VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA
Mid Semester Examination February – 2019

COURSE NAME: **B.Tech.** SEMESTER: **2nd**

BRANCH NAME: **All Branches (Section: A, B, C, D, E, F, & G)**

FULL MARKS: **20** TIME: **2 Hours**

SUBJECT NAME: **CHEMISTRY**

Answer **All** Questions.

The figures in the right hand margin indicate Marks. The symbols carry usual meaning.

Q1. Answer all Questions. **[1 × 5=5]**

(a) Define the term "ultraviolet catastrophe" using the energy density plot. - CO1

(b) Write the conditions that an eigen function must satisfy. - CO1

(c) An electron is confined in a one-dimensional box of length 10 Å. Calculate the ground state energy of the electron. - CO1

(d) Which of the following molecules will show (i) pure rotational, and (ii) vibrational spectrum: H_2, NO_2, HCl, CH_4, CH_3Cl, H_2O, SF_6, CO_2, CO, OCS - CO2

(e) Calculate the molar absorptivity of $1x10^{-4}$ M solution, which has an absorbance of 0.20 when the path length of solution is 2.5 cm. - CO2

Q2. **[5.0]**

(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 Schrödinger time-independent wave equation. [5.0] - CO1

OR

(b) (i) How would you explain the photoelectric effect using quantum theory? [2.5]

(ii) When a radiation of certain wavelength is incident on a metallic surface, the stopping potentially is found to be 5 V. If the same surface is illuminated by the radiation of double the wavelength, the stopping potential is found to be 2.5 V. What is the threshold wavelength of the surface? [2.5] - CO1

Q3. **[5.0]**

(a) (i) Derive an expression for bond length of a diatomic molecule using the application of microwave spectroscopy. [3.0]

(ii) The first line in the pure rotational spectrum of $^1H^{35}Cl$ appears at 21.18 cm^{-1}. Find out the rotational constant of $^2D^{35}Cl$. Given atomic masses of H, D and Cl are 1.008 amu, 2.015 amu and 35.45 amu, respectively. Assume, the bond length in $^2D^{35}Cl$ is same as that in $^1H^{35}Cl$. [2.0] - CO2

OR

(b) (i) Write the selection rule for harmonic and anharmonic vibrations in IR spectroscopy. [2.0]

(ii) The fundamental and first overtone transitions of $^{14}N^{16}O$ are centered at 1876.06 cm^{-1} and 3724.20 cm^{-1}, respectively. Evaluate the equilibrium vibrational frequency, exact zero point energy, and force constant of the molecule. [3.0] - CO2

Q4. **[5.0]**

(a) (i) Show that the entropy change of an irreversible process is always greater than zero. [2.0]

(ii) One mole of nitrogen gas is mixed with three mole of oxygen gas at 25 °C to form a mixture at the final pressure of 1 atm. The initial pressure of each being also 1 atm. Calculate the molar entropy of mixing. [3.0] - CO1

OR

(b) Discuss the different processes that occurs (such as absorption, radiative and non-radiative decay, and chemical reaction), when light incident on a system using Jablonski diagram. [5.0] - CO2