


Name:			
Enrolment No:			
UPES End Semester Examination, May 2024			
Course: Material Synthesis & Characterization Program: Integrated BSc-MSc Physics Course Code: PHYS3041P		Semester: VI Time: 03 hrs. Max. Marks: 100	
Instructions: All abbreviations have their usual meaning. Use of scientific calculators is permitted. No. of pages- 2. All questions are compulsory; Questions 8 & 11 have internal choices.			
SECTION A (5Qx4M=20Marks)			
S. No.		Marks	CO
Q 1	Mention two advantages and two disadvantages of the ‘sputtering’ technique for the synthesis of thin films.	4	CO1
Q2	Describe in brief the ‘top-down’ and ‘bottom-up’ approaches for the synthesis of nanomaterials.	4	CO1
Q3	In the context of UV-visible spectroscopy, what are the different possible types of electronic transitions in a molecule?	4	CO2
Q4	Distinguish between secondary electrons and backscattered electrons in SEM.	4	CO2
Q5	Name the principle on which XPS is based. In XPS, how will you differentiate between photoelectrons and Auger electrons?	4	CO2
SECTION B (4Qx10M= 40 Marks)			
Q6	Write short notes on the following: (i) E-beam lithography; (ii) Chemical vapor deposition.	10	CO1
Q7	What is the basic principle involved in atomic force microscopy? Discuss the constant height and constant force modes of operation in AFM.	10	CO2
Q8	(a) An X-ray generator delivers a constant accelerating voltage of 6.8 kV. Elaborate if this X-ray tube will be able to generate Cu K_{α} radiation if copper (Cu) is used as the anode material. Given wavelength of Cu K_{α} = 1.54 Å.	4	CO2
	(b) Discuss how the XRD pattern would look like for single-crystalline, poly-crystalline, nano-crystalline and amorphous form of the same material.	4	

	(c) For probing valence band electrons, which photon source will you use: X-ray or UV? Why?	2																						
	OR																							
	(a) Describe the 'rotating crystal' method of X-ray diffraction.	5																						
	(b) Is Raman scattering elastic or inelastic? Discuss Raman spectroscopy vis-à-vis FTIR spectroscopy.	5																						
Q9	The SAED pattern of an FCC metal is in the form of concentric rings with diameters as given below. Index the SAED pattern and hence estimate the lattice parameter (given camera constant = 0.629 cm-nm).	10	CO2																					
	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Ring</th> <th>Diameter 1 (cm)</th> <th>Diameter 2 (cm)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>3.8</td> <td>3.8</td> </tr> <tr> <td>2</td> <td>4.4</td> <td>4.35</td> </tr> <tr> <td>3</td> <td>6.25</td> <td>6.2</td> </tr> <tr> <td>4</td> <td>7.28</td> <td>7.3</td> </tr> <tr> <td>5</td> <td>7.50</td> <td>7.70</td> </tr> <tr> <td>6</td> <td>8.80</td> <td>8.80</td> </tr> </tbody> </table>			Ring	Diameter 1 (cm)	Diameter 2 (cm)	1	3.8	3.8	2	4.4	4.35	3	6.25	6.2	4	7.28	7.3	5	7.50	7.70	6	8.80	8.80
Ring	Diameter 1 (cm)			Diameter 2 (cm)																				
1	3.8			3.8																				
2	4.4			4.35																				
3	6.25			6.2																				
4	7.28			7.3																				
5	7.50			7.70																				
6	8.80	8.80																						
SECTION-C																								
(2Qx20M=40 Marks)																								
Q10	(a) Explain the four stages involved in the process of thin film synthesis via pulsed laser deposition.	15	CO1																					
	(b) Describe the gel combustion synthesis method.	5																						
Q11	(a) Illustrate, with an appropriate schematic, the construction of a transmission electron microscope.	15	CO2																					
	(b) Determine the zone axis for the planes (111) and (100).	5																						
	OR																							
	(a) Illustrate, with an appropriate schematic, the construction of a scanning electron microscope.	15																						
	(b) Calculate the smallest distance that can be resolved by an electron microscope operating at an accelerating potential of 100 kV.	5																						