JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

Supplementary Examination- 2026

M.Sc-III Semester (BT)

Course Code(Credits): 20MS1BT312 (2) Max. Marks: 75

Course Name: Emerging Technology

Course Instructors: Dr. Abhishek Chaudhary Max. Time: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

Q.No	Question	Marks
Q1	a. Confocal microscope have tremendous ability to capture sharp, 3D images of thick specimens by eliminating extra light and makes it ideal for studying detailed structures, dynamic processes in live cells.So, describe the working principle of confocal microscope using neat and clean ray diagram. b. Also compare it with wide-field fluorescence microscopy. c. Signify the importance of pin hole and point-by-point illumination in confocal microscopy	5+2+2
Q2	Fluorescence spectroscopy is mainly used to determine the content of certain components in biological samples, analysis of biotechnology and immunotechnology, such as the determination of deoxyribose and deoxyribonucleic acid, DNA, antibodies, antigens, and other aspects of research. Using the concept of fluorescence spectroscopy, answer the following a. What do you understand by radiative and non radiative transition b. Write down the relation between quantum yield, radiative decay constant (Kr) and Non radiative decay constant (Knr) and significance of quantum Yield c. Elaborate IC and ISC and their importance in fluorescence spectroscopy d. Explain REES with suitable ray diagram	2+2+3 +3
Q3	a. Explain the mechanism of fluorescence quenching. Discuss dynamic and static quenching with suitable equations and diagrams. b. FRET microscopy is a powerful technique capable of investigating dynamic interactions between proteins and a plethora of biochemical signaling events based on the development of specific biosensors. Describe the principle, conditions, and applications of FRET in studying biomolecular interactions.	5+5
Q4	Raman spectrometry is a non-destructive analytical technique that uses laser light to probe the vibrational modes of molecules, providing a unique "fingerprint" for chemical identification and structure analysis a. Discuss the principle of Raman Scattering and its association with stokes and anti-stokes shift b. Elaborate Mie scattering and how Mie scattering differ from Raman Scattering c. Explain Rayleigh Scattering with suitable example	5+3+2

Q5	Mass spectrometry (MS) is a versatile analytical technique used across many fields to identify and quantify substances, determine molecular structures, and analyze isotopes, with key applications in pharmaceuticals,environmental analysis, clinical diagnostics, and forensics. a. Write down the working principle of mass spectrometer and the mechanism of ionization with suitable example. b. What do you understand by Free radical ion and its importance in mass spectroscopy? c. What would be the molecular formula of hydrocarbon cation with an m/z value of 57, 43, and 71.	4+3+3
Q6	a. The fluorescence intensity of compound X is 1.6 units in the absence of a quencher and decreases to 0.4 units in the presence of a quencher. Using a Stern–Volmer constant of 2.0 L mol^{-1}, calculate the concentration of the quencher. Additionally, determine the quantum yield of the compound if the number of photons absorbed is 1.0×10^{22} and the number of photons emitted is 0.5×10^{21}. b. A Fluorescein donor and a TAMRA acceptor are attached to the terminal ends of a DNA sequence. Assuming random orientation of the donor and acceptor transition dipoles, the average Förster resonance energy transfer (FRET) efficiency is 50%. Given that the Förster radius (R0) for this donor–acceptor pair is 6.5 nm, calculate the average distance between the donor and acceptor molecules .	3+2 +5
Q7	a. A compound X exhibits an NMR spectral peak at 555.2 Hz relative to tetramethylsilane (TMS). Calculate the chemical shift (in ppm) of the compound when the spectrum is recorded on (i) a 300 MHz NMR spectrometer and (ii) an 80 MHz NMR spectrometer. b. Further, state which of the two spectrometers provides better spectral resolution and justify your answer. c. Also explain why tetramethylsilane (TMS) is commonly used as an internal standard in NMR spectroscopy. d. Ethanol is not typically considered a suitable solvent for routine proton nuclear magnetic resonance (^{1}H NMR analysis), Why?	5+2 +2+1
Q8	Determine the splitting pattern and intensity distribution of the following compound using the concept of NMR spectroscopy. a. 1,1-Dibromopropane b. Dimethyl ether c. Ethyl Chloride d. n-Butane	1.5*4