SEM EXAMINATION

Course Code: CYC602 **Full Marks: 30**

Course Name: Coordination Chemistry **Time: 90 minutes**

Question Paper no. NITDGP/CYC602/1 Date: 19.04.2022

Instructions: *Answer all questions*

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Calculate the crystal field stabilization energy (CFSE) for the high spin (h.s) and low spin (l.s) octahedral complexes of a metal ion having d^6 and d^7 electronic configuration. (b) Calculating CFSE prove that when the crystal field splitting parameter, Δ is greater than the pairing energy, P of the electrons i.e Δ>P then for both d^6 and d^7 ion l.s will be more stable than the h.s one. (c) Based on CFSE predict whether $NiAl_2O_4$ will prefer to stabilize inverse spinel structure.	2+2+1=5	CO2
2	2. (a) What does tetragonal distortion and Jahn-Teller distortion means. In case of hexa-coordinated Cu(II) ion what will be the 'd' electron configuration when it generates tetragonally elongated and compressed complexes. (b) Explain why in case of a tetragonally elongated Cu(II) ion the unpaired electron will reside in $d_{x^2-y^2}$ orbital whereas for tetragonally compressed situation the unpaired electron will resides on d_{z^2} orbital.	3+2=5	CO3
3	(a) What are the origins of colours for transition metal coordination complexes. (b) Explain why the 1 molar aqueous solution of potassium permanganate shows intense color whereas that of copper sulfate generates faint color. (c) Give one example of each type complexes where (i) Ligand to Metal (ii) Metal to ligand and (iii) Metal to Metal charge transfer transition occurs.	1+2+2=5	CO3
4	(a) With the help of Orgel diagram, explain how many absorption bands are expected in the electronic spectra of $[Cr(H_2O)_6]^{+3}$, $[CoCl_4]^{-2}$ and $K_2[NiF_6]$ mentioning all the parameters. Derive the corresponding Term Symbols also. (b) What are the limitations of Orgel diagram?	6+2+2=10	CO4
5	Explain the following fact: (a) $[Cr(H_2O)_6]^{+3}$ is pale violet but CrO_4^{-2} intensely yellow. (b)$HgCl_2$ is white in colour but HgI_2 is red. (c) The colour of $[Mn(H_2O)_6]^{+2}$ is extremely light.	2+1+2=5	CO6

COs: CO1: Concepts of coordination complexes, ligand types and isomerism; CO2: Theories of bonding (e.g. VBT, CFT, MOT); CO3: Application of CFT and MOT to explain the spectroscopic and magnetic properties of metal-ligand complexes; CO4: Spectroscopic Term symbols, Orgel diagram and Tanabe Sugano diagram; CO5: Circular dichroism, optical rotatory dispersion, cotton effect; CO6: Electronic spectral properties of Lanthanides and actinides

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: CYC603

Course Name: Reagents in organic synthesis

Question Paper No.: NITD/CYC603/01

Full Marks: 30

Time: 90 Minutes

Date of Exam:27.04.2022

Q.No.	Body of the Question	Marks	CO
1	(i) Give one example of each on Regio-selective and enantio-selective reaction controlled by special reagents desiamylborane, Oxazoline derivatives and bis-lactone ether based chiral auxiliary. (ii) Write the uses and advantages of Dicyclohexyl-carbodiimide (DCC) in organic synthesis.	(2+2+2) +(2+2) = 10	1 2 4
2	(i) What is 'phase transfer catalyst' and how purple benzene is prepared? Mention one uses of it. (ii) Write dawn the structure of criptates and mention its uses in organic synthesis. ii) Write down the different reagents used for protection and de-protection of amino and acid group for solid state peptide synthesis.	(1+2)+ (1+2)+(2+2)=10	2 2 3
3	(i) What is Wilkinson catalyst? Describe its catalytic uses of it on hydrogenation of olifination reaction with mechanism. (ii) What are the reagents of hydroformylation reactions or Oxo reaction? (iii) Show one uses of the following reagents in organic synthesis (a) Moffat oxidation, (b) Swern oxidation, (c) Dess-Martin periodinane oxidation	(1+ 2) +2+ (2+2+2) =10	3 3 4 4 4