Hong Kong Baptist University
Faculty of Science – Department of Physics

Title (Units): **PHYS 3025 PHYSICS AND TECHNOLOGY OF ENERGY CONVERSION (3,3,1)**

Course Aims: This course provides a solid foundation of energy conversion technology which is the key to renewable energy science. The processes include the conversion of Thermal, Mechanical and Chemical energy into electricity.

Pre-requisite: PHYS 2005 Heat and Motion or consent of instructor

Course Reviewed by: Prof. Shu-kong So and Dr. Mau-hing Chan

Course Intended Learning Outcomes (CILOs):

No.	Upon successful completion of this course, students should be able to:
1	Establish a broad knowledge base in thermal energy conversion from thermodynamic principles, thermal conductivity, to system implementation and operation; and the principles of chemical energy conversion into electricity by batteries and fuel cells.
2	Examine three basic thermal sources, solar, geothermal and waste heat, and energy conversion schemes including both the direct (internal combustion engine, Stirling engine and turbine) and indirect (focused mirror array, solar pond and ocean thermal energy conversion) processes
3	Describe the principle of advanced devices including: thermal electric devices, thermionic devices and alkali metal thermal energy conversion (AMTEC)
4	Describe the basic concept of three direct mechanical to electrical energy conversion devices, namely, magneto-hydrodynamics (MHD), electric generators and piezoelectric devices, and their applications in wind, ocean wave and hydroelectric energy conversion.
5	Recognize the source of parasitic mechanical energy appeared as random motion in our daily life and the schemes to capture them and analyze the power spectrum of such energy source by Fast Fourier Transformation.

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Teaching & Learning Activities (TLAs)

CILOs	TLAs will include the following:
1-5	Lectures will highlight the physical principle of various energy conversion processes. The lecture materials will be heavy in physics contents which are the extension of fundamental physics courses covered in lower division classes.
2, 3, 4, 5	Extensive list of examples will be used to illustrate these topics with substantial technology contents.
5	Lectures will be supplemented by demonstration with 3-axis accelerometer to measure random motion. Students will be taught to carry out power spectrum analysis with Fast Fourier Transformation.
2-5	Case studies will be used to aid the analysis

Assessment Methods (AMs):

No.	Assessment Methods	Weighting	CILOs to be addressed	Remarks
1	Semester test, tutorial assignments and Continuous Assessment	50%	1-5	Test and assignments are designed to guide the learning process of students on how to express known facts to equations. From the known data the students can then learn the basic skills in problem solving.
2	Final Examination	50%	1-5	Final Examination questions are 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 solving problems that can be used in a wide range of problems.

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Learning Outcomes and Weighting:

Content	**CILO No.**	**Teaching (in hours)**
I. Fundamental principles of energy conversion	1-5	10
II. Thermal energy conversion	1-3	10
III. Mechanical energy conversion	4, 5	10
IV. Chemical energy conversion	1	6

Textbook:

- John Twidell and Tony Weir: *Renewable Energy Resources,* (Taylor and Francis Press, 2006)
- Aldo Vieira da Rosa: *Fundamentals of Renewable Energy Processes,* (Academic Press, 2009)

References:

- Vaughn Nelson: *Wind Energy, Renewable Energy and Environment* (CRC Press, 2009)
- Mukund R. Patel: *Wind and Solar Power Systems* (CRC Press, 1999)
- Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese: *Renewable Energy, Technology, Economics and Environment,* (Springer-Verlag, 2007)

Course Content in Outline:

	Topic	**Hours**
I.	Fundamental principles of energy conversion	10
	A. Thermodynamics of energy conversion	
	B. Thermal conductivity and heat pipe technology	
	C. Basic fluid dynamics	
	D. Electrochemistry related to batteries and fuel cells	
II.	Thermal energy conversion	
	A. Thermal energy sources	
	B. Direct thermal energy conversion system and heat engines	10
	C. Indirect thermal energy conversion systems	
	D. Advance thermal energy conversion devices	

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III.	Mechanical energy conversion	10
	A. Basic fluid dynamics of turbines	
	B. Natural mechanical energy resources	
	C. Energy conversion from random motion	
IV	Chemical energy conservation	6
	A. The science and technology of batteries	
	B. The science and technology of fuel cells	