

STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
(For the candidates admitted from the academic year 2023-2024 & thereafter)

M.Sc. DEGREE EXAMINATION, APRIL 2026
BRANCH III - PHYSICS
FOURTH SEMESTER

COURSE : CORE
PAPER : SPECTROSCOPY
SUBJECT CODE : 23PH/PC/SP44
TIME : 3 HOURS

MAX. MARKS: 100

Q. No.	SECTION A ANSWER ALL QUESTIONS (10 x 3 = 30)	CO	KL
1	What is a symmetric top molecule? Give one example.	1	1
2	Define quadrupole effect in microwave spectroscopy.	1	1
3	State the expression for vibrational energy levels of a harmonic oscillator.	1	1
4	Mention the advantages of FTIR spectroscopy.	1	1
5	Distinguish between Stokes and Anti-Stokes lines in Raman spectrum.	2	2
6	Explain the Rule of Mutual Exclusion.	2	2
7	Define Fortrat diagram and mention its purpose.	2	2
8	Distinguish between XPES and UPES.	2	2
9	Differentiate between T ₁ and T ₂ relaxation times.	3	3
10	Explain how hyperfine splitting arises in ESR spectra.	3	3
Q. No.	SECTION B	CO	KL
	Part A ANSWER ANY TWO QUESTIONS (2 x 5 = 10)		
11	For a rigid diatomic molecule with rotational constant B = 1.931 cm ⁻¹ , calculate the rotational energy of the J = 4 level and the wavenumber corresponding to the J = 4 → 5 transition.	3	3
12	A monochromatic radiation of wavelength 435.8 nm produces a Raman Stokes shift of 1000 cm ⁻¹ . Calculate the wavelength of the Stokes line.	3	3
13	Calculate the resonance frequency of ¹³ C nucleus in a magnetic field of 7 T. (Given: γ for ¹³ C = 6.73 × 10 ⁷ rad T ⁻¹ s ⁻¹)	3	3
	Part B ANSWER ANY SIX QUESTIONS (6 x 5 = 30)		
14	Describe the working principle and main components of a microwave spectrometer.	4	4
15	Discuss the instrumentation of an infrared spectrometer.	4	4
16	Discuss the Raman activity of CO ₂ and H ₂ O vibrations with symmetry considerations.	4	4

17	Elucidate the vibrational structure of electronic spectra based on the Franck–Condon principle.	4	4
18	Explain chemical shift in NMR of Hydrogen nuclei and analyse the factors affecting it.	4	4
19	Evaluate the role of isotopic substitution in determining molecular structure.	4	4
20	Describe the working principle of Molecular Photoelectron Spectroscopy.	4	4
21	Describe the instrumentation of ESR spectroscopy.	4	4
Q. No.	SECTION C ANSWER ANY TWO QUESTIONS (2 x 15 = 30)	CO	KL
22	Discuss in detail the theory of vibrating diatomic molecule and derive the expression for vibrational energy levels. Explain the concept of zero-point energy.	5	5
23	Discuss structural determination of molecules using combined IR and Raman spectroscopy.	5	5
24	Describe the principle and instrumentation of Auger Electron Spectroscopy (AES) and evaluate its importance in surface chemical analysis.	5	5
25	Explain the principles and instrumentation of NMR spectroscopy and evaluate its importance in chemical analysis and molecular structure determination.	5	5
