Hong Kong Baptist University
Faculty of Science – Department of Physics

Title (Units): PHYS 4047 ADVANCED FUNCTIONAL MATERIALS (3, 3, 1)

Course Aims: This course aims to provide a broad base on structures and properties of advanced materials and their applications. Topics cover structures, properties and functionality of materials including metals, ceramics, polymers, magnetic materials and carbon-based nanomaterials.

Pre-requisite: Year 4 standing or consent of instructor

Course Reviewed by: Dr. Zhifeng Huang and Prof. Kok-wai Cheah

Course Intended Learning Outcomes (CILOs):

No.	Upon successful completion of this course, students should be able to:
1.	Describe structures of materials and structural effect on mechanical, magnetic, electronic, thermal and optical properties.
2.	Compare and contrast the physics of materials such as metals, ceramics, polymers, magnetic materials, and low-dimension carbon nanomaterials.
3.	Appraise the applications and functionality of advanced materials.

Teaching & Learning Activities (TLAs)

CILOs	TLAs will include the following:
1-3	Students will learn from lectures on the concepts and related issues of the topics outlined in the course content.
1-3	Emphasis is placed on the structural effect on diverse properties of advanced materials and their applications.
1-3	By doing assignment problems and quizzes, students can study the physics of advanced materials.
1-3	Students will be grouped to select a project topic related to current development of advanced materials. Using the knowledge taught in this course, they will study the structures, properties and applications of the selected materials. Oral presentation and report will be required to fulfill the course project.

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Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Remarks
1	Continuous Assessment (assignments and quizzes)	25%	1-3	Assignments and quizzes are designed to measure how well the students have learned the basic principles and applications of various advanced materials.
2	Course projects	25%	1-3	Oral presentation and report are graded based on students' understanding on the structures, properties and applications of the studied materials.
3	Final Examination	50%	1-3	Final Examination is designed to see how far students have achieved their intended learning outcomes. Questions will primarily be analysis and skills based to assess the student's versatility in answering problems in topics taught in this course.

Learning Outcomes and Weighting:

Content	LO No.	Teaching (in hours)
I. Principle Properties of Materials	1	4
II. Metals	1-3	7
III. Ceramics	1-3	6
IV. Polymers	1-3	6
V. Magnetic materials	1-3	6
VI. Carbon-based nanomaterials	1-3	7

Textbook: None

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References:

1. James A. Newell, Essentials of Modern Materials Science and Engineering, John Wiley, 2009.
2. Gabor L. Hornyak, Harry F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience & Nanotechnology, CRC Press, 2009.
3. William D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 2007.
4. Wolfram Herqert, Arthur Ernst, Markus Dane, Computational Materials Science: From Basic Principles to Material Properties, Springer-Verlag Berlin Heidelberg, 2010.
5. J. C. Anderson, Keith D. Leaver, Rees D. Rawlings, Patrick S. Leevers, Materials Science for Engineers, Chapman and Hall, 2003.
6. M. G. Kanatzides, S. D.Mahanti, T. P. Hogan, edit: Chemistry, Physics and Materials Science of Thermalelectric Materials, Kluwer Academic/Plenum Publisher, N. Y. 2003

Course Content in Outline:

	Topic	**Hours**
I.	Principle Properties of Materials	4
	A. Atomic structure	
	B. Atomic bonding in solids	
	C. Defects and impurities	
II.	Metals	7
	A. Crystal structures	
	B. Mechanical properties	
	C. Thermal properties	
	D. Metallic alloys	
III.	Ceramics	6
	A. Crystal structures	
	B. Silicate ceramics	
	C. Mechanical properties	
	D. Applications	

IV.	Polymers	6
	A. Molecular structures	
	B. Copolymers	
	C. Polymer crystals	
	D. Defects in polymers	
V.	Magnetic Materials	6
	A. Diamagnetism and paramagnetism	
	B. Ferromagnetism	
	C. Antiferromagnetism and ferrimagnetism	
	D. Magnetic storage	
	E. Superconductivity	
VI.	Carbon-based nanomaterials	7
	A. Types and bonding of carbon materials	
	B. Fullerenes	
	C. Carbon nanotubes	
	D. Graphene	