SCHOOL OF APPLIED PHYSICS

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Introduction

The School of Applied Physics is constantly venturing into research and development (R&D) in selected fields and offering postgraduate programmes at the level of Masters and Doctor of Philosophy (PhD). Physics is a fundamental knowledge of modern technology. Postgraduate programmes at PhD level are offered by thesis while the Masters programmes are offered by thesis and coursework. The Masters programmes by thesis are supported by a few courses that will provide the candidates with essential knowledge before carrying out research. The Masters programmes by coursework require candidates to complete a short and focused research project. The Masters programmes (course work) are offered on full time mode.

Research Areas and Degrees Offered

The School of Applied Physics offer research in the field of Space Physics, Thin Films, Mathematical Physics, Physics Education, Medical Physics, Computational Physics, Nuclear Medicine, Solid State Ionics, Metallurgy, Corrosion, Advanced Carbon, Composite Materials, Magnetic Materials, Ceramics, High Temperature Superconductivity, Nanotechnology, Biomaterials, Bio-polymer Composites Technology, Polymer Technology, Pulp and Paper Technology, Renewable Energy, Solar Thermal Technology, Photovoltaic Technology, Non-destructive Testing, Radiological Impact Assessment, NORM-Contaminated Industrial Waste, Waste Analysis and Treatment, Radiation Shielding Modeling, Radiation Processing, Nanomaterials Synthesis and Application, Small-angle Scattering Technique, Glycolipids and Biosurfactants, Soil Remediation, Materials Modification using Radiation, Nuclear Technique in Environmental Pollution Research, Biological Dosimetry, Nuclear Safety and Security, Nuclear Technique in Food and Agriculture and Industrial Safety Management.

Degrees offered are Doctor of Philosophy & Master of Science as follows:

- Doctor of Philosophy (Physics)
- Doctor of Philosophy (Materials Science)
- Doctor of Philosophy (Nuclear Science)
- Doctor of Philosophy (Industrial Safety Management)

a) Master by thesis

- Master of Science (Physics)
- Master of Science (Materials Science)
- Master of Science (Nuclear Science)

b) Master by coursework

- Master of Science (Applied Physics)
- Master of Science (Energy Technology)
- Master of Science (Radiation and Nuclear Safety)

c) Master by coursework (Executive)

- Master of Science (Industrial Safety Management)

Entry Requirements

Candidates applying for the postgraduate programmes must have the following qualifications:

Doctor of Philosophy Programme (Physics, Material Science and Nuclear Science)

a) A Master degree from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications or related experience which are recognized as equivalent to a Master degree in Science by the Senate; or
c) Currently pursuing in a Master programme at the Universiti Kebangsaan Malaysia and being recommended by the Graduate Studies Committee and the relevant Faculty for conversion to the Doctor of Philosophy programme; or
d) A First Class Honours Degree or equivalent to a Cumulative Grade Point Average (CGPA) not less than 3.67 from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or

Doctor of Philosophy (Industrial Safety Management)

This programme is a continuation of the Post-graduate Diploma in Industrial Safety Management and the Master in Industrial Sagety Management. Candidates wishing to apply for the above program must fullfilled the following requirement:-

a) A Master degree in Industrial Safety Management from UKM or degree recognized by the Senate; or
b) Other qualification equivalent to a Master Degree in Science and other qualifications or experience recognized by the Senate; or
c) Presently following a Master programme at UKM and certified by the Graduate Studies Committee to change the status to a Doctor of Philosophy with permission of the Faculty.

Master of Science Programme (Applied Physics)

a) Bachelor degree in Physics or courses related to physics, with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications equivalent to bachelor degree in physics or relevant experience approved by the Senate.

Master of Science Programme (Physics, Energy Technology, Material Science and Nuclear Science)

a) Bachelor degree in Science with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications equivalent to Bachelor degree or relevant experience approved by the Senate.

Master of Science (Radiation and Nuclear Safety)

a) Bachelor degree in Science with good cumulative grade point average (CGPA) or any other university approved by the Senate;
b) Post Graduate Diploma in Radiation Protection with a CGPA 3.0 or above or its equivalent approved by the Senate; or
c) Othe qualifications of the same level as a Bachelor in Science or experience approved by the Senate;

Master of Science (Industrial Safety Management) – Executive

a) Bachelors degree with a Cumulative Grade Point Average (CGPA) of 2.7 or above in the fields of Science, Technology or Engineering from UKM or its equivalent approved by the Senate; or
b) Graduate Diploma in Industrial Safety Management from UKM with a CGPA of 3.0 or above

Structure of Programme

Doctor of Philosophy
All candidates of this programme are required to register course STPD6014 Research Methodology and register for the thesis for each semester until completion of the academic programme. Students are required to schedule meetings with their supervisor or postgradute committee for no less than 40 hours per semester for full time students and 20 hours per semester for part-time students.

Master of Science

Thesis
All candidates of this programme have to register and pass 10 credit hours and register for the thesis for each semester until completion of the academic programme.

The required 10 credit hours of courses should be made up of 4 credit hours of core courses and 6 credit hours of electives, respectively. The core courses are those offered by the faculty and school of study. The elective courses are courses offered by the school of study and candidates can choose from any available elective courses offered.

Candidates are required to schedule meetings with their supervisor or postgradute committee for no less than 26 hours per semester for full time students and 13 hours per semester for part time candidates.

Course Work
Candidates for Master of Science (Energy Technology) programme have to register and pass 42 credit hours course including 10 credit hours for Research Project. Candidates for Master of Science (Applied Physics) programme have to register and pass 40 credits hour course including 10 credit hours for Research Project.

Candidates for Master of Science (Radiation and Nuclear Safety) programme have to register and pass 44 credit hours of courses including Research Project. Units for Research Project are 8 credit hours. For the Master of Science (Industrial Safety Management) offered in executive mode, candidates must register and pass 40 notional credits, which include 10 credits for Research Project.

DOCTOR OF PHILOSOPHY (PHYSICS)

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent
PEO3: Who are able to apply knowledge of Physics in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the physics knowledge up to Phylosofical level.
PO2: Technical competence in materials science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in physics.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.

PO8: Who understand issues and the need for scientific ethics.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

DOCTOR OF PHILOSOPHY (MATERIALS SCIENCE)

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent.
PEO3: Who are able to apply knowledge of Materials Science in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the Materials Science knowledge in the Phylosofical level.
PO2: Technical competence in materials science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in Materials Science.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.
PO8: Who understand issues and the need for scientific ethics.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

DOCTOR OF PHILOSOPHY (NUCLEAR SCIENCE)

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent.
PEO3: Who are able to apply knowledge of Nuclear Science in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the Nuclear Science knowledge up to Philosophical level.
PO2: Technical competence in nuclear science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in nuclear science.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.

PO6. With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.
PO8: Who understand issues and the need for scientific ethic.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

DOCTOR OF PHILOSOPHY (INDUSTRIAL SAFETY MANAGEMENT)

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: To produce a graduate who has mastered the current industrial safety management knowledge holistically.
PEO2: To produce a graduate who is competent in soft skills.
PEO3: To produce a graduate who has the awareness towards environment.
PEO4: To produce a graduate who is able to contribute to other disciplines in order to give impetus to the national and global development.

PROGRAMME OUTCOME (PO)

PO1: Mastery in industrial safety management knowledge which can contribute to other disciplines.
PO2: Having in-depth technical competence in industrial safety management and able to undertake problem identification, formulation and solution.
PO3: Be able to practice and disseminate industrial safety management knowledge effectively.
PO4: Competence to conduct research & development in industrial safety management and possess high creativity and innovative skills.
PO5: Possess moral, ethical and professional values and environmentally concern.
PO6: Capable to work skillfully and communicate effectively.
PO7: Possess entrepreneurship and leadership skills effectively.
PO8: Willingness to explore and adopt long life learning.
PO9: Possess high confidence, self-esteem and open minded.

MASTER OF SCIENCE (PHYSICS)

Introduction

The Master of Science (Physics) programme by thesis is offered to candidates who intend to further their studies in the field of physics on full time or part time. The programme offered will allow candidates to carry out research individually. Candidates are also exposed to courses which will equip them with in depth understanding and knowledge in their research field.

Entry Requirements

Candidates applying for the postgraduate courses must have the following qualifications:

a) A Bachelor degree in Science with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications or relevant experience approved by the Senate.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent.
PEO3: Who are able to apply knowledge of physical science in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the physical science knowledge.
PO2: Technical competence in physical science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in physical science.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.
PO8: Who understand issues and the need for scientific ethics.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

Programme Structure

Thesis

All candidates have to pass 10 credit hours courses and research findings should be written as a thesis.

The required 10 credit hours of courses should be made up of 4 credit hours of faculty core course and 6 credit hours of school courses. Candidates can choose from any courses offered by the school.

Candidates are required to schedule meetings with their supervisor or postgraduate committee for not less than 26 hours per semester for full time students and 13 hours per semester for part time students.

Core course should be register is STPD6014 Research Methodology and any 6 credit hours of courses offered in the Master of Science (Applied Physics) or Master of Science (Energy Technology) with the approval of the student's supervisor.

MASTER OF SCIENCE (MATERIALS SCIENCE)

Introduction

The Master of Science (Materials Science) programme by thesis is offered to candidates who intend to further their studies as full time or part time students. The programme offered will allow the candidates to carry out research individually and require them to pass several courses. Candidates are required to take those courses that will equip them with in depth understanding and knowledge in their research field.

Entry Requirements

Candidates applying for the Master of Science (Materials Science) by thesis and by coursework must have the following qualifications:

a) A Bachelor degree in Science with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications or relevant experience approved by the Senate.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent.
PEO3: Who are able to apply knowledge of materials science in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the materials science knowledge.
PO2: Technical competence in materials science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in materials science.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.
PO8: Who understand issues and the need for scientific ethics.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

Programme Structure

Thesis

All candidates have to pass 10 credit hours courses and research findings should be written as a thesis.

The required 10 credit hours of courses should be made up of 4 credit hours of faculty core course and 6 credit hours of school courses. Candidates can choose from any courses offered by the school.

Candidates are required to schedule meetings with their supervisor or postgraduate committee for not less than 26 hours per semester for full time students and 13 hours per semester for part time students.

