Roll Number:

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

B.Tech-VII Semester (Open Elective)

COURSE CODE (CREDITS): 18B1WPH731 (03) MAX. MARKS: 35

COURSE NAME: Nanotechnology

COURSE INSTRUCTORS: Dr. Ragini Raj Singh 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

(c)Calculators allowed

Q.No	Question	CO	Marks
Q1	**a)** What is surface plasmon resonance (SPR)? Explain how the surface plasmon resonance (SPR) of metal nanoparticles depends on size, shape and dielectric environment.	3	2
	b) Describe *superparamagnetism*. Why does it occur only at the nanoscale for magnetic nanoparticles?		2
	c) Explain the force–distance curve in Atomic Force Microscopy and what material properties can be extracted from it.		2
	d) Describe X-ray diffraction spectra anatomy. What can be analyzed using XRD?		2
	e) With a neat sketch, explain the working of tapping-mode AFM and state why it is preferred over contact mode for soft biological samples.		2
Q2	**a)** Interpret how bandgap varies with size in Quantum Dots.	4	2
	b) Explain how QDs can be tuned for multiplexed bioimaging.		2
	c) Why do larger QDs have lower quantum confinement?		2
Q3	**a)** Describe the interaction of electrons with matter in SEM that leads to secondary electron generation.	4	2
	b) Explain electron transmission, diffraction contrast, and lattice imaging in TEM.		2
Q4	**a)** Explain mechanisms of magnetic hyperthermia therapy by magnetic nanoparticles.	5	2
	b) Describe two surface functionalisation strategies for biomedical use for magnetic nanoparticles.		2

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Q5	**a)** A diffraction peak for an FCC metal occurs at $\theta = 35°$ using Cu Kα radiation ($\lambda = 0.154$ nm).If the peak corresponds to the (200) plane, calculate the interplanar spacing (d) using Bragg's law. **b)** A nanoparticle sample shows an XRD peak at $2\theta = 44°$ with FWHM = 0.18°.Given: K = 0.9; $\lambda = 0.154$ nm. Calculate the crystallite size. **c)** In tapping mode AFM, the cantilever with spring constant k = 20 N/m shows a change in amplitude corresponding to a deflection of 0.5 nm. Find the tip–sample interaction force.	5	**2** **2** **2**
Q6	Explain how XRD, SEM, TEM, and AFM together provide a complete characterization protocol for a metal nanoparticle sample. Discuss: **i.** crystal structure **ii.** particle size & shape **iii.** surface roughness **iv.** defects **v.** elemental contrast	5	**5**