Annex A

TEMPLATE FOR REVISED COURSE CONTENT

New Course Code and Title	MS7055 Magnetic Materials
Details of Course	Summary of course content *(please note that this information provided will also be uploaded to the web for viewing at large)* This course will cover the subject of magnetic materials. Magnetic materials are a core component of many high value added, cutting edge, functional devices. The application space includes information storage, energy production and distribution, bioengineering and transducers.
	Rationale for introducing this course A materials approach will be adopted. The processing-structure-property-performance paradigm will be employed. Magnetic field, magnetic moment, types of magnetic materials and their properties will be discussed. Domains and effects of nano structuring will be delineated. Soft and hard magnetic materials will be discussed. Applications in information storage, energy, bioengineering and transducer applications will be delineated.
	Aims and objectives The aim of this course is to cover magnetic materials and their applications employing a processing-structure-property-performance framework. At the end of this course the students will 1. Obtain an understanding of magnetic materials and their role in modern technological applications. 2. Understand the functional requirements of magnetic materials for various applications 3. Critically analyze and predict future directions in magnetic materials

	Syllabus 1. Magnetostatics 2. Experimental methods 3. Types of magnetism 4. Magnetic domains 5. Magnetic anisotropy 6. Nanostructured magnetic materials 7. Types of magnetic materials 8. Magnetic materials in bioengineering 9. Magnetic materials for energy applications 10. Magnetic materials for information storage 11. Magnetic materials for transducers Students need to have background in quantum mechanics and solid-state physics to understand the material at the PG level. Hence, a pre-requisite of quantum mechanics and solid-state physics is required.
Assessment Please specify if components are individually assessed or group assessed	*Participation and attendance (Individual) - 10%* *Continuous Assessment (Individual) - 30%* *Seminar (Individual) -30%* *Group project- 30%*
	Total: 100 %
Hours of Contact/Academic Units	*39 hours / 3 AU*
Proposed Date of Offer	*Semester 2, AY2021-22*
Instructor and Co-instructor (if any)	Professor Raju V. Ramanujan
Class size	50
Any duplication of course School is advised to coordinate/check with the School offering the course to avoid duplication.	Nil

Details of Course

The following topics will be covered

1. Magnetostatics

Introduction. Magnetic poles. Magnetic moment. Magnetic dipoles. Magnetic effects of currents.

Magnetization curves and hysteresis loops.

2. Experimental methods

Field production. Measurement of field strength. Instruments for measuring Magnetization.

3. Types of magnetism

Diamagnetism and Paramagnetism. Ferromagnetism. Antiferromagnetic. Ferrimagnetism.

4. Magnetic domains

Domain wall structure. Domain wall motion. Magnetization by rotation. Effect of plastic deformation.

5. Magnetic anisotropy

Anisotropy in cubic crystals. Anisotropy in hexagonal crystals. Shape anisotropy.

6. Nanostructured Magnetic materials Amorphous magnets. Single domain versus multidomain behavior. Coercivity of fine particles. Superparamagnetic. Magnetic thin films.

7. Types of magnetic materials

Soft magnetic materials. Applications to electrical machines. Amorphous and nanocrystalline soft magnetic materials. Hard magnetic materials and their applications.

8. Magnetic materials in bioengineering Magnetic materials in targeted disease treatment, immunoassay, magnetic resonance imaging.

9. Magnetic materials for energy applications

Soft magnetic materials for energy generation and conservation. Hard magnetic materials for electrical machines. Magnetocaloric materials and systems.

10. Magnetic materials for information storage

Longitudinal magnetic recording. Perpendicular magnetic recording. Magneto-optic recording. Spin electronics.

11. Magnetic materials for transducers Magnet-polymer composites for sensing, actuation and self-healing. Materials design and selection aspects of magnet-polymer composites for bioengineering and structural health monitoring.