



BBA-003-0491101 Seat No. _____

**B. Sc. / M. Sc. (Applied Physics) (Sem. X)
(CBCS) Examination**

July - 2021

**Core-10, Paper-13 : Ion Beams in Materials Science
(New Course)**

Faculty Code : 003

Subject Code : 0491101

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

Instructions :

- (1) Attempt any FIVE questions.
- (2) Numbers in the right margin indicate marks.

1 Write answer of following short questions : (Two marks each) **14**

1. What do you mean by ripple formation ?
2. What is the Bethe-Bloch Formula ?
3. Why RBS has poor sensitivity and good mass resolution for lighter elements ?
4. What is the projected range of ions in a target material ? Give the expression of the projected range.
5. What is the disadvantage if one wishes to do ERD measurements on "RBS set-up" i.e., by using beam of α -particles ?
6. Write down any two applications of Secondary Ion Mass Spectrometer (SIMS).
7. What is the sputter yield ? Write any two applications of sputtering ?

2 Write answer of following short questions : (Two marks each) **14**

1. What is channelling ?
2. What do you mean by straggling ? What are the types of straggling ?
3. What are the basic approaches in the synthesis of nanostructures ? Give the name of two synthesis methods for nanostructures based on ion beam.
4. Define kinematic factor for RBS ? State the assumptions used to derive expression for kinematic factor ?

5. What are the limitations in the synthesis of nanoparticles by ion implantation ?
 6. Describe the radiation enhanced diffusion process in solids ?
 7. What are the additional requirements for NRA setup as compared to RBS and ERDA setup ? Write down any two limitations of the NRA ?
- 3** Write answer of following questions : **14**
1. Discuss the working principle of ERDA briefly.
 2. Give a brief overview of what energetic ions can do while interacting with the material.
- 4** Write answer of following questions : **14**
1. Explain the working principle of RBS ?
 2. What is ion implantation ? What are the applications of ion implantation in material science ?
- 5** Write answer of following questions : **14**
1. A. State the working principle of the NRA. Why NRA is used to measure the low Z-elements ?
 B. Write down the parameters which determine the (a) energy and (b) yield of the emitted particle in case of NRA ?
 2. Find the energy of the particles as well as the thickness of Au layer if the RBS spectrum contains 5,000 counts of α -particles backscattered from this Au layer ? Given: Incident angle $\alpha = 0^\circ$, scattering angle $\theta = 170^\circ$, $E = 2 \text{ MeV}$, $\Delta\Omega = 10^{-3} \text{ steradian}$, $Q = 10 \text{ } \mu\text{C}$, $d\sigma/d\Omega = 8.0634 \text{ barn steradian}^{-1}$ for $E = 2,000 \text{ keV}$ and density of Au as 19.31 g cm^{-3} .
- 6** Write answer of following questions : **14**
1. What do you mean by kinematic factor in case of ERDA ? In an elastic scattering recoil detection experiment, an incident particle of mass M_1 , having energy E_0 is colliding with the target atom at rest having mass M_2 . After the collision, particle of mass M_1 has energy E_1 and it is scattered at an angle θ . The target particle is scattered at angle ϕ with energy E_2 , then derive the expression of kinematic factor ? Give a list of assumptions taken to derive this expression ?

2. (a) What is the working principle of Rutherford Backscattering (RBS) ? Write down any three limitations of the Rutherford back scattering spectrometry (RBS) ?
- (b) Consider an experiment involving 2.0 MeV He⁺ ions back scattered to 170° from 200nm TiO₂ target. Sketch the back scattering spectrum indicating the energies of the features in the spectrum.
- 7** Write answer of following questions : **14**
1. Discuss the working principle of RF-sputtering briefly.
 2. Explain the role of swift heavy ions (SHI) in Nano structuring.
- 8** Write answer of following questions : **14**
1. Explain the depinning of Fermi level along ion tracks.
 2. Explain the irradiation-induced Self organization Phenomenon briefly.
- 9** Write answer of following questions : **14**
1. What is the importance of ion implantation in the creation of controlled defects ? Explain point defects, line defects, and columnar defects produced by energetic ion irradiation.
 2. Define sputtering process. Write a short note on nuclear and electronic sputtering.
- 10** Write answer of following questions : **14**
1. What do understand by ion beam mixing ? Explain importance of the ion beam mixing for the synthesis of alloys.
 2. What is the difference between crystalline and amorphous solids ? Explain the ion induced epitaxial crystallization process. Also write a short note on the in-situ technique used in the investigation of the irradiation induced phase transformations.