Registration No.: | | | | | | | | | | |

Total Number of Pages: 02 **Course: B.Tech**
Sub_Code: RCH1A002

1st Semester Back Examination: 2025-26
SUBJECT: Chemistry
BRANCH(S): CIVIL, CSE, CSEAI, CSEAIML, CSIT, CST, ECE, EEE, ELECTRICAL, ELECTRICAL & C.E, ETC, MECH, MINING
Time: 3 Hours
Max Marks: 100
Q.Code: U583
Answer Q1 (Part-I) which is compulsory, any eight from Part-II, and any two from Part-III.
The figures in the right-hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) Write the basic laws governing the quantum chemistry.
b) Arrange the following in increasing order of energy and wavelength:
X-ray, Visible, Gamma ray, Infrared, Microwave, Radiowave, Ultraviolet
c) How many vibrational modes are possible for CO_2, and state which of the vibrational modes are IR active?
d) What is the main criterion for a molecule to Microwave active? Which of the following molecules will show a microwave rotational spectrum: HCl, CH_4, CH_3Cl, SF_6
e) Define degree of freedom. Calculate the degrees of freedom in the Following system.
H_2O (s)↔ H_2O (l)↔ H_2O (g)
f) I. Electrochemical corrosion occurs in _____. (Anode/ Cathode)
II. Corrosion is an example of _____ (reduction/ oxidation/ neutralization/ precipitation) reaction.
g) Write the composition of producer gas and synthetic petrol.
h) Define a 0D nanomaterial with example.
i) What is pitting corrosion?
j) Write the full form and difference between LPG and CNG.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) What is meant by time independent wave function, Ψ of a particle? What is the physical significance of the wave function (ψ & ψ^2)? What do you mean by (i) Eigen value and (ii) Eigen function.
b) Define chromophore and auxochrome with example. Discuss the effect of conjugation on the chromophore.
c) i) State Lambert-Beer's Law. Write the expressions for the absorbance and define the different terms in it. ii) When a monochromatic radiation is allowed to fall on a solution of a compound with concentration 0.05 M, the intensity of the incident radiation reduces to one fifth of the initial value. If the path length is 1 cm, calculate the molar extinction coefficient.
d) i) Write down the zero-point energy expression for a vibrating diatomic molecule. Explain the terms. ii) The vibrational energy levels for a diatomic molecule are equispaced (according to SHO). Explain.
e) The separation of lines in the microwave spectrum of CO molecules was found to be 298 m^{-1}. Calculate the rotational constant, bond length of the molecule and the energy corresponding to first excited state energy level.

f) Write down the energy expression of allowed vibrational energy level in joules, in wavenumber and explain the terms (*follow simple harmonic oscillator model*). What are the selection rules for the vibrational transition?

g) Explain with the help of Clausius-Clapeyron equation; why transition curve of rhombic Sulphur has positive slope and that of fusion curve of water system is negative.

h) Draw a neat diagram and discuss the Water equilibrium system.

i) What is corrosion? How is it prevented for metallic materials by using cathodic protection method?

j) What is gross calorific value? When does GCV = NCV? A sample of coal has the following ultimate analysis by mass (on a dry, ash-free basis): Carbon (C) = 82.0 % Hydrogen (H) = 5.5 %, Sulfur (S) = 1.5 %, Oxygen (O) = 10.0 %, Nitrogen (N) = 1.0% (Inert, does not contribute to heating value) Calculate the GCV.

k) Distinguish between the Top-down and Bottom-up approaches to nanomaterial synthesis. List one common technique for each approach. Discuss two major advantages and two significant challenges/limitations associated with the Bottom-up approach compared to the Top-down method.

l) Write a short note on the Refining of petroleum.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Derive the complete wave function and total energy for a particle of mass *m* moving in a one-dimensional box of length *a* using Schrodinger time-independent wave equation. **(12)**

b) An electron is confined to a 1-micron thin layer of silicon. Assuming that the semiconductor can be adequately described by a one-dimensional quantum well with infinite walls, calculate the lowest possible energy within the material in units of electron volt. If the energy is interpreted as the kinetic energy of the electron, what is the corresponding electron velocity? (The effective mass of electrons in silicon is $m^* = 0.26\ m_0$, where $m_0 = 9.11 \times 10^{-31}$ kg is the free electron rest mass). **(4)**

Q4 **a)** The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1876.06 cm^{-1} and 3724.20 cm^{-1}, respectively. Evaluate the equilibrium vibrational frequency, the anharmonicity, the exact zero-point energy, and the force constant of the molecule. **(8)**

b) Define condensed phase rule. Draw and explain the phase diagram of bismuth –cadmium system. Explain the terms: eutectic point and eutectic mixture. If Bi-Cd eutectic mixture has 40 % of Cd by mass, then what would happen if a molten mixture of Bi and Cd containing 15 % of Cd is gradually cooled to the eutectic temperature of the system? **(8)**

Q5 **a)** Discuss electrochemical corrosion with mechanism. **(8)**

b) The percentage composition of a sample of bituminous coal was found to be as C = 75.4 %; H = 5.3 %; O = 12.6 %; N = 3.2 %; S = 1.3 % and Ash = rest. Calculate the minimum weight of air necessary for complete combustion of 1 kg of coal and the percentage composition of dry products of combustion by weight. **(8)**

Q6 **a)** (i) Write any three principles of Green Chemistry that are directly applied in green nanomaterial synthesis. (ii) Describe the general procedure for synthesizing nanoparticles using a plant-mediated green route. **(6)**

b) Compare the green synthesis method with a conventional chemical reduction method for producing metal nanoparticles with example. Highlight two comparative advantages of the green method from an environmental and economic standpoint. **(6)**

c) Why is achieving a narrow size distribution often more challenging in green synthesis compared to some precisely controlled chemical methods? **(4)**