Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

**End Semester Examination – April/May – 2017**

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| **Code :** | **15PH3009** | **Duration :** | **3hrs** |
| **Sub. Name :** | **ATOMIC AND MOLECULAR SPECTROSCOPY** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| Q. No. | Sub Div. | Questions | Course  Outcome | Marks |
| 1. | a. | Write the significance of “wave function”. | CO1 | 4 |
| b. | The orbital angular momentum of an electron in a hydrogen like atom is 1.3115 x 10-23 J/T. Justify the state of the electron. | CO2 | 4 |
| c. | Distingush between the orbital and spin electronic angular momentum and explain the concept of total electronic angular momentum. | CO1 | 12 |
| (OR) | | | | |
| 2. | a. | Justify how a spinning electron possess magnetic dipole moment. | CO1 | 4 |
| b. | Classify normal and anomalous Zeeman Effect. | CO1 | 4 |
| c. | Explain the effect of an applied magnetic field on the energy levels of an electron with J=3/2. | CO2 | 12 |
| 3. | a. | Distinguish between symmetric top and spherical top molecules. | CO1 | 4 |
|  | b. | Evaluate the average period of rotation of HCl molecule if it is in the J=1 state. The internuclear distance of HCl is 0.1274 nm. Given the mass of the hydrogen and chlorine atoms are 1.673 x 10-27 Kg and 58.06 x 10-27 Kg, respectively. | CO2 | 4 |
|  | c. | With a neat sketch explain the fine structure of the hydrogen atom spectrum. | CO2 | 12 |
| (OR) | | | | |
| 4. | a. | Sketch the fundamental vibrations of a CO2 molecule. | CO1 | 4 |
|  | b. | The normal modes of vibrations of CO2 molecule have wave numbers as 1330, 667, and 2349 cm-1. Calculate the zero point energy. | CO2 | 4 |
|  | c. | Discuss the vibrational energy levels and transitions between them for a diatomic molecule undergoing anharmonic oscillations using FTIR spectroscopy. | CO2 | 12 |
| 5. | a. | Classify stokes and anti-stokes lines. | CO1 | 4 |
|  | b. | Irradiation of carbon tetrachloride by 4358 Å radiation gives Raman lines at 4419 Å. Calculate the Raman shift in cm-1. | CO2 | 4 |
|  | c. | With neat sketch exaplain the concepts of stokes and anti-stokes lines using Quantum theory of raman effect. | CO2 | 12 |
| (OR) | | | | |
| 6. | a. | State the principle of mutual exclusion. | CO1 | 4 |
|  | b. | The fundamental and first overtone transitions of 14N16O are centred at 1876.06 cm-1 and 3724.20 cm-1, respectively. Evaluate the equilibrium vibration frequency. | CO2 | 4 |
|  | c. | With a neat sketch explain the transitions between the rotational-vibrational energy levels of a diatomic molecule, together with the spectrum arising from them (Diatomic – Vibrating rotator). | CO2 | 12 |
| 7. | a. | How Born-Oppenheimer approximation is useful in spectroscopy. Justify. | CO1 | 4 |
|  | b. | Choose the type of spectra that is given by all the types of molecules.  (i) electronic spectra  (ii) vibrational spectra  (iii) rotational spectra | CO2 | 4 |
|  | c. | By ignoring the rotational fine structure, discuss the appearance of the vibrational coarse structure of spectra. | CO1 | 12 |
| (OR) | | | | |
| 8. | a. | Mention the applications of Raman Spectroscopy. | CO1 | 4 |
|  | b. | Give the expansion for “SERS” and relate its advantage over conventional Raman spectrocopy. | CO1 | 4 |
|  | c. | With a near sketch, explain the instrumentation part of Raman Spectrophotometer. | CO2 | 12 |
|  | | **Compulsory:** |  |  |  |
| 9. | a. | State the Franck-Condon Principle. | CO1 | 4 |
|  | b. | Discuss the intensity of Vibrational-Electronic Spectra: the Franck-Condon Principle. | CO2 | 16 |

ALL THE BEST