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MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

# VI SEM B.TECH. (BME) DEGREE GRADE IMPROVEMENT EXAMINATIONS, JAN 2021 SUBJECT: INTRODUCTION TO BIOMEDICAL NANOTECHNOLOGY (BME 4012)

Friday, 8<sup>th</sup> January 2021, 2 PM-5 PM

# TIME: 3 HOURS

# MAX. MARKS: 50

#### **Instructions to Candidates:**

#### 1. Answer ALL questions.

2. Draw labeled diagram wherever necessary

1.	(a)	Explain the relation between surface energy and particle size.	02
	(4)	Explain the relation between surface energy and particle size.	L L

(b) Explain the mechanisms for reducing overall surface energy in nanomaterials. 03

- (c) Explain "LaMer's mechanism" of nanoparticle synthesis. Discuss the electrostatic 05 stabilization mechanism associated with nanoparticles.
- 2. (a) You have synthesized 4 samples (A,B,C & D) of ZnO nanoparticles. 05
  Explain the principle behind and application of Scanning Electron Microscope (SEM) and X-ray Diffraction (XRD) for the characterization of these nanoparticles.
  - (b) i) Draw a rough diagram of the UV-Vis absorption spectra associated with each ZnO nanoparticle (spherical shape) samples (exact calculation of absorption wavelength is not required) and explain the differences in the absorption wavelength with "particle in a box" concept.

Assume that the following parameters pertaining to the 4 samples:

 $\label{eq:constraint} \begin{array}{l} \text{Diameter of Sample } A < \text{Diameter of Sample } B < \text{Diameter of Sample } C < \text{Diameter of Sample } D. \end{array}$ 

ii) If the particles you synthesized were gold nanoparticles (spherical or rod shaped), how would the UV-Visible absorption spectra change with size and shape? Explain the reasons.

3.	(a)	Describe physical vapor deposition method (PVD) and chemical vapor deposition	05
		method (CVD) for nanomaterial synthesis.	

- (b) Explain the principle behind and operation modes of Atomic force microscopy (AFM) and Scanning Tunneling Microscope (STM). What is Dip pen lithography?
- 4. (a) Explain "temperature induced" and "ultrasound induced" nano drug delivery 03 systems.
  - (b) Explain the concept of nanowire FET based biosensor with an example. 02
  - (c) Design a pH induced intracellular drug delivery system for doxorubicin delivery, 05 which can also deliver multi modal imaging nanoprobes (MRI+ Optical imaging).
- 5. (a) Explain type 1 and type 2 pathways of photosensitization. How photosensitization  $_{03}$  is useful in Tumor therapy.
  - (b) Describe the concept of photothermal therapy (PTT) and how nanomaterials are improving the efficiency of photothermal therapy (PTT).
  - (c) Design a strategy for drug delivery in which release of the drug will be activated by Fluorescence Resonance Energy Transfer (FRET).
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