Core course should be register is STPD6014 Research Methodology and 3 credit hours of courses offered in the Master of Science (Applied Physics) and 3 credit hours from any of the Master of Science offered in the faculty with the approval of the student's supervisor.

MASTER OF SCIENCE (NUCLEAR SCIENCE)

Introduction

The Master of Science (Nuclear Science) programme by thesis is offered to candidates who intend to further their studies as full time or part time students. The programme offered will allow the candidates to carry out research individually and require them to pass several courses. Candidates are required to take those courses that will equip them with in depth understanding and knowledge in their research field.

Entry Requirements

Candidates applying for the Master of Science (Nuclear Science) programme by thesis must have the following qualifications:

a) A Bachelor degree in Science with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other relevant professional/vocational qualifications or relevant experience approved by the Senate.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: With outstanding moral and character.
PEO2: Who are able and competent.
PEO3: Who are able to apply knowledge of nuclear science in a scientific manner.
PEO4: Who profess in their professions and commensurate with the demand of development of their time.

PROGRAMME OUTCOME (PO)

PO1: Mastery the nuclear science knowledge.
PO2: Technical competence in nuclear science with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.
PO3: Ability to identify and solve problems critically, creatively and innovatively in nuclear science.
PO4: Ability to work effectively as an individual and as a team.
PO5: With the ability to communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: With the ability to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Who have high motivation for engaging in research and life-long learning.
PO8: Who understand issues and the need for scientific ethics.
PO9: Who have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment.

Programme Structure

Thesis

All candidates have to pass 10 credit hours courses and research findings should be written as a thesis.

The required 10 credit hours of courses should be made up of 4 credits hours of faculty core course and 6 credit hours of school courses. Candidates can choose from any courses offered by the school.

Candidates are required to schedule meetings with their supervisor or postgraduate committee for not less than 26 hours per semester for full time students and 13 hours per semester for part time students.

Core course should be register is STPD6014 Research Methodology and 6 credit hours from any of the Master of Science Programmes offered by the faculty with the approval of the student's supervisor.

MASTER OF SCIENCE (ENERGY TECHNOLOGY)

Introduction

Energy is the most important resource for the development of a country. The dependence on conventional energy such as oil, gas and coal as the main source of energy will have a detrimental effect on the development of a country if the supplies are disrupted. Utilization of conventional energy also contributes to environmental pollution. Alternative sources of energy should be explored and their utilization should be stepped up.

Some of the sources of alternative energy being considered actively at the international level are solar energy, wind energy, biomass, biogas and hydro. They are not only excellent sources of alternative energy but also easy to access, clean and recyclable. Initiatives to promote renewable energy, energy efficiency and energy demand management are actively being implemented.

Energy technology must be improved in order to fulfill the increasing demand in energy. In order to plan and execute the development of the energy technology effectively and economically, a number of experts in the field of alternative energy is needed.

This programme is multidisciplinary and is offered at the School of Applied Physics, with teaching staff from the Faculty of Science and Technology as well as the Faculty of Engineering.

Entry Requirements

Candidates applying for the Master of Science Programme (Energy Technology) programme by thesis must have the following qualifications:

a) Bachelor of Science (B.Sc.) or Bachelor of Engineering (B.Eng.) with honours from UKM or other universities approved by the Senate, or
b) Other qualifications that are equivalent to a B.Sc. or B. Eng. or relevant experience approved by the Senate.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: Are with outstanding moral and character.
PEO2: Are able and competent.
PEO3: Are able to apply scientific knowledge of energy technology in a scientific manner.
PEO4: Profess in their professions and commensurate with the demand of development in their time.

PROGRAMME OUTCOME (PO)

PO1: Master the advanced knowlege of Energy Technologi design, conduct experiments, analyze and interpret data.
PO2: Demonstrate technical competence in Energy Technology with the ability to use scientific methods to design, conduct experiments, analyze and interpret data.

PO3: Are able to identify and solve problems critically, creatively and innovatively Energy Technology.
PO4: Are able to work effectively as an individual and as a team.
PO5: Are able to communicate verbally and in writing with the scientific community, and the public at both local and international level
PO6: Are able to acquire, manage and apply the state of the art information systematically and effectively.
PO7: Have high motivation for engaging in research and life-long learning.
PO8: Understand issues and the need for scientific ethics
PO9: Have acquired basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment

Programme Structure

This is a coursework programme offered either full time or part time. Candidates are required to pass thirty (30) credit hours of core courses and twelve (12) credit hours of elective courses.

COMPONEN	SEMESTER 1		SEMESTER 2	
	CODE / NAME OF COURSE	**CREDIT HOURS**	**CODE / NAME OF COURSE**	**CREDIT HOURS**
University Compulsory Courses	-			
Faculty Core Courses	STPD6014/ Research Methodology	4		
Programme Core Courses (Total = 18 units)	STSF6013/ Energy Conversions Materials STSF6073/ Energy Economics and Management STSF6083/Instrumentation and Control for Energy	3 3 3	STSF6023/ Conceptual Design of Energy Systems STSF6033/ Energy Philosophy, Issues and Policy STSF6063/ Environment and The Energy	3 3 3
Elective Courses (Choose 4 courses – Total 12 units)	STSP6333/Thin Film Technology STSF6133/Photovoltaic Technology STSF6173/Solar Thermal Technology	3 3 3	STSP6763/Management and Assessment Technology STSP6343/Nanotechnology STSP6383/Sensor and system	3 3 3
Thesis / dissertation / research project	STSF6972/Research Project I	2	STSF6986/Research Project II	6
Total credit hours		21		21

Courses Offered

Core courses

STPD6014 Research Methodology
STSF6013 Energy Conversions Materials
STSF6023 Conceptual Design of Energy Systems
STSF6033 Energy Philosophy, Issues and Policy
STSF6063 Environment and the Energy

STSF6073 Energy Economics and Management
STSF6083 Instrumentation and Control for Energy
STSF6972 Research Project I
STSF6986 Research Project II

Elective courses

STSF6113 Battery Technology
STSF6133 Photovoltaic Technology
STSF6173 Solar Thermal Technology

Course Contents

STSF6013 Energy Conversions Materials

The course begins with an introduction to materials and devices for energy conversion and on the basic solid state physics. In addition, materials classification and material properties such as electrical, thermal, optical and mechanical properties will be discussed. Next, the characteristics of the materials for energy conversion will also be touched. This course will also introduce students to the basic concepts and working principles of energy conversion devices such as nanogenerator, organic light emitting diodes, solar cells and energy storage. Finally, the latest technology in energy conversion will be reviewed.

References

Kathy Lu, 2014, *Materials in Energy Conversion, Harvesting, and Storage*, New York, John Wiley & Sons.

C. C. Sorrell, Sunao Sugihara, Janusz Nowotny, 2005, *Materials for Energy Conversion Devices*, Woodhead Pub

Yong X. Gan, 2010, *Advanced Materials and Systems for Energy Conversion: Fundamentals and Applications*, Nova Science Pub Inc.

Ashutosh Tiwari and Sergiy Valyukh, 2014, *Advanced Energy Materials*, New York, John Wiley & Sons.

Granqvist, C.G. , 1991., *Materials Science for Solar Energy Conversion Systems*., Elsevier Science.

STSF6023 Conceptual Design of Energy Systems

This course discusses topics on design concept of energy systems. Energy systems for electricity generation using petroleum, natural gas, coal, hydro, solar, wind, geothermal, tidal and wave will be studied. Modification on existing systems and the effect on system performance will be elaborated. The use of HOMER for hybrid system optimization will be conducted.

References

Cengel, Y.A. & Boles, M.A. 2000. *Thermodynamics- An Engineering Approach.* New York: McGraw Hill.

Cengel, Y.A. 1998. *Heat Transfer: A Practical Approach.* New York: McGraw Hill.

Denno, K. 1988. *Power System Design and Applications for Alternative Energy Sources.* New York: Prentice Hall.

El-Wakil, M.M. 1984. *Power Plant Technology.* New York: McGraw Hill.

HOMER. 2008. *User Manual.* Denver: National Renewable Energy Laboratory.

Stoecker, W.F. 1989. *Design of Thermal Systems.* 3rd. Ed. New York: McGraw Hill.

STSF6033 Energy Philosophy, Issues and Policy

This course discusses the historical development in the usage of energy, current issues related to energy and the philosophical bases of energy policies worldwide and in Malaysia. The 1970s saw

tremendous upheavals in the oil industry, which started with the formation of OPEC and the IEA. The oil industry underwent a revolution, when the oil producing countries began to take control of their resources. This forced the oil companies and the oil producing countries to adjust to more equal relationship. The oil crises lead most countries to develop their energy policies. Some representative energy policies such as that of USA, UK, Germany, Russia, China and Malaysia will be analyzed. The student is encouraged to analyze his own country's energy policy.

References

Cassedy, E. S. 2000. *Prospects for sustainable energy: a critical assessment.* Cambridge: Cambridge University Press.

Flavin, C. & Lenssen, N. 1994. *Power surge: guide to the coming energy revolution.* New York: W. W. Norton & Company.

Malaysia, Ministry of Energy, Telecommunications and Posts, 1992. *An Introduction to Malaysia's Energy Sector,* Kuala Lumpur.

Taher, AbdulHady Hassan, 1992. *Energy, a global outlook: the case for effective international cooperation.* Oxford: Pergamon Press.

World Energy Council, 1993. *Energy for tomorrow's world*. New York: Kogan Page Ltd.

OECD, 1995. *The history of the International Energy Agency, 1974-1994: IEA the first 20 years.*

OECD, 2003. *Energy to 2050: Scenarios for a sustainable future.*

IEA, OECD, OPEC, World Bank Joint Report Prepared for Submission to the G-20 Summit Meeting Toronto (Canada) , 26-27 June 2010.

STSF6063 Energy and The Environment

This course discusses topics on the world energy resources, fossil energy resources, nonrenewable energy and renewable energy resources, effects of fossil energy on environment, effects from NOx, COx and SOx emission, air and water pollution, acid rain as well as effect on eco system and global warming.

References

Ristinen R. A & . Kraushaar J. P. 2006. Energy and the Environment. New Jersey. John Wiley & Sons.

