BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – M.Sc.(BT)-2024
Course Name – Optical Instrumentation
Course Code - MBT10201
(Semester I)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A
(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Select why quartz lenses are used in ultraviolet microscopes instead of glass lenses.
   a) Quartz lenses are cheaper
   b) Glass lenses are opaque to UV light
   c) Quartz lenses are lighter
   d) Quartz lenses provide better magnification

(ii) Identify the main applications of interference microscopes.
   a) Analyzing fluorescent dyes in biological samples
   b) Measuring the thickness of thin films
   c) Studying the movement of cells in real-time
   d) Visualizing color changes in chemical reactions

(iii) Identify thw component of a CSLM that eliminates out-of-focus light.
   a) Objective lens
   b) Pinhole aperture
   c) Dichroic mirror
   d) Emission filter

(iv) Predict the phenomenon that involves high-energy electrons being deflected by atomic nuclei and producing X-ray radiation.
   a) Elastic Scattering
   b) Inelastic Scattering
   c) Bremsstrahlung
   d) Photoelectric Effect

(v) According to the Laporte rule, conclude the transition that is generally forbidden for centrosymmetric molecules.
   a) g ↔ u
   b) u ↔ u
   c) g ↔ g
   d) All of these

(vi) Conclude the primary effect of spin-orbit coupling on electronic transitions.
   a) It enforces stricter selection rules.
   b) It changes the quantized energy levels.
   c) It makes all transitions forbidden.
   d) It can relax the strictness of spin selection rules.

(vii) Conclude the main function of a conical intersection in molecular photochemistry.

a) To facilitate radiative transitions between electronic states.
b) To provide pathways for non-radiative transitions between electronic states.
c) To increase the photostability of molecules by emitting photons.
d) To describe the geometric shape of molecules in three-dimensional space.

(viii) Cite the biological process in which conical intersection is known to play a crucial role.

a) Cellular respiration
b) Protein synthesis
c) Photosynthesis
d) DNA replication

(ix) Identify the aromatic amino acid that is most commonly responsible for the intrinsic fluorescence of proteins.

a) Tryptophan
b) Phenylalanine
c) Tyrosine
d) Histidine

(x) Identify the light source that provides high irradiance at narrow wavelengths but lacks adjustability.

a) Laser
b) Xenon arc lamp
c) LED
d) Incandescent bulb

(xi) Cite the type of charge that the oxygen atom in an O-H bond bear due to the unequal sharing of electrons.

a) Positive
b) Negative
c) Neutral
d) Variable

(xii) Determine how many vibrational modes does a non-linear molecule with 5 atoms have.

a) 6
b) 15
c) 12
d) 9

(xiii) In UV Circular Dichroism (UV CD), choose what aspect of proteins is typically analyzed.

a) Protein tertiary structure
b) Charge transfer transitions
c) Protein secondary structure
d) Protein-metal interactions

(xiv) Choose the correct option: Near-UV CD spectra provide information about which aspect of proteins?

a) Secondary structure
b) Tertiary structure
c) Alpha-helix content
d) Enthalpy changes

(xv) Predict the effect of adding a denaturing agent like urea on a protein as observed by CD.

a) It unfolds the protein, causing a transition from alpha-helix to random coil
b) It causes a shift from random coil to alpha-helix
c) It sharpens the alpha-helix signals
d) It stabilizes the protein's secondary structure

Group-B
(Short Answer Type Questions) 3 x 5=15

2. Explain the concept of degeneracy at a conical intersection and its significance in non-radiative transitions. (3)
3. Determine the significance of the 90° detection angle in fluorescence spectroscopy. (3)
4. Evaluate how Circular Dichroism (CD) spectroscopy detect protein conformational changes. (3)
5. Write short notes on Oblique Illumination. (3)
6. Evaluate the role of quartz lenses in ultraviolet microscopy. (3)

OR

Evaluate the role of DAPI as a fluorescent stain in fluorescence microscopy. (3)

Group-C
(Long Answer Type Questions) 5 x 6=30

7. Explain the principle and components of a fluorescence microscope. How does it differ from a standard optical microscope? (5)
8. Deduce how the emission and absorption spectra provide information about electronic transitions and energy levels in a substance. How are these spectra used to characterize and analyze materials? (5)
9. Explain the Beer-Lambert Law and how it is used to determine the concentration of a chromophore in a solution. Provide a sample calculation. (5)

10. Establish the role of IR spectroscopy in identifying unknown compounds and its application in quantitative analysis. (5)
11. Evaluate the working principle of NMR spectroscopy, including the role of nuclear spin, the external magnetic field, and the steps involved in obtaining an NMR spectrum. (5)
12. Explain the principle of confocal microscopy and explain how it achieves higher optical resolution and contrast compared to traditional wide-field fluorescence microscopy (5)

OR

Describe the process and components of Fluorescence-Activated Cell Sorting (FACS) and explain how it sorts cells based on their characteristics. (5)

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