

6. (a) Briefly describe a scanning tunneling microscope (less than 100 words).
- (b) Electrons with energy 1.0 eV are incident on a potential barrier $U=10.0$ eV high and $L=0.50$ nm wide. Find their transmission probability.
- (c) Write a short note on Giant Magnetoresistance (GMR). (5+5+8)
7. (a) What is spin relaxation process? Discuss Dresselhaus and Rashba spin-orbit interaction for the crystals.
- (b) Discuss the spin transport mechanism in an PN junction. (10+8)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1202

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Unique Paper Code : 2513010008

Name of the Paper : Quantum and Spintronic Devices

Name of the Course : B.Sc. (H) Electronics (DSE)

Semester : V (Under NEP UGCF Mode)

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are seven questions in all, out of which you have to attempt any five questions
3. All questions carry equal marks
4. First Question is Compulsory.

1. (a) Discuss the CPP and CIP configurations of GMR.
(b) Draw the unit cell of simple cubic (SC), face center cubic (FCC), and body center cubic (BCC) structures. What is the number of atoms in these unit cells?
(c) What are the disadvantages of Electronics which have led to the research in the area of spintronics?
(d) What is the difference between bit and qubit?
(e) What is jj coupling?
(f) Illustrate with the help of a diagram, the electrochemical potential difference for up- spin and down spin electrons near a ferromagnetic metal/non-magnetic metal interface when a current is flowing through the junction. (3×6)
2. (a) What are the properties of a well-behaved function?
(b) Given $\psi(x) = 5x$ for a particle confined between $x = 0$ and $x = 1$. Find the probability of finding the particle between $x = 0.40$ and $x = 0.60$. Also find the expectation value of the particle position between $x = 0$ and $x = 1$.

- (c) How are qubit states $|0\rangle$, $|1\rangle$, and operators $|+\rangle$ and $|-\rangle$ defined in respect of quantum computing?
(3+10+5)
3. (a) Starting from the quantum mechanics of spin, obtain the expressions for the three Pauli's spin matrices.
(b) What is Zeeman effect? Explain with suitable diagrams. (10+8)
4. (a) Discuss the crystal structure of GaAs. Plot energy band diagram (E-k diagram) of GaAs crystal, showing the valence bands for heavy holes, light holes, and the split-off bands.
(b) Write a short note on Optical orientation.
(c) What is spin accumulation? (10+4+4)
5. (a) Explain with diagrams working of Magnetic Bipolar Transistor.
(b) How MRAM can efficiently replace traditional DRAM or SRAM?
(c) What do you understand by magnetic tunneling devices? (8+5+5)