P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010

Autonomous -ISO 9001 – 2015 Certified

ATOMIC AND MOLECULAR PHYSICS

Offered to : M.Sc.(PHYSICS) **Course Code**: 22PH1T3

Course Type : Core **Course: ATOMIC AND MOLECULAR PHYSICS**

Year of Introduction :2004 **Year of offering :** 2022

Year of Revision :2022 **Percentage of Revision :** Nil

Semester : I **Credits : 4**

Hours Taught : 60 hrs. per Semester **Max.Time** : 3 Hours

Course Description : Atomic and Molecular Physics (22PH1T3) course deals the interaction between matter and electromagnetic radiation. It covers rotational, vibrational and electronic transitions responsible for atomic and molecular spectra. The atomic absorption and emission spectroscopic techniques are introduced for their wide applications in research and development, technology and medicine. A crucial component of this course is to understand, the behaviour of the electrons that surround the atomic nucleus, the way atoms and molecules interact with their environment.

Course Objectives:

1. To learn principles, instrumentation and applications of atomic absorption spectroscopy
2. To learn principles, instrumentation and applications of atomic emission spectroscopy
3. To understand the rotational motion of diatomic molecules and role of dipole moment in molecular spectroscopy
4.To learn the vibration rotation spectra of diatomic molecules
5. To learn the electronic spectroscopy of diatomic molecules

CourseOutcomes:

Attheendof thiscoursethestudentsshouldbeableto:

CO1: Understandtheprincipleandapplicationsofatomicabsorption,emissionspectrometer.
CO2: Apply the techniques of theatomic emission spectroscopyand flame photometry to the materials.
CO3: Apply the concept of rotational spectra to find the bond lengths of different molecules.
CO4: Understand the concept of vibrational spectra of different molecules.
CO5: Understand the electronic spectra of diatomic molecules.

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Atomic Absorption Spectroscopy** Introduction – Principle – Differences between Atomic Absorption Spectroscopy and Flame Emission Spectroscopy– Advantages of Atomic Absorption Spectroscopy over Flame Emission Spectroscopy–Disadvantages of Atomic Absorption Spectroscopy– Instrumentation– Single and Double beam Atomic Absorption Spectroscopy— Applications of Atomic Absorption Spectroscopy. (CO1)	12
II	**Atomic Emission Spectroscopy and Flame Photometry** Introduction – Theory of Emission Spectroscopy –Instrumentation –Spectrographs – Applications of Emission Spectroscopy– Advantages and Disadvantages of Emission Spectroscopy– principle and instrumentation of Inductively coupled plasma - atomic emission spectroscopy (ICP-AES) Principle and Instrumentation of Flame Photometry –Applications of Flame Photometry (CO2)	12
III	**Rotational Spectroscopy** Introduction – Classification of molecules – Rotational spectra of a diatomic molecule – rigid rotator – Isotopic effect in Rotational spectra–Intensity of rotational lines– non-rigid rotor – linear polyatomic molecules – Symmetric top molecules. Moment of Inertia and bond lengths of linear tri-atomic molecule– Microwave spectrometer. Applications of Rotational Spectroscopy - Microwave Oven. (CO3)	12
IV	**Vibrational Spectroscopy** Introduction – Diatomic molecule as simple harmonic oscillator – Anharmonic oscillator – vibrating rotator - Energy levels and spectrum, Effect of isotopic substitution on vibrational bands, Sample handling techniques– FTIR spectroscopy – Principle – FTIR Spectrometer - Applications of vibrational spectroscopy (CO4)	12
V	**Electronic Spectroscopy of Diatomic Molecules** Introduction– Vibrational coarse structure– Vibrational analysis of band systems: Deslandres table – Progressions and sequences information derived from vibrational analysis – Morse potential energy curve – Frank-Condon principle – Rotational fine structure of electronic vibranic spectra- FortratParabolae – Dissociation – Predissociation. (CO5)	12

Text and Reference Books:

1. Atomic and Molecular Spectroscopy, Gurdeep Chatwal, Sharma Anand, Himalaya Publishing House

2. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt, New Delhi, (2014).

3. Fundamentals of Molecular Spectroscopy, C.N. BANWELL and E.M. McCASH (Tata McGraw-Hill - 2013).

4. Modern Spectroscopy, J.M. HOLLAS (John Wiley &Sons).

5. Molecular Spectroscopy, J.M. Brown, Oxford Science Publications, Oxford. (1998).

Course Delivery method : Face-to-face / Blended
Course has focus on : Employability
Websites of Interest :https://nlist.inflibnet.ac.in/vsearch.php
Co-curricular Activities : Quiz.

(An Autonomous College in the jurisdiction of Krishna University)
M.Sc., (PHYSICS) Programme – I Semester
Course Code: 22PH1T3 Title: ATOMIC AND MOLECULAR PHYSICS
(w.e.f admitted batch 2022-23)

Time: 3 Hours **Max. Marks: 70**

SECTION-A

Answer all questions **5x4=20 M**

1. **(A)** What are the difference between atomic absorption spectroscopy and flame emission spectroscopy?

(Or) CO1, L1

(B) What are applications of atomic absorption spectroscopy?

2. (A) What are the applications of emission spectroscopy? CO2, L1

(Or)

(B) What are the applications of photometry?

3. (A) What are the conditions for pure rotational spectrum of a diatomic molecule?

(Or)

(B) What are the features of pure rotational spectrum? CO3, L1

4. (A) What change does the interaction between vibration and rotation cause in the spectrum of a diatomic molecule? CO4, L1

(Or)

(B) What are applications of vibrational spectroscopy?

5. (A)Explain Morse potential energy curve. CO5, L1

(Or)

(B)What are Fortratparabolae?

SECTION-B

Answer all questions **5x10=50M**

1. (A) Explain the principle of atomic absorption spectroscopy. CO1,L2

(Or)

(B) With a neat schematic diagram explain the construction and working of atomic absorption spectrometer

7. A)Explain the theory of emission spectroscopy with neat diagram. CO2, L2

(Or)

B) Explain the principle of flame photometry and discuss the instrumentation of flame photometry with neat diagram

8. A)Explain the rotational spectrum of a diatomic molecule treating it as a rigid rotator.CO3,L2

(Or)

B) With the help of neat block diagram explain the set up and working of microwave spectrometer.

9. A) Explain the vibrational spectrum of a diatomic molecule treating it as harmonic oscillator and explain isotopic effect in vibration bands.

(Or)

B) Explain the set up and working of FTIR spectrometer with a neat block diagram.

CO4, L2

10. A) Explaindeslandres table for the band spectrum of a diatomic molecule. CO5, L2

(Or)

B)Explain the fine structure of electronic vibrational transitions

Note: Question paper contains 5 short answers with internal choice from each unit and 5 long answer questions with internal choice from each unit.