



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3163906

NANOMAGNETISM AND NANOFLUIDS

6th SEMESTER

Type of course: Material Science, Nano Science

Prerequisite: Basics of magnetic material science and fundamental of physics and chemistry

Rationale: The purpose of this course is to develop understanding of nanoparticles behavior in magnetic materials for various applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	FUNDAMENTAL PROPERTY OF MAGNETIC MATERIALS. 1.1 Introduction to magnetic materials, 1.2 Types of magnetic materials. 1.3 Magnetic Ordering 1.4 Magnetic Transport. 1.5 Non – linear Magnetic Behaviour 1.6 Effect of temperature on magnetization.	10	20%
2	THE FIELD OF NANO MAGNETISM: 2.1 Introduction to nano magnetism. 2.2 Magnetic Nano structure: Spin configuration and magnetization 2.3 Enhancement of magnetization. 2.4 Magnetic anisotropy. 2.5 Magnetic thin film 2.6 Magnetization of ultrathin film. 2.7 Magnetization of Multilayer.	10	20%
3	NANO MAGNETIC EXCHANGE ANISOTROPY: 3.1 Introduction to Exchange anisotropy 3.2 MIKLEJOHN AND BEAN'S nano film. 3.3 Recent nano thin film. 3.4 Antiferromagnetic system in thin film 3.4.1 Oxide thin film. 3.4.2 Metallic thin film 3.4.3 Fluorides thin film. 3.5 Spin probing methods. 3.5.1 Neutron diffraction 3.5.2 Linear and Circular Magnetic Dichroism	10	20%



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	3.5.3 X-ray Photoelectron Emission Microscopy. 3.6 Application of nano magnetic exchange anisotropy.		
4	NANO FLUIDS: 4.1 Introduction. 4.2 Property of nano fluid 4.2.1 Thermal conduction in nano fluid 4.2.2 Effect of particle volume fraction 4.2.3 Effect of particle materials 4.2.4 Effect of base fluid 4.2.5 Effect of particle size 4.2.6 Effect of particle shape 4.2.7 Effect of temperature. 4.2.8 Effect of sonication time. 4.3 applications of nano fluid.	10	20%
5	FABRICATION AND APPLICATION OF NANO FLUID. 5.1 Fabrication of nano fluid. 5.1.1 Single step process. 5.1.2 Two-step process. 5.1.3 other method 5.2 Stability evaluation method for nano fluid 5.2.1 Zeta potential. 5.2.2 Sedimentation method 5.2.3 Centrifugation method 5.2.4 Spectral analysis method 5.2.5 Electron microscopy and light scattering methods 5.3 Stability enhancement procedures 5.3.1 Addition of surfactants 5.3.2 Surface modification techniques 5.3.3 pH control of nanofluids 5.3.4 Ultrasonic agitation 5.4 Stability Mechanism 5.4.1 Electrostatic stabilization 5.4.2 Steric stabilization 5.5 Application of nano fluid.	10	20%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance	Understanding U	Application A	Analyze	Evaluate E
R Level	Level	Level	N Level	Level
18	17	28	7	-

Legends: R : Remembrance; U : Understanding; A Application and above Levels (Revised Bloom's Taxonomy)



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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. Molecular Nanomagnets by Dante Gatteschi, Roberta Sessoli, Jacques Villain, OUP Oxford, ISBN-10: 0199602263.
2. Nanofluids: Synthesis, Properties and Applications by Sohail Murshed, C A Nieto Castro, Nova Science Publishers ISBN-10: 1633216772.
3. Nanofluids Properties and Their Applications by Debendra Das Devdatta Kulkarni LAP Lambert Academic Publishing, ISBN-10: 365916609X.
4. Introduction to Magnetism and Magnetic Materials by D.C. Jiles Springer, ISBN 10: 0412386402
5. Magnetic Materials by Rainer Hilzinger, Werner Rodewald, Wiley VCH, ISBN10: 3895783528

Course Outcome:

After a successful completion of the course, students should be able to

1. Describe and compare the properties of Magnetic materials in the vicinity of magnetic field and temperature
2. Describe and compare nano fluid and its properties.
3. Demonstrate the preparation of nano magnets and nano fluid of various chemical and physical techniques.
4. Explain recent and advance application magnetic materials

List of Experiments:

(Perform any Five experiments from below list and one open ended project)

1. Preparation of Nano fluid.
2. Preparation of Nano magnet.
3. Preparation of Nano magnetic thin film.
4. Determine the thermal conductivity of fluid.
5. Comparison Between fluid and Nano fluid of their thermal properties.
6. Preparation of Ferrofluid.
7. Preparation of ZnO based Nanofluid.
8. Preparation of TiO₂ based Nanofluid
9. Preparation of CuO based Nanofluid
10. Preparation of doped CuO Nanofluid for Cooling application.

Major Equipment:



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Apparatus of Magnetic Hysteresis Loop & Magnetization Curve

Furnace

Microwave Oven

Nanomaterial Synthesis setup

List of Open Source Software/learning website:

<http://www.aspbs.com/jon.htm>

<http://www.northeastern.edu/nanomagnetism/>