GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
SUBJECT CODE: 3173906

Semester – VII
SUBJECT NAME: MEGNETOELECTRONIC AND SPINTRONICS

Type of course: Physics of Material Science, microelectronics and VLSI, Nanotechnology and Electronics Devices

Prerequisite: Physics of Nanomaterials, microelectronics and VLSI, Coating Technology and Nano thin film devices

Rationale To make the students understand the newly developed devices and its operation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	MAGNETO RESISTANCE 1.1History and overview of magnetic recording 1.2 Magnetism in solid state 1.3Form of magnetic media 1.4Types of magnetic anisotropy energies 1.5 Magnetic anisotropy and Magnetostriction; 1.6Soft and hard magnetic materials; 1.7 Stoner-Wohlfarth theory. 1.8Electronic structure of normal metals 1.9 ferromagnetic metals 1.10 Half-metals 1.11 Spin-dependent transport 1.12Spin polarization.	9
2	ASPECTS OF MAGNETIC RECORDING HEAD 2.1Introduction to Giant Magneto Resistance 2.2Magnetic circuits 2.3Eddy current loss; 2.4Selection of core materials; 2.5Magnetoresistance 2.6Giant Magnetoresistance (GMR) Heads 2.7 Tunneling Magnetoresistance (TMR) heads 2.8 Spin Valves 2.9 Field from Magnetic Heads	9

	3.0 High-gradient heads 3.1 Perpendicular head fields 3.2 Response of probe heads 3.3 Shielding 3.4 Flux linkage 3.5 Flux leakage.	
3	Spin and Spin Electronics 3.1Introduction about Spin Electronics: 3.2 The Bohr planetary model and space quantization 3.3 The birth of "spin" 3.4 The Stern-Gerlach experiment 3.5 The advent of Spintronics 3.6 Problems	9
4	MAGNETIC DOMAIN WALLS AND ITS DYNAMICS 4.1 Detection of domain-wall propagation 4.2 Ratchet Effect in domain wall motion 4.3 Domain wall velocity measurements: 4.4 Concept of current-driven domain wall motion: 4.5 Towards applications of current-driven domain wall motion: 4.6 Domain wall scattering	6
5	ADVANCES IN SPINTRONIC MATERIALS, TECHNOLOGY AND DEVICES 5.1Materials for spin electronics 5.2 Nanostructures for spin electronics 5.3 Spin-Valve 5.4 Spin-tunneling devices: 5.5 Advanced Read Heads, 5.6 MRAMS 5.7 Field Sensors, 5.8 Spintronic Biosensors, 5.9 Quantum Computing with spins.	9

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35	**35**	**30**	**0**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy Note: This specification table shall be treated as a

general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. F. Jorgensen, The Complete Handbook of Magnetic Recording, TAB Books; 1995.
2. M.L. Plumer, Ek. J. van, D. Weller, The Physics of Ultrahigh-Density Magnetic Recording, Springer, 2001.
3. M. Ziese, M.J. Thornton (Eds)., Spin Electronics, Springer 2001.
4. C. D. Mee and M. H. Clark, Magnetic Recording, Wiley-IEEE, 1999.
5. M. Johnson, Magnetoelectronics, Academic Press 2004.

6. S. Bandyopadhyay, M. Cahay, Introduction to Spintronics, CRC Press, 2008.
7. M. Johnson, Magnetoelectronics, Academic Press 2004.
8. D. J. Sellmyer, R. Skomski, Advanced Magnetic Nanostructures, Springer, 2006.
9. S. Maekawa, Concepts in Spin Electronics, Oxford University Press, 2006.
10. D.D. Awschalom, R.A. Buhrman, J.M. Daughton, S.V. Molnar, and M.L. Roukes, Spin Electronics, Kluwer Academic Publishers, 2004.
11. Y.B. Xu and S.M.Thompson, Spintronic Materials and Technology, Taylor & Francis, 2006.

Course Outcomes:

Sr. No.	CO statement After learning the course the students should be able to:	Marks % weightage
CO-1	Describe fundamental aspect associated with Spintronics-based devices.	25%
CO-2	Describe aspect associated with spin based transport in the device.	25%
CO-3	Understand aspect associated with magnetic domain dynamics.	25%
CO-4	Understand aspect associated with advanced electronic devices.	25%

List of Open Source Software/learning website:

http://nptel.ac.in/courses/115103039/

http://nptel.ac.in/syllabus/115103038/