City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester B 2017 / 2018

Part I Course Overview

Course Title:	**Smart and Functional Materials for Advanced Students**
Course Code:	**AP6177**
Course Duration:	**One Semester**
Credit Units:	**3**
Level:	**P6**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**AP8177 Smart and Functional Materials for Advanced Students**

Part II Course Details

1. Abstract

New nanostructured active materials are being developed thanks to the advances in the fabrication technologies and to the understanding of frequently non-equilibrium conditions during their synthesis. They are now basis of numerous 21st century engineering solutions related to the control of environment, for energy management, for biotechnology, for integrated electronics, for aerospace, and for many others.

This course will provide the students with the state-of-the-art knowledge on smart materials and smart systems, as well as the techniques used to functionalize common materials.

Particular emphasis will be placed on the application of these materials in the industry. Examples of advanced practical applications will include smart sensors, smart actuators, energy conversion devices, advanced materials for electronics and data storage, etc.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Understand the concepts of functional material, smart material and smart system.	10%			
2.	Master the techniques for the synthesis of functional and smart materials.	20%		√	
3.	Select smart materials for specific engineering applications	20%			
4	Judge the appropriate application of smart materials with respect to the feasibility of their fabrication and implementation, and to the economic aspects	20%	√		
5	Innovatively apply the above knowledge to selected applications, particularly electronics, data storage, sensing and automation.	30%			√
		100%			

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 self-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.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
1	Lectures	√	√	√	√	√		26 hrs/13 wks
2	Tutorials			√	√			4 hrs / 4 wks
3	Laboratory		√	√				6 hrs / 2 wks
4	Group project and presentation			√		√		6 hrs / 6 wks

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 50 %								
Laboratory reports		√	√				15%	
Group project and presentation			√	√	√		15%	
Mid-term Test	√	√	√				20%	
Examination: 50% (duration: 2 hrs)								
							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Laboratory reports	Understanding and explaining methodology. Ability to identify experimental problems. Ability to find solutions to problem occurred.	High	Significant	Moderate	Basic	Not reaching marginal level
2. Mid-Term test	Understanding concepts of smart materials, their synthesis and characterization techniques and applications.	High	Significant	Moderate	Basic	Not reaching marginal level
3. Group project and presentation	Ability to select an application. Ability to explain how the selected smart system works.	High	Significant	Moderate	Basic	Not reaching marginal level
4. Examination	Ability to explain the fundamental principle behind selected smart materials. Ability to explain the working principle of selected smart systems within the framework of a specific application.	High	Significant	Moderate	Basic	Not reaching marginal level

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

- 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).
- Acceptance of new materials and systems in industry:
  Process and materials optimization. Economic models. Standardization. Future perspectives

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

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

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Advanced functional materials: a perspective from theory and experiment. Edited by Biplab Sanyal, Olle Eriksson