MSE4714: SPECIAL TOPICS IN MATERIALS SCIENCE AND ENGINEERING I

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Special Topics in Materials Science and Engineering I

Subject Code
MSE - Materials Science and Engineering
Course Number
4714

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
AP2102/MSE2102 Introduction to Materials Engineering
AP3109/MSE3109 Kinetic Processes in Engineering Materials
AP3113/MSE3113 Polymer Engineering

Equivalent Courses
AP4714 Special Topics in Materials Science and Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

This course will provide students with state-of-the-art knowledge on the properties, applications and recent development of selected advanced functional materials.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize and understand the concepts of smart and functional materials.	10	x		
2	Relate the novel combinations of properties found in various advanced materials	20			
3	Select the proper characterization techniques and materials synthesis in preparing nanomaterials, selected functional materials and devices.	20		x	
4	Apply the above knowledge to explicit advanced functional nanomaterials in selected applications.	20			x
5	Understand recent developments in selected advanced functional materials through special topics, which may vary from year to year.	30		x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Present basic theories, concepts and examples of smart and functional materials	1, 2, 3, 5	26/13
2	Tutorials	Provide practical examples of applications of smart and functional materials	3, 4, 5	6/12
3	Laboratory	Practical demonstration of synthesis and application of smart materials.	3, 4	6/2

4	Students' presentations	The students need to propose a new application for a chosen smart material and present it to the class	3, 4	6/12

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Mid-Term test	1, 2, 5	20	
2	Laboratory Reports	3, 4	20	
3	Presentation	3, 4	10	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task

1. Midterm Test

Criterion

Understand the concept of smart and functional materials, their fabrication techniques and the basic physical principles behind them.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not reaching marginal level

Assessment Task

2. Lab Report

Criterion
Synthesis of smart nanomaterials and systems. Use of the fabricated smart materials in selected applications.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
3. Presentation

Criterion
Creativity. Novel application of a selected smart or functional material.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Part III Other Information

Keyword Syllabus

- Instruction to Smart and Functional Materials:
  Challenges in the science and technology of advanced materials – areas of applications. Concept of smart materials, smart structures and adaptronics systems.
- Materials synthesis and microstructure:
  Overview of the materials synthesis techniques. Importance of the relationship between the microstructure on nanoscale and the functional properties.
- Properties of active materials and their assessment:
  Optical properties (optical bandgap engineering, nonlinear optical effects). Electrical properties (piezoelectric effect). Thermo-mechanical properties (shape memory and phase change alloys). Magnetic properties (magnetoresistance and magnetostrictive effect).

- Applications:
  Sensors (temperature, strain, stress, magnetic field, electrical field, mechanical quantities, adaptive structures). Actuators (piezo-actuators for advanced microscopy and sonar communications, magnetostrictive-actuators for solid-state speakers). Automotive (valve position, torque sensors for active steering, pedal positions, velocity, acceleration). Energy (solar cells, solar absorbers, piezoelectric energy harvesting). Biomedical (functionalized nanoparticles for cancer detection and treatment, shape-memory alloys for dentistry, bone repair and cardiovascular stents, wear-free switches for peace-makers). Electronics and data storage (rewritable CDs and DVDs, magnetic hard disk technology, non-volatile memories for aerospace applications). Smart glasses (thermo-chromic and photo-chromic and electro-chromic materials).
- Acceptance of new materials and systems in industry:
  Process and materials optimization. Economic models. Standardization. Future perspectives

Reading List

Compulsory Readings

	Title
1	Mel Schwartz, Smart Materials, CRC Press, Boca Raton, 2009
2	A.K. Tyagi, Functional materials: preparation, processing and applications. Edited by S. Banerjee

Additional Readings

	Title
1	Mel Schwartz, Smart Materials, CRC Press, Boca Raton, 2009
2	A.K. Tyagi, Functional materials: preparation, processing and applications. Edited by S. Banerjee