Hinrichs R. A ,& Kleinbach M. H.Energy: 2012. Its Use and the Environment. Boston. Brooks/Cole.

Martenson C. 2011. The Crash Course: The Unsustainable Future Of Our Economy, Energy, And Environment Hardcover. New Jersey. John Wiley & Sons.

Boeker E. & van Grondelle R. 2011. Environmental Physics: Sustainable Energy and Climate Change. New Jersey. John Wiley & Sons.

World Energy Council. 1993. Energy For Tommorrow's World. New York: Kogan Page Ltd.

World Energy Council. 1993. *Energy For Tommorrow's World.* New York: Kogan Page Ltd.

STSF6073 Energy Economics and Management

This course discusses topics on role of energy managers, energy audit, the identification of energy conservation opportunities and establishing effective energy management propgramme in a facility. The energy conservation opportunities can be indentify in electrical systems, process steam, air conditioning system, and lighting. Energy economic decision making will be applied to find alternatives for energy efficient system and financing of the new system.

References

Doty S. & Turner W. C. 2012. *Energy Management Handbook*. 8th Edition. Lilburn. The Fairmont Press, Inc.

Bhattacharyya S. C. 2011. *Energy Economics: Concepts, Issues, Markets and Governance*. London. Springer-Verlag

Capehart B. L., Turner W. C. & Kennedy W. J. 2011. *Guide to Energy Management*. 7th Edition. Lilburn. The Fairmont Press, Inc.

Kreith F, Goswami DY. Energy Management and Conservation Handbook. Boca Raton: CRC Press Taylor & Francis Group; 2008.

Banks F. E. 2000. *Energy Economics: A Modern Introduction*. New York. Springer Science+Bussiness Media

STSF6083 Instrumentation and Control for Energy

This course focuses on the design, construction and monitoring of a photovoltaic system. The main items covered include assessment of solar resources, solar modules, batteries, charge controller, inverter, control instrumentation and wiring, system integration, sensors and data acquisition system. System design, operation and monitoring, power distribution and control. Analysis of photovoltaic system performance.

References

Carr, J. J. 1988. *Elements of electronic instrumentation and measurements.* Englewood Cliffs, New Jersey: Prentice-Hall.

Diedenderfer, A. J. & Holton, B. E. 1994. *Principles of electronic instrumentation. (*3rd Ed.) New York: Harcourt/Academic Press.

Endecon Engineering, 2001. *A guide to photovoltaic (PV) system design and installation,* Sacramento, Ca.: California Energy Commission.

Gottlieb, I. R. 1993. *Electronic power control.* New York: McGraww-Hill.

Roberts, S. 1991. *Solar Electricity.* Englewood Cliffs: Prentice-Hall.

Enrique Acha, Vassilios Agelidis, Olimpo Anaya, TJE Miller 2002. *Power Electronic Control in Electrical Systems,* Newnes Power Engineering Series.

California Energy Commission 2011. A Guide to Photovoltaic System Design, http://www.energy.ca.gov/reports/2001-09-04_500-01-020.PDF

STSF6113 Battery Technology

In the first part of the course, types and basic properties of batteries will be discussed. Types of materials used in batteries developments will also be discussed. The second part will discuss the various techniques used in the batteries production various characterization techniques and tests used in the study of batteries. The last part of the course will explore the potential applications of the ionic and mixed ionic-electronic conducting materials in related devices and challenges that need to be attended.

References

Minami, T., Tatsumisago, M., Wakihara, M., Iwakura, C, Kohjiya, S., Tanaka, I. (pnyt.), 2005. *Solid State Ionics for Batteries*. Tokyo: Springer.

Lvovich, V.F., 2012. *Impedance Spectroscopy: Applications to Electrochemical and Dielectric Phenomena*. New Jersey: John Wiley & Sons.

Zhang, Z., Zhang, S. (pnyt.), 2015. *Rechargeable Batteries: Materials, Technologies and New Trends*. Cham, Switzerland: Springer.

Yuan, X., Liu, H., Zhang, J. (pnyt.), 2011. *Lithium-Ion Batteries: Advanced Materials and Technologies*. Florida: CRC Press.

Scrosati, B., Garche, J., Tillmetz, W. (pnyt.), 2015. *Advances in Battery Technologies for Electric Vehicles*. Cambridge: Woodhead Publishing.

Pop, V., Bergveld, H.J., Danilov, D., Regtien, P.P.L., Notten, P.H.L. 2008. *Battery Management Systems: Accurate State-of-Charge Indication for Battery-Powered Applications* (Vol. 9). New York: Springer.

Ogumi, Z., Dudney, N.J., Narayanan, S.R. (pnyt.), 2010. Battery/Energy Technology (General) - 216th ECS Meeting, (Issue 35). New Jersey: The Electrochemical Society.

STSF6133 Photovoltaic Technology

Generators and photovoltaic components: semiconductors material, characteristics of solar cell, solar panels, electric energy power stations from solar radiation. Battery and energy storage system. Solar

water pump technology, street lighting technology, indoors photovoltaic technology, photovoltaic technology for remote applications, photovoltaic telecommunication system, grid connected photovoltaic system, Building Integrated Photovoltaic System (BIPV). Photovoltaic Thermal (PV/T) collector system, applications of PV/T. The future of photovoltaic technology.

References

Kamaruzzaman Sopian, Mohd. Yusof Hj. Othman dan Baharudin (Pyt), 2000. *Renewable Energy: Resource and Applications in Malaysia* Bangi, Pusat Tenaga Malaysia.

Mohd. Yusof Hj. Othman dan Kamaruzzaman Sopian, 2002. *Teknologi Tenaga Suria*. Bangi, Penerbit UKM.

Mertens, K., 2014. *Photovoltaics: Fundamental, Technology and Practices*. West Sussex, UK, John Wiley & Sons Ltd.

Mohd Nazari Abu Bakar & Mohd Yusof Hj Othman, 2013. *Teknologi Pengumpul Suria Fotovolta-Terma*. Bangi, Penerbit UKM.

Wieder S., 1996. *Pengenalan Tenaga Suria untuk Ahli Sains dan Jurutera*. Kuala Lumpur, Dewan Bahasa & Pustaka

STSF6173 Solar Thermal Technology

In this course we will start with consideration of solar energy itself, including radiation fundamentals, measurement, and data processing required to predict solar irradiance with respect to time, location and orientation. Then we will examine the characteristics of various components in solar thermal systems (with particular emphasis on flat plat and concentrating collectors, heat exchangers, and thermal storage) to understand how they work and how their performance is influenced by their design. This will lead us to an examination of systems and system performance, including system design, predicted energy savings and economics. The focus will be on low temperature applications for solar hot water, space heating and water distillation.

References

Duffie, J.A & Beckman, W.A. *Solar Thermal Engineering of Thermal Processes*. 4th Edition. 2013. New York: John Wiley.

Felix A. Peuser, Karl-Heinz Remmers, Martin Schnauss. 2013. *Solar Thermal Systems: Successful Planning and Construction*. Berlin: Routledge

Deutsche Gesellshaft für Sonnenenergie. 2010. *Planning and Installing - Solar Thermal Systems: A guide for installers, architects and engin*eers, Second edition. London: earthscan

David Thorpe. 2013. Solar Technology: The Earthscan Expert Guide to Using Solar Energy for Heating, Cooling and Electricity. Berlin: Routledge

S. Sukhatme, J Nayak. 2013. *Solar Energy - Principles of Thermal Collection and Storage*. Third edition. McGraw Hill Education.

STSF6972 Research Project I

This course is aimed at training students to study specific topics through extensive readings and guided research. Students are required to prepare a literature survey of a chosen topic.

References

Mohd Yusof Hj Othman (ed). 2014. *Kaedah Penyelidikan Saintifik*. Kuala Lumpur: Dewan Bahasa dan Pustaka.

Palya, W. L. 2000. *Research Methods Lecture Note*. 5th Ed. Jacksonville. Albama

O'Handley R. C. 2000. *Modern Magnetic Materials*. New York: John Wiley & Sons

Greenfiled, T. 2001. *Research Methods for Postgraduates*. 2nd Ed. London: An Arnold Publication.

Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Bangi: Graduate Studies Centre, UKM

STSF6986 Research Project II

This course offers student the opportunity to do research on specific topics of interest under the supervision of one or a group of supervisors. The research can be conducted experimentally or analytically. Students are required to prepare a dissertation report on the research and will be asked to defend the results orally.

References

Mohd Yusof Hj Othman (ed). 2014. *Kaedah Penyelidikan Saintifik*. Kuala Lumpur: Dewan Bahasa dan Pustaka.

Palya, W. L. 2000. *Research Methods Lecture Note*. 5th Ed. Jacksonville. Albama

O'Handley R. C. 2000. *Modern Magnetic Materials*. New York: John Wiley & Sons

Greenfiled, T. 2001. *Research Methods for Postgraduates*. 2nd Ed. London: An Arnold Publication.

Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Bangi: Graduate Studies Centre, UKM

MASTER OF SCIENCE (APPLIED PHYSICS)

Introduction

Applied Physics is a field that studies of both classical and modern physics and combines it with topics on most recent applications of these principles. It is the science which has made possible the design and operation of many everyday components including computer chips, lasers, solar collectors, medical equipment, sensors and mobile phones.

The curriculum of the graduate program in Applied Physics consists of core courses and elective courses. The core courses are designed to provide students with the fundamentals of physics and skills in computing, mathematics and instrumentations. The core courses also include the management and evaluation of technology and communications skills. The electives which can be taken from a range of topics are designed so that students can develop their own course of study according to their interests. A research project is required to be undertaken throughout the duration to provide the experience of doing independent research under the supervision of the school academics. The research project focuses on applying physics to scientific and technological problems. The research project starts by conducting extensive literature review, followed by performing experiments and preparing a dissertation.

This programme is designed to develop professionals with broad capabilities appropriate for careers in technical research or advanced graduate study. It provides valuable graduate training and research project experience sought after by industry, government and R & D organizations.

The interests and expertise of school academics include the following areas of specialization: material science, solid-state physics, the physics of thin films devices, the physics of medical radiations and theoretical/computational physics.

Entry Requirements

a) Bachelors degree in Physics or courses related to physics, with good cumulative grade point average (CGPA) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or

b) Other relevant professional/vocational qualifications equivalent to bachelors degree in physics or relevant experience approved by the Senate.

Students with degree in courses related to physics must officially register for selected prerequisite courses offer at the undergraduate level. The course will be scheduled as an audit.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: Able with outstanding moral and character.
PEO2: Able and competent.
PEO3: Able to apply scientific knowledge of applied physics and in a scientific manner.
PEO4: Able in their professions and commensurate with the demand of development in their time.

PROGRAMME OUTCOME (PO)

PO1: Master the advanced knowlege of Applied Physics design, conduct experiments, analyses and interpret data.
PO2: Demonstrate technical competence in Applied Physics with the ability to use scientific methods to design, conduct experiments, analyses and interpret data.
PO3: Identify and solve problems critically, creatively and innovatively in Applied Physics.
PO4: Work effectively as an individual and as a team.
PO5: Communicate verbally and in writing with the scientific community, and the public at both local and international level.
PO6: Acquire, manage and apply the state of the art information systematically and effectively.
PO7: Engage actively in research and life-long learning.
PO8: Understand issues and the need for scientific ethics.
PO9: Apply basic knowledge in entrepreneurship and management with the aim to develop and commercialize research findings for a sustainable community and environment

Programme Structure

This is a coursework programme offered only for full time candicates. Candidates for this programme are required to pass 40 credit hours course, comprising 28 credit hours of core courses and 12 credit hours selective courses.

COMPONEN	SEMESTER 1		SEMESTER 2	
	CODE / NAME OF COURSE	CREDIT HOURS	CODE / NAME OF COURSE	CREDIT HOURS
University Compulsory Courses	-			
Faculty Core Courses	STPD6014/ Research Methodology	4		
Programme Core Courses (Total = 16 units)	STSP6014 /Method of Instrumentation Analysis	4	STSP6023/ Applied Quantum Mechanics	3
	STSP6033/ Advanced Mathematical Methods	3	STSP6043/ Advanced Computational Physics	3
	STSP6053/ Advanced Electromagnetism	3		
Elective Courses (Choose 4 courses – Total 12 units)	STSP6113/ Physical Metallurgy	3	STSP6123/ Advanced Polymer	3
	STSP6133/ Biomaterials	3	STSP6143/ Materials Design and Modeling	3
	STSP6153/ Materials and Composites Technology	3	STSP6163/ Corrosion Control and Monitoring	3
	STSP6173/ Science and Technology of Agro-Materials	3	STSP6323/ Superconductor and Magnetism	3
	STSP6513/ Diagnostic Radiological Physics	3	STSP6383/ Sensor and Systems	3
	STSP6533/ Medical Nuclear Physics	3	STSP6523/ Radiation Therapy Physics	3
	STSP6753/ Physics of Modern Imaging	3	STSP6723/ Introduction to Non-linear Dynamics Theory	3
	STSP6773/ Modification of Wood	3		
	STSP6313/ Semiconductor Physics and Devices	3	STSP6743/ Space Physics	3
			STSP6343/ Nanotechnology	3
	STSP6333/ Thin-Film Technology	3	STSP6763/ Management and Assessment of Technology	3
	STSP6373/ Applied Optics and Optoelectronics	3		

	STSP6733/ Fluctuations in Physical System STSP6713/ Statistical Mechanics	3 3	(Choose 3 Elective course)	
Thesis / dissertation / research project	STSP6972/ Research Project I	2	STSP6986/ Research Project II	6
Total credit hours		19		21

Courses Offered

Core courses

STPD6014 Research Methodology
STSP6014 Method of Instrumentation Analysis
STSP6023 Applied Quantum Mechanics
STSP6033 Advanced Mathematical Methods
STSP6043 Advanced Computational Physics
STSP6053 Advanced Electromagnetism
STSP6972 Research Project I
STSP6986 Research Project II

Elective courses

STSP6113 Physical Metallurgy
STSP6123 Advanced Polymer
STSP6133 Biomaterials
STSP6143 Materials Design and Modeling
STSP6153 Materials and Composites Technology
STSP6163 Corrosion Control and Monitoring
STSP6173 Science and Agro materials Technology
STSP6313 Semiconductor Physics and Devices
STSP6323 Superconductor and Magnetism
STSP6333 Thin-Film Technology
STSP6343 Nanotechnology
STSP6373 Applied Optics and Optoelectronics
STSP6383 Sensor and System
STSP6513 Physics of Diagnostic Radiology
STSP6523 Physics of Radiation Therapy
STSP6533 Medical Nuclear Physics
STSP6713 Statistical Mechanics
STSP6723 Introduction to Non-linear Dynamics Theory
STSP6733 Fluctuations in Physical Systems
STSP6743 Space Physics
STSP6753 Physics of Modern Imaging
STSP6773 Modification of Wood
STSP6793 Nuclear Techniques in Industry & Research

Course Contents

STSP6014 Method of Instrumentation Analysis

This course discusses several techniques and designs of experiments regarding the characterization methods in research and industry. Topics to be discussed are analysis of structure and microstructure which include compositional analysis, investigation of structure and morphology of surfaces by using X-ray fluorescence (XRF), X-ray diffraction (XRD) and electron microscopy techniques. A number of techniques for material characterization such as X-ray photoemission spectroscopy (XPS), Fourier transform infra-red (FTIR) spectroscopy, Raman spectroscopy, impedance technique, thermal analysis and mechanical analysis are also discussed. Methods of sample preparation for the respective technique of analysis are also introduced.

References

Cullity, B.D. & Stock, S.R. 2001. *Elements of X-ray diffraction*. 3rd edition. New Jersey: Prentice Hall.

Goodhew, P.J. Humphreys, J. & Beanland, R. 2000. *Electron microscopy and analysis*. 3rd edition. London: Taylor and Francis.

Haines, P. J. 2012. *Thermal methods of analysis: principles, application and problems. Springer Science and Business Media*.

Larkin, P.J. 2011. *Infrared and Raman spectroscopy: principles and spectral interpretation*. Amsterdam: Elsevier.

Smith, G. C. 2013. *Surface analysis by electron spectroscopy: measurement and interpretation. Springer Science and Business Media*.

STSP6023 Applied Quantum Mechanics

(Prerequisite : Quantum mechanics at undergraduate level)

This course is designed to be the third in the sequence of required graduate quantum mechanics courses. Prerequisites are the successful completion of STSF2223 and STSF3213 or their equivalents. This course builds upon the core formalism, concepts, and techniques of quantum mechanics. Solutions to Schrodinger's equation for various potentials. Application of quantum mechanics in metal physics, semiconductors (e.g quantum wells), low dimensional materials and superconductors. Interpretation of Quantum Mechanics and foundational problems : Copenhagen Interpretation, Consistent Histories, Parallel Universe, De Broglie-Bohm and Qubism. Entanglement theory, decoherence theory and quantum teleportation. Application of decoherence theory and entanglement in photonics, spintronics, quantum biology and nanotechnology.

References

J.J. Sakurai,1985. *Modern quantum mechanics***,** (Benjamin/Cummings, Menlo Park CA)

A.F.J Levi , 2006. Applied Quantum Mechanics , Cambridge Univ.Press

Di Giulini , E.Joos, C.Kiefer , J.Kopsch , I O Stomatescu and H.D Zeh , 1996. Decoherence and the appearance of a classical world in quantum theory , Springer Pub.

I.Bengtsson and K.Zyzkowski , 2006. Geometry of Quantum States : an introduction to quantum entanglement , Cambridge Univ.Press.

J.L Basdevant and J.Dalibard , 2000. The Quantum Mechanic Solver – how to apply quantum theory to modern physics , Springer Pub.

STSP6033 Advanced Mathematical Methods

(Prerequisite Programming language (C/C++, Fortran or Matlab) or Numerical Method or computational physics)

This course is designed to introduce first-year graduate student to mathematical concepts and tools needed for research, and more advanced math courses. The subject exposes the students to the level of mathematical rigor required for doctoral research. Some of the topics to be covered are vector fields, deformed Cartesian system and curved coordinates. Topics in complex variable, surface Riemann, Cauchy theorem, Taylor and Laurent series, residue theorem and conformal mapping are covered.

Green's function and tensor application in physics are discussed and includes Cartesian and kronecker delta and Levita-Civita tensor, tensor derivatives and covariant and contravariant representations and first and second order Christoffel symbols.

References

Ablowitz, M.J. & Fokas, A.S. 1998. Complex Variable. Cambrige University Press.
Nazrul Islam , 2006. Tensors and their Applications , New Age Publication (Delhi)
Hayek, S.I., 2001.Advanced Mathematical Methods in Science and Engineering. Marcel Dekker.
Riley, R.F., Habson, M.P.& Bence, S.J., 1997. Mathematical Methods for Physics and Engineering. Cambrige: Cambridge Univ. Press.
Spiegel , M, Spellmann , D., Lipschutz, S., Schiller, S., 2009. Complex Variables , Schaums Series , Mc Graw Hill , USA

STSP6043 Advanced Computational Physics

(Prerequisite: Computational Physics at undergraduate level)

This course aims to expose the student to a through grounding in the use of computers to solve physics problems and common computational techniques used in physics: modeling, simulation, numerical techniques and visualization. The course is therefore delivered as formal class lectures and programming exercises in the computer laboratory. Main topics to be covered would be specific problems in Solid States, Material Science, Quantum Mechanics and Astro-physics. The computational techniques will use both Dos/Windows and open source (LINUX) platforms. The course will also introduce the use cluster computational techniques.

References

Gibbs, W R. Gibbs. 1999 . *Computation in Modern Physics*. 2nd ed. World Scientific, Singapore.
Thissen, J.M. 1999. *Computational Physics.* Cambridge: Cambridge Univ. Press.
Landau, R.H & Paez, M.J. 1997. *Computational Physics – Problem Solving with Computers*. New York; John Wiley and Sons.
Pang, T 1997 *An Introduction to Computational Physics*. Cambridge University Press.
Press, W.H, Teukolsky, S.A., Vetterling, W.T. & Flannery, B.P. 1992. *Numerical Recipes in C or Fortran: The Art of Scientific Computing.* 2nd ed. Cambridge: Cambridge Univ. Press.
Programming Language allowed: C/C++, MATLAB or Forrtran 70/90.

STSP6053 Advanced Electromagnetism

(Prerequisite: Electromagnetism at undergraduate level)

This course will discuss the methodology of information processing using electromagnetic waves, electromagnetic materials and electromagnetic devices. This course is conducted by classroom lectures and the main topics cover: Basic electromagnetic theory, special relativity in electromagnetism, Maxwell equations, tensor analysis and pseudo-tensor in electromagnetic materials, retarded potentials, Interaction of electromagnetic waves with charged particles, Lagrange formulation, Gauge transformation, monopole and multiples, application of electromagnetism in solid state, classical optics, radiation theory and telecommunication.

References

Vanderlinde, J. 2004. *Classical Electromagnetic Theory*, 2nd Ed. New York: Kluwer Acad. Publ.
Jackson, J.D. 1998. *Classical Electrodynamics*, 3rd Ed. New York: John Wiley & Sons.
Griffiths, D.J. 2012. *Introduction to electrodynamics*, 4th Ed. Addison-Wesley.
Jian-Ming Jin. 2015. *Theory and Computation of Electromagnetic Fields*, 2nd Ed. Wiley-IEEE Press.
Julius Adams Stratton. 2015. *Electromagnetic Theory*. CreateSpace Independent Publishing Platform.

STSP6113 Physical Metallurgy

This course discusses topics on solidification, heat treatment, advanced alloys and metal processing. Thermodynamic and kinetic of solidification is discussed. Types and techniques of heat and mechanical treatments and their effects on metal defects and properties are also discussed. This course also introduces advanced alloys i.e. light alloys, high temperature alloys, shape memory alloys, biomaterial alloys and super plastic alloys. Metal and alloy processing methods and their relation to properties and application of the metal and alloy products is also highlighted.

References

Fredriksson, H. & Akerlind, U., 2012. *Solidification and Crystallization Processing in Metals and Alloys.* Chichester, UK, John Wiley & Sons Ltd.

Hosford, W.F. & Caddell, R.M., 2014. *Metal Forming: Mechanics and Metallurgy. New York, Cambridge University Press*.

Laughlin, D.E. & Hono, K., 2014. *Physical Metallurgy.* Amsterdam, Elsevier.

Mandal, S.K., 2014. S*teel Metallurgy: Properties, Spesifications and Applications*. New Delhi, McGraw Hill Education (India) Private Ltd.

Smallman, R.E. & Ngan, A.H.W., 2014. *Modern Physical Metallurgy, 8th Edition.* Oxford, UK, Elsevier.

STSP6123 Advanced Polymer

The course will cover an introduction of polymer, properties and processing technique of various types of polymeric materials. The main topic of discussion will focus on types of advanced polymer, properties, applications, its specialty, advantages and processing methods. The details of the discussion will be based on the latest category of advanced polymer.

References

Cheremisinof, N.P (pnyt), 1998, Advanced polymer processing operations, New Jersey, Noyes Publ.

Ray S.S, 2013, Environmentally Friendly Polymer Nanocomposites: Types, Processing and Properties, Woodhead Publishing Limited.

Fried J.R 1995, Polymer science and technology, New Jersey, Prentice Hall

Shonaike G.O and Advani S.G, 2010, Advanced Polymeric Materials, CRC Press

Montgomery T.S, 2012, *Introduction to polymer rheology*, Wiley

STSP6133 Biomaterials

The course will discuss various biomaterials which can be substituted as biological materials of the human body. The topics of discussion will cover polymeric materials as biomaterials, their characteristics, applications and processing technique. The discussion will continue with bio-ceramic which will be focusing on basic composites of ZrO_2, Al_2O_3 and other oxides system in the human body. The course will also discuss hydroxyl apatite, its properties, preparation technique and latest applications of the materials. The applications of biomaterials will be also highlighted on materials used in dental and orthopedic implants. The final parts of the course will discuss the mechanical and biological suitability tests.

References

Agrawal, C.M., Ong, J.L., Appleford, M.R., Gopinath Mani. 2014. *Intoduction to Biomaterials: Basic Theory with Engineering Applications.* New York: Cambridge University Press.

Lary L Hench. 2013. *An Introduction to Bioceramics. 2nd Ed.*, London: Imperial College Press.

Micheal N. 2015. *Biopolymers: Application and Trends. 1st Ed*., United State: William Andrew.

Niklaus Baltzer, Thierry Copponnex. 2013. *Precious Metals for Biomedical Applications. 1st Ed.*, United Kingdom: Woodhead Publishing.

Qizhi Chen, George Thouas. 2014. *Biomaterials: A Basic Introduction. 1st Ed*., United State: CRC Press.

Silver, F.H. & Christiansen, D.L. 1999. *Biomaterials science and biocompatibility.* London: Springer Verlag.

STSP6143 Materials Design and Modeling

The course will start with an introduction on modeling and simulation technique for materials. The topics will cover modeling equations which include thermodynamic aspects in metal phase modeling, examples of application of modeling in materials processing and materials design, crystal defect, radiation damage and fracture mechanics. The standard and code of practices in materials design will also be discussed.

References

Rao C.L, Deshpande A.P, 2014, Modelling of Engineering Materials, Wiley

Park, J.B. & Lakes, R.S. 1992. *Biomaterials: an introduction.* 2nd Ed., New York: Plenum Publ.

Farag M.M, 1999, Material selection for engineering design, Prentice Hall

Ashby M.F, Johnson K, 2010, Material and designs, Elsevier.

Sanjay K.N, Pratap C.P, 2012, *Fundamental of plastics mould design*, Tata McGraw Hill Education Private Limited.

STSP6153 Materials and Composites Technology

An introduction of this course will highlight on types of composites, properties, manufacturing process and its applications. The main topics of discussion will cover types of fibers and matrix, polymer matrix composites (PMC), metal matrix composites (MMC) and ceramic matrix composites (CMC). The analysis of micromechanics, micromechanics and interface will also be discussed. The course will also highlight the latest technology of composites manufacturing and fabrications.

References

Chawla, K.K. 2013. *Composite materials: Science and Engineering.*3rd• Ed., London: Springer.
Gibson, R.F. 1994. *Principles of composite materials mechanics.* New York: McGraw-Hill.
Gutoski, T.G. 1997. *Advanced composites manufacturing.* New York: John Wiley & Sons.
Hull, D. & Clyne, T.W. 1996. *An introduction to composite materials.* 2nd Ed., Cambridge: Cambridge University Press.
Metthews, F.L. & Rowlings, R.D. 1994. *Composite materials: engineering and science.* London: Chapman & Hall.

STSP6163 Corrosion Control and Monitoring

This course introduces corrosion control techniques, namely materials selection, alteration of environment, product design, coatings, and cathodic and anodic protection. The discussion on corrosion control techniques will cover principle and mechanism and also the related equipment. The suitability of corrosion control techniques over types of corrosion is also discussed. Corrosion monitoring techniques that will be discussed include non-destructive testing techniques, electrochemical techniques and nuclear techniques. The important of corrosion control and monitoring in terms of safety and economics are also discussed.

References

Cicek, V., 2013. *Cathodic Protection: Industrial Solution for Protecting Against Corrosion.* New York, John Wiley & Sons.
Lennon, G., 2015. *Advances in Corrosion Evaluation and Protection.* New York, NY Research Press.
Popov, N.B., 2015. *Corrosion Engineering: Principles and Solved Problems.* Amsterdam, Elsevier.
Sastri, V.S., 2015. *Challenges in Corrosion: Costs, Causes, Consequences, and Control.* New Jersey, John Wiley & Sons.
Yang, L, 2008. *Techniques for Corrosion Monitoring.* Cambridge, UK, Woodhead Publishing Ltd.

STSP6173 Science and Technology for Agrobased Materials

The course will cover the raw materials, lignocelluloses based from agriculture industry (agro industry) available in Malaysia such as rice, kenaf, sugar cane, coconut, oil palm, pineapple, banana and forest products from hardwood and non woody and bamboo. The course will emphasis on the preparation of lignocelluloses materials from these raw materials. The course will discuss the manufacturing process of pulp, paper, medium density board (MDF), oriental stand board (OSB), particle board, plywood, wood plastic board and cement board. Chemical modification on fibred will be emphasised in order to improve the fibred chemical interaction. The chemistry and types of adhesive and coating, surface modification and bonding will be discussed.

References

Sarani Zakaria 2013. Lignoselulosa: Sumber keterbaharuan untuk produk biopolimer mesra alam. Penerbit UKM (UKM Press). Bangi.

Wirasak Smitthipong, Rungsima Chollakup, Michel Nardin. 2014. Bio-Based Composites for High-Performance Materials: From Strategy to Industrial Application 1st Edition, New York. CRC Press Taylor and Francis Group,

Susheel Kalia, Kaith B.S. 2011. Cellulose Fibre: Bio-Nano Polymer Composite Green Chemistry and Technology. Springer. New York

Jean-Luc Wert, Jean P Mercier, Olivier Bedue. 2010. Cellulose Science and Technology: Fundamental Sciences Chemistry. EPFL Press. New York.

Susheel Kalia (Editor), B. S. Kaith (Editor), Inderjeet Kaur (EditorCellulose Fibers: Bio- and Nano-Polymer Composites: Green Chemistry and Technology 2011, Springer, New York

J.G Smook. 2003. Handbook for pulp and paper technologist. Tappi Press. Atlanta. USA

Hemingway, RW., Conner, A.H and Brahan, SJ (Pnyt). 1987. Adhesives from renewable resources. Washington: American Chemical Society

STSP6313 Physics of Semiconductor and Devices

This course is aimed towards understanding the theories of the semiconductor materials and semiconductor devices. The concept of electron and hole in energy band. Intrinsic and extrinsic semiconductors The properties and processes in semiconductors. Measurements of quantities related to semiconductor, such as conductivity, effective mass, mobility and diffusion. Semiconductor devices - devices based on conductivity and junctions. Preparation and fabrication of semiconductor materials and devices, which includes purification, single crystal growth, doping techniques and lithography.

References

Burhanuddin Yeop Majlis. 2000. *Teknologi Fabrikasi Litar Bersepadu.* Bangi: Penerbit Universiti Kebangsaan Malaysia.

Cooke, M.J. 1990. *Semiconductor Devices.* New York: Prentice-Hall.

Neamen, D.A. 1997. *Semiconductor Physics and Devices:Basic Principles.* New York: McGraww-Hill.

Sze, S. M. 1981. *Physics of Semiconductor Devices*. New York: John Wiley & Sons.

Tyagi, M.S. 1999. *Semiconductor Materials and Devices.* New York: John Wiley & Sons.

STSP6323 Magnetism and Superconductivity

This course covers two topics; first on magnetism and the second on superconductivity. Topics on magnetism include magnetic materials, diamagnetic, paramagnet, ferromagnet, ferromagnetic, antiferromagnet, domain theory and magnetization processes, measurements, preparation methods and applications. Topic on superconductivity include basic phenomenon, superconducting materials, type-I and Type-II superconductors, phase transition, Ginzburg-landau theory, Abrikosov vortex, BCS theory, energy gap, isotope effect, Josephson tunneling, SQUIDs, high-temperature superconductors, anisotropy, structure, phase diagram and applications of superconductors.

References

Cullity, B. D. Graham C. D. 2009. *Introduction to Magnetic Materials*. New Jersey: John Wiley & Sons.

Nicola A. Spaldin. 2011. *Magnetic Materials: Fundamentals and Applications*. Cambridge. Cambridge University Press

O'Handley R. C. 2000. *Modern Magnetic Materials*. New York: John Wiley & Sons

Morrish, A. H. 2001. *Physical Principles of Magnetism*. New York: John Wiley.

Abd. Shukor, R. 2004. *Introduction to superconductivity in metals alloys and Cuprates*. Tanjung Malim: UPSI Publishers.

Roslan Abd. Shukor. 1996. *Superkonduktor konvensional dan suhu tinggi*. Kuala Lumpur: Dewan Bahasa dan Pustaka.

STSP6333 Thin-Film Technology

This course is divided into 3 parts which are related to the theoretical and technical aspects of preparation, application and characterization of thin films. The course begins with the introduction to physics of thin films which cover topics such as formation process and structure of thin films. Next, the technique of preparation such as evaporation, sputtering and spin coating will be discussed. The thin films characterization covers the thickness of the film, physical structure, surface morphology, electronic structure and chemical composition. Other properties such as mechanical, electrical, optical and magnetic properties will also be deliberated followed by discussion on various applications of thin films either in passive or active form including devices. Finally each student must present a seminar on the topics related to recent development in thin films.

References

Fray, H. and Khan, H.R., 2015, Handbook Thin Films Technology, Heidelberg, Springer.

Heavens, O.S., 2011, Optical Properties of Thin Solid Films, New York, Dover Publications

Harsha, K.S.S., 2006, Principles of Vapor Deposition of Thin Films, New York, Elsevier

Friedbacher, G & Bubert, H., (pnyt) 2011, Surface and Thin Film Analysis: A Compendium of Principles, Instrumentation, and Applications, Germany, Wiley-VCH

Wagendristel, A & Wang, Y.1994. An Introduction to Physics and Technology of Thin Films. Singapore: World Scientific.

STSP6343 Nanotechnology

This course discusses topics on electronic, magnetic, mechanical and optical changes that occur when bulk materials of nonconductors, semiconductors and metals becomes nanosized. Methods to reduce bulk to nanosize materials both by top down and bottom up approach is discussed exemplified by physical methods (laser ablation, ball mill, plasma deposition) and chemical methods (sol-gel, micelle and microemulsion templating, mechanochemistry and sonochemistry). Characterisation of nanomaterials by AFM (Atomic Force Microscopy), SNOM (Scanning near-field Optical microscopy), UV-Vis spectroscopy, TEM (Transmission electron microscopy), XPS (X-ray spectroscopy) and other techniques are discussed. Some thermodynamics aspects of nanomaterials are discussed especially its non-extensive aspects. The relationship between changes in nanomaterial properties due to environmental effects are related to applications in sensors and nanofluids. Students might be ask to present a seminar on recent findings in Nanotechnology.

References

Sulabha K.Kulkarni 2007. *Nanotechnology: Principles and Practices.* New Delhi: Capital Publishing Company.

H.S Nalwa, 2000. *Handbook of Nanostructured Materials and Nanotechnology Vol.1-5.* New York: Academic Press.

Colm Durkan , 2007. *Current at the Nanoscale*. Singapore: World Scientific.

Guozhong Cao, 2007. *Nanostructures and Nanomaterials*. Singapore: World Scientific.

Wolf E, 2015 *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience 3rd Edition*, Wiley VCH.

STSP6373 Applied Optics and Optoelectronics

This course exposes students to the applications of optics in various fields besides the theory and applications of optoelectronics. The course will range from basic wave optics to optoelectronics. The characteristics of optoelectronic materials, nonlinear optics and optoelectronic devices will be discussed. Topics on optical fibers will be discussed in depth embracing its uses in optical communication system and fiber optics sensors. Special topics on optical display as in LED, optical signal processing will be discussed.

References

Francombe, M.H. (pnyt.) 2000. *Thin Film. Vol 28: Frontiers of Thin Film Technology*. New York: Academic Press.

Emmanuel Rosencher and **Borge Vinter., 2002**. *Optoelectronic*s., Cambridge University Press.

Khare, R P., 2004., *Fiber Optics and Optoelectronics*., Oxford University Press.

Nalwa. H.S., 2001. *Handbook of Thin Films Materials*. Jild. 1-5. New York: Academic Press.

S. O. Kasap, 2006., *Principles of Electronic Materials and Devices*. 3nd Ed. McGraw-Hill.

S. O. Kasap, 2012., *Optoelectronics and Photonics: Principles and Practices*, 2nd Edition., Pearson Education Inc.

STSP6383 Sensors and Systems

Introduction, Classification of sensors and actuators, sensing and actuating strategies, general requirements for interfacing and actuation, sensing, transduction, actuation. Performance Characteristics of Sensors and Actuator, Optical sensors-Photodiodes, phototransistors and photo resistors based sensors, Photo multipliers, light-to-light detectors, Infrared sensors, Temperature Sensors-Thermoresistive sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Magnetic and Electromagnetic Sensors and Actuators, Mechanical Sensors-Accelerometers (capacitive, piezoelectric, piezoresistive, thermal), Force sensors (strain gauges, tactile sensors), Pressure sensors (semiconductor, piezoresistive, Acoustic Sensors and Actuators, Chemical Sensor-Electrochemical, Thermo-chemical, ChemFET, Gas, pH, Humidity, moisture and Optical -chemical, Radiation Sensors.

References

Dunn, P.F., 2011, Fundamentals of Sensors for Engineering and Science, Florida, CRC Press

Kalantar-zadeh, K. &Fry, B., Nanotechnology-Enabled Sensors, 2008, New York, Springer

Sinclair, I., 2000, Sensors and Transducers, London, Newnes

Brauer, J.R., 2014, Magnetic Actuators and Sensors, New Jersey, Wiley

Grundler, P., 2010, Chemical Sensors: An Introduction for Scientists and Engineers, Berlin, Springer-Verlag

Tiwari, A.and Demir.M.M, 2014, Advanced Sensor and Detection Materials, Massachusetts, Wiley

STSP6513 Physics of Diagnostic Radiology

This course exposes students to the applications of physics in diagnostic radiology. The topics discussed are diagnostic radiology, the generation of X-ray, physical basic of diagnostic radiology and exposure and protection of patients. In diagnostic radiology the topics that are discussed include primer radiological image, radiographic image, CT scan, mammography, exposure to patient, the risk in diagnostic radiology and selection of equipments. In the generation of X-ray, X-ray tube, interactions at target, X-ray spectrum, quality and intensity of X-ray, factors that affect the quality and intensity of X-ray are discussed. While in the topic of physical basic of diagnostic radiology, X-ray film and how it is processed, the characteristic of X-ray film, the effect of absorption of X-ray and radiographic image, effects and control of scattered radiation, radiographic exposure, diagnostic X-ray tube and its shield, and radioactive isotope in clinical medicine will be discussed. In the topic of exposure and protection of patients, the pattern of X-ray exposure, exposure limit, source of exposure, shielding of a place, shielding of personal and exposure from radioactive source will also be discussed.

References

Ball, J.L. & Moore, A.D., 1997, Essential Physics for Radiographers. Ed. Ke 2. Melbourne: Blackwell Scientific Publ.

Carter, P.H., 1984, An Introduction to Diagnostic Radiography. New York: Churchill Livingstone.

Dowsett, D.J., Kenny, P.A., Johnston, R.E. 1998. The Physics of Diagnostic Imaging. UK. Chapman & Hall Medical.

Hubbell, J.H. & Seltzer, S.M. 1995, Tables of x-ray mass attenuation coefficients and mass energy-absorption coefficients 1 keV to 20 MeV for elements Z=1 to 92 and 48 additional substances of Dosimetric Interest, National Institute of Standards and Technology, NISTIR 5632, Gaithersburg USA.

Sprawls, P. 1993. Physical Principles of Medical Imaging. Ed. Ke 2. Madison: Medical Physics Publ.

STSP6523 Physics of Radiation Therapy

This course gives exposure to the students pertaining to the application of physics in radiation therapy. The topics that are discussed are dosimetry, radiation measurement, X-ray and gamma-ray beam interaction with scattering medium, and external beam therapy machine. In dosimetry the topics that are discussed are radiation beam quantities, the two stage process of energy transfer, kerma and absorbed dose, exposure and determination of absorbed dose in phantom using ionisation chamber with exposure quantities. While under the topic of radiation measurement, different types of ionisation chamber, solid state detector, chemical dosimetry, thermolumiscence dosimetry, film dosimeter and calorimeter are discussed. In X-ray and gamma-ray beam interaction with scattering medium, tissue to air ratio, back-scattered factor, percentage depth dose, tissue to phamtom ratio, calculations of dose delivered to patient and to any point will be discussed. In the topic of external beam therapy machine, the topics that are discussed include superficial X-ray machine, internal X-ray therapy machine, linear accelator and Co-60. Lastly radiotherapy services in Malaysia will be explained too.

References

Easton, S. 2009. An Introduction to Radiography. Philadelphia. Churchill Livingstone Elsevier.

Johns, H.E. & Cunningham, J.R., 1983, The Physics of Radiology. Ed. Ke 4, Springfield: Charles C Thomas Publ.

Rajan, K.N.G.., 1992, Advanced Medical Radiation Dosimetry. New delhi: Prentice-Hall of India Private Limited.

Stanton, R. & Stinson, D., 1996, Applied Physics for Radiation Oncology. Wisconsin: Medical Physics Publ..

Williams, J.R. & Twaites, D.I., 1993, Radiotherapy Physics. New York: Oxford University Press.

STSP6533 Medical Nuclear Physics

This course exposes the students to the applications of physics in nuclear medicine. The topics that are discussed are nuclear medicine, measurement and instrumentations, and radiopharmaceutical. In nuclear medicine the topics that are discussed are imaging technique using radioactive tracer, absorbed dose from radionuclides in human body and acceptable dose in nuclear medicine. While in the topic measurement and instrumentation, the topics that are discussed include radioactivity measurement, Geiger counter, scintillation counting, gamma spectrometry, gas-filled and semiconductor detectors, sample and whole body counting, radioisotopes scanner, gamma camera and selection of operation parameters and instruments. In the topics of radiopharceutical, radiaoctive nuclide generation, radiopharmaceutical, laboratory facilities and its safety procedures in nuclear medicine department will be discussed.

References

Hobbie, R.K. 1988. Intermediate physics for medicine and biology. 2nd Ed., New York: John Wiley and Sons.

Parker, R.P., Smith, P.H.S. & Taylor, D.M. 1984. Basic Science of nuclear medicine. 2nd Ed., New York: Churchill and Livingstone.

Supian Bin Samat & Evans, C.J. 1992. Statistics and nuclear counting – theory, problems and solution. Serdang: Universiti Pertanian Malaysia Press.

Rachel, A., Powsner, M. & Powsner, E.R. 1998. Essentials of nuclear medicine physics. London: Blackwell Science Inc.

Williams, J., Allisy- Roberts, P. 2008. Farr's Physics for Medical Imaging. Philadelphia. Saunders Elsevier.

STSP6713 Statistical Mechanics

This course discusses topics on statistical ensembles (microcanonical, canonical ,grand canonical , and mixed ensemble), partition function and free energies for these ensembles and their use in deriving thermodynamic quantities. Mayer functions and some models of liquids using hypernetted chain equations. Fluctuation dissipation theorems. 2-d and 3-d Ising model. Phase transitions theory and their characterization using Ising models. Landau-Ginsburg models applied to magnetic , liquid crystals and solids. Superfluidity, superconductivity and Bose-Einstein condensate. Thermodynamics application in X-ray and light scattering and statistical mechanics of fluid membranes. Non-extensive thermodynamics (nanothermodynamics) in low dimensional materials.

References

A. Baracca, R. Livi, and S. Ruffio, *Statistical Mechanics: Foundations, Problems, Perspectives*,World Scientific (2002).

R. Bowley & M. Sanchez, Introductory Statistical Mechanics, second edition, Oxford University Press (2000).

D. A. R. Dalvit, J. Frastal, and I. D. Lawrie, *Problems in Statistical Mechanics*, IOP Press (2000).

A. M. Glazer and J. S. Wark, Statistical Mechanics: A Survival Guide, Oxford University Press (2002).

J.Woods Halley , 2007. Statistical Mechanics : From First principle to Macroscopic Phenomena , Cambridge Univ Press.

L. Peliti. Statistical Mechanics in a Nutshell. Princeton University Press. (2011)

STSP6723 Introduction to Nonlinear Dynamics Theory

This course introduces the theory of nonlinear dynamics in a number of physical and engineering systems. It starts with nonlinear systems, chaos, universality of chaos, and the dynamics of state space for one, two and three dimensions. We will also discuss iterated maps, quasi-periodicity, Hamiltonian systems and quantifying chaos. Specific concepts to be covered include the Lorenz model,

Feigenbaum number, self-similarity, scaling, Jacobian matrix, attractor, Poincare section, Lyapunov exponent, fractal dimension and correlation dimension.

References

Ott, E. 2002. *Chaos in Dynamical Systems*. 2 ed. Cambridge University Press, UK.

Hilborn, R. C. 2000. *Chaos and Nonlinear Dynamics: An Introduction for Scientists and Engineers*. 2 ed. Oxford University Press, UK.

Strogatz, S. H. 2001. *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering*. Colorado: Perseus Books.

McCauley, J. L. 1993. *Chaos, Dynamics and Fractals: An Algorithmic Approach to Deterministic Chaos.* Cambridge University Press, UK

STSP6733 Fluctuations in Physical Systems

This course introduces fluctuation theory in various physical systems, and their applications in solving physical problems. It starts with discussions on basic statistics and probability. Then we cover examples of fluctuations – thermal, electrical and chemical. Then we learn about advanced fluctuation theories – Nyquist theorem and its applications, fluctuation-dissipation theorem, diffusion process models and diffusion dynamical equations, quantum fluctuation, vacuum fluctuation, and stochastic mechanics as an alternative formulation for quantum mechanics.

References

Pecseli, H. L. 2000. *Fluctuations in Physical Systems*. Cambridge University Press, UK.

Doering, C. R., Kiss, L. B. & Shesinger, M. F. (pnyt). 1997. *Unsolved Problems of Noise in Physics, Biology, Electronic Technology and Information Technology*. Singapore: World Scientific.

Kogan, S. 1996. *Electronic Noises and Fluctuations in Solids*. Cambridge University Press, UK.

van der Ziel, A. 1986. *Noise in Solid State Devices and Circuits*. New York: John Wiley & Sons.

van Kampers, N. G. 1981. *Stochastic Processes in Physics and Chemistry*. Amsterdam: North-Holland.

STSP6743 Space Physics

In this course, students will deal with space plasmas – the fourth state of matter – that largely pervade space environments. Students will learn the different theories conceived and used to describe the behavior of plasmas, paying careful attention to electromagnetic properties that set plasmas uniquely apart from other states of matter. Students will apply these basic theories of plasma to investigate several astrophysical bodies and processes. Students will also be aware of the role of technology in monitoring and probing plasma environments and processes via satellites. The detection of rays and particles from space will also be discussed. Finally an overview of space law and policy will be provided in order to acquaint the students with the various geopolitical, legal and ethical issues concerning the proper use of space.

References

National Research Council, 2015. *Solar and Space Physics: A Science for a Technological Society.* Washington D. C.: The National Academies Press.

Harra L.K., Keith O Mason. 2004. *Space Science.* London: Imperial College Press

Kivelson, Margaret G. & Russel, Christopher C. 1995. *Introduction to Space Physics (Cambridge Atmospheric and Space Science Series).*Cambridge: Cambridge University Press.

Baumjohann W., Treumann R.A. 1996. *Basic space plasma physics*. London: Imperial College Press

Hale Bradt. 2004. Astronomy Methods: *A Physics Approach to Astronomical Observation.* Cambridge : Cambridge University Press

STSP6753 Physics of Modern Imaging

This course discusses the theories and physical concepts of modern imaging in different applied topics. It introduces two imaging waves, namely electromagnetic wave and sound wave (acoustic); and considers the wave and particle properties and the related quantum effects. The production,

focusing, detection and image construction will be discussed based on these properties. Then, we review the different optical instruments and their applications in the fields of astronomy, medicine, and industry and science. Finally, we introduce a number of digital image processing techniques for the acquired images.

References

Gonzalez, R. C. 1992. *Digital Image Processing*. 3rd Ed. New York: Addison-Wesley.
Jain, A.K.1998. Fundamentals of Digital Image Processing. New Jersey: Prentice Hall.
McLean, I. 1997. *Electronic Imaging in Astronomy: Detectors and Instrumentation*. Chichester, UK: John Wiley.
Sanchez, J. & Canton, M. P. 1999. *Space Image Processing*. New York: CRC Press.
Sprawls, P. 1993. *Physical Principles of Medical Imaging*. 2nd Ed. Madison: Medical Physics Publ.

STSP6773 Chemical Modification of Wood

The course will discussed on chemistry of lignocellulose-bioresource mainly with chemical constituent of lcellulose, lignin and hemicellulose. Cellulose chemistry which consists of cellulose I,II,III and IV will be highlighted. Chemical reaction of cellulose with main chemical reagent involve the reaction of hydroxyl group in cellulose with the chemical reagent involve which be focus on preparation of cellulose derivatives and regenerated cellulose. While lignin chemistry of lignin will show the differentiation between the HGS monomer from different species. Reaction of lignin with the suitable chemical for the preparation of adhesive and adhesion together with composite materials will be discussed. Hemicellulose which is polymer consist of various types of fine sugar monomer depending of different wood species. The discussion will cover the utilisation of these fine sugar into levulinic acid, methanol etc for bio fuel.

References

Eero Sjostrom. 1993. Wood Chemistry, Second Edition: Fundamentals and Applications. Academic Press Inc. New York.
Susheel Kalia, Kaith B.S. 2011. Cellulose Fibre: Bio-Nano Polymer Composite Green Chemistry and Technology. Springer. New York
Biplab Kr. Deka, Tanun Kr Maji. 2012. Development of Wood Polymer Nanocomposite: A Green Approach Based on Non Conventional Plant Material and Nanofillers. Lap Lambert Academic Publishing. New Delhi
Roger M. Rowell. 2012. Handbook of Wood Chemistry and Wood Composites, Second Edition. CRC Press Taylor and Francis Group. Boca Raton, Florida.
Jean-Luc Wert, Jean P Mercier, Olivier Bedue. 2010. Cellulose Science and Technology: Fundamental Sciences Chemistry. EPFL Press.
Thomas Q. Hu. 2013. Chemical Modification, Properties, and Usage of Lignin (preprint 1st edition 2002) Springer, New York
Sarani Zakaria 2013. Lignoselulosa: Sumber keterbaharuan untuk produk biopolimer mesra alam. Penerbit UKM (UKM Press). Bangi.
Ashok Pandey, Rainer Höfer, Mohammad Taherzadeh, Madhavan Nampoothiri, Christian Larroche. 2015. Industrial Biorefineries & White Biotechnology. Elsevier, New York.

STSP6972 Research Project I

This course is aimed at training students to study specific topics through extensive readings and guided research. Students are required to prepare a literature survey of a chosen topic.

References

Mohd Yusof Hj Othman (ed). 2014. *Kaedah Penyelidikan Saintifik*. Kuala Lumpur: Dewan Bahasa dan Pustaka.
Palya, W. L. 2000. *Research Methods Lecture Note*. 5th Ed. Jacksonville. Albama
O'Handley R. C. 2000. *Modern Magnetic Materials*. New York: John Wiley & Sons

Greenfiled, T. 2001. *Research Methods for Postgraduates*. 2nd Ed. London: An Arnold Publication.
Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Bangi: Graduate Studies Centre, UKM.

STSP6986 Research Project II

This course offers student the opportunity to do research on specific topics of interest under the supervision of one or a group of supervisors. The research can be conducted experimentally or analytically. Students are required to prepare a dissertation report on the research and will be asked to defend the results orally.

References

Mohd Yusof Hj Othman (ed). 2014. *Kaedah Penyelidikan Saintifik*. Kuala Lumpur: Dewan Bahasa dan Pustaka.
Palya, W. L. 2000. *Research Methods Lecture Note*. 5th Ed. Jacksonville. Albama
O'Handley R. C. 2000. *Modern Magnetic Materials*. New York: John Wiley & Sons
Greenfiled, T. 2001. *Research Methods for Postgraduates*. 2nd Ed. London: An Arnold Publication.
Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Bangi: Graduate Studies Centre, UKM

MASTER OF SCIENCE (RADIATION AND NUCLEAR SAFETY)

Introduction

This programme is based on continuous assessment of all courses given. For practical works, students are required to hand in laboratory reports. Seminars and Technical visits (even though not accounted) are compulsory. This program is offered full-time only and is only offered once in every study session.

Programme objectives

i. To prepare and to develop competent, skillful and professional human capital in the field of nuclear and radiation safety in line with rapid progress in radiation technology in the industrial sector, medicine and health in the world.
ii. To full fill a vision of academic excellence in the field of radiation and nuclear safety.
iii. To establish Malaysia as an educational hub of higher learning in the field of radiation and nuclear safety.

Entry Requirements

Candidates applying for the postgraduate programme must have the following qualifications:

a) Bachelor of Science with a good Cumulative Grade Point Average (CGPA) or any other university approved by the Senate;
   or
b) Post Graduate Diploma in Radiation Protection with a CGPA 3.0 or above or its equivalent approved by the Senate;
   or
c) Other qualifications of the same level as a Bachelor in Science or experience approved by the Senate;

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: To produce a graduate who has mastered the current radiation and nuclear safety knowledge holistically.
PEO2: To produce a graduate who is competent in soft skills.
PEO3: To produce a graduate who has the awareness towards environment.

PEO4: To produce a graduate who is able to contribute to other disciplines in order to give impetus to the national and global development.

PROGRAMME OUTCOME (PO)

PO1: Masters in radiation and nuclear safety knowledge which can contribute to other disciplines.
PO2: Having in-depth technical competence in radiation and nuclear safety and able to undertake problem identification, formulation and solution.
PO3: Be able to apply and disseminate radiation and nuclear safety knowledge effectively.
PO4: Competence to conduct research & development in radiation and nuclear safety and possess high creativity and innovative skills.
PO5: Possess moral, ethical and professional values and environmentally concern.
PO6: Capable to work skillfully and communicate effectively.
PO7: Possess entrepreneurship and leadership skills effectively.
PO8: Willingness to explore and adopt long life learning.
PO9: Possess high confidence, self-esteem and open minded.

Programme Structure

All candidates in this programme must following the curriculum structure which contains 44 credit hours. Students must pass all 44 credit hours to be awarded the Master and are subjected to Master and PhD for Graduate Studies Act (see Graduate Studies Act and Table for Graduate Studies Act published by Graduate Studies Center, UKM).

KOMPONEN	SEMESTER 1		SEMESTER 2	
	CODE / NAME OF COURSE	CREDIT HOURS	CODE / NAME OF COURSE	CREDIT HOURS
University Compulsory Courses	-			
Faculty Core Courses	STPD6014 Research Methodology	4		
Programme Core Courses (Total = 32 units)	STSN6012/ Interaction of Radiation with Matters	2	STSN6052 Intervention for Protection of the Public	2
	STSN6132/ Regulatory Controls	2		
	STSN6212/ Quantities and Measurements	2	STSN6142 Environmental Engineering of Nuclear Power	2
	STSN6312/ Effects of Ionizing Radiation on Biological Systems	2		
			STSN6222 Internal Exposure Assessment	2
	STSN6422/ Principles of Radiation Protection	2		
			STSN6322 Nuclear Safety, Security and Safeguards	2
	STSN6614/ Practical I	4		
			STSN6412 Radioactive Waste Management	2
			STSN6512 Medical Exposure	2
			STSN6522 Protection Against Occupational Exposure	2
			STSN6624 Practical II	4
Elective Courses	-		-	
Thesis /	STSN6972 Research Project I	2	STSN6986 Research Project II	6

dissertation / research project				
Total credit hours		20		24

Courses Offered

STPD6014 Research Methodology
STSN6012 Interaction of Radiation with Matters
STSN6052 Intervention for Protection of the Public
STSN6132 Regulatory Controls
STSN6142 Environmental Engineering of Nuclear Power
STSN6212 Quantities and Measurements
STSN6222 Internal Exposure Assessment
STSN6312 Effects of Ionizing Radiation on Biological Systems
STSN6322 Nuclear Safety, Security and Safeguards
STSN6412 Radioactive Waste Management
STSN6422 Principles of Radiation Protection
STSN6512 Medical Exposure
STSN6522 Protection against Occupational Exposure
STSN6614 Practical I
STSN6624 Practical II
STSN6972 Research Project I
STSN6986 Research Project II

Course Content

STSN6012 Interaction of Radiation with Matters

This course covers an introduction to radiation protection and safety of radiation sources, basic nuclear physic and mathematics including statistics used in radiation protection. This course also includes interaction of radiation with matter and sources of radiation and also detection and measurement of quantum particles.

References

Hooshang Nikjoo, Shuzo Uehara, Dimitris Emfietzoglou. 2012. *Interaction of Radiation with Matter*. Boca raton: CRC Press.

Tsoulfanidis, N. & Landsberger, S. 2011. *Measurement and Detection of Radiation*. London: CRC Press.

Knoll, G.F. 2010. *Radiation Detection and Measurement, Fourth Edition*. N. York: John Wiley & Sons.

Cember, H. 2000. *Introduction to Health Physics*. 3rd Ed. New York: McGraw-Hill.

Martin, J. 2000. *Physics for Radiation Protection*. New York:Wiley-Interscience Publication.

Krane, K.S. 1988. *Introduction to Nuclear Physics*. New York: John Wiley.

STSN6052 Intervention for Protection of the Public

This course covers awarenes due to chronic esposure, radiological and nuclear accidents. It also covers basic of emergency procedures, evaluation and monitoring in emergency situation and radiological and nuclear accidents.

References

Byrnes, M.E., King, D. A. & Tierno, P.M. 2003. *Nuclear, Chemical, and Biological Terrorism: Emergency Response and Public Protection*. CRC Publications.

IAEA. 1989. *IAEA Safety Series No. 91 - Emergency Planning and Preparedness for Accidents Involving Radioactive Materials Used in Medicine , Industry, Research and Training.* IAEA. Vienna.

IAEA. 1993. *A Model National Emergency Response Plan for Radiological Accidents*, IAEA-TECDOC-718. IAEA.Vienna.

Johns, H.E. & Cunningham, J.R.1983. *The Physics for Radiology*. Illinois: Charles Thomas Pub Martin, A and Horbison, A.S. 1979. *An Introduction to Radiation Protection*. Chapman and Hall.

Swindon, T.N. 1987. *Manual on the Medical Management of Individuals Involved in Radiation Accident*, Australian Radiation Lab.

STSN6132 Regulatory Control

This course is aim at discussing the scope and framework of basic regulation and the regulatory body involved in radiation protection. It also covers effective regulatory programmes in radiation protection.

References

IAEA. 1989. *Safety Series No. 91. Emergency Planning and Preparedness for Accidents Involving Radioactive Materials Used in Medicine, Industry, Research and Training*. IAEA. Vienna.

IAEA. 1999. *IAEA-TECDOC-1113. Safety Assessments Plans for Authorisation and Inspection of Radiation Sources.* IAEA. Vienna.

IAEA. 2000. *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety*, Safety Standards Series No. GSR-1. IAEA. Vienna.

IAEA. 2001. *Safety Standards Series RS.G-1.4. Building Competence in Radiation Protection and the Safe Use of Radiation Sources*. IAEA. Vienna.

Wade, H. L. 2004. *Basic and Advanced Regulatory Control: Design and Application*. ISA Publications.

STSN6142 Environmental Engineering of Nuclear Power

This course covers the environmental effects of nuclear power and radiations. Radiological assessment methods and characterizing the various radiation sources are deals directly with analysis. Liquid effleunt managemement and dispersion of gaseous radioactive nuclides and transport or migration of radioactivity through surface water, underground water and biosphere are described. Finally environmental pathway modelling is examined and compared.

References

IAEA. 1996. *IAEA, FAO, ILO, OECD, PAHO, WHO. 1996. Safety Series no 115. International Basic Safety Standards for Protection against Ionizing Radiation and fot the Safety of Radiation Sources*. IAEA. Vienna.

IAEA and ILO. 1999. *Safety Standards Series no. RS-G-1.3. Assessment of Occupational Exposure due to External Sources of Radiation.* IAEA. Vienna.

IAEA.2004. *Assessment of Occupational Exposure due to External Source of Radiation.* IAEA. Vienna.

ICRU. 1993. *Report no.51. Quantities and Units in Radiation Protection Dosimetry.*

STSN6212 Quantities and Measurements

This course covers dosimetric quantities, units and calculation. It also includes dosimetric calculations and measurements, principles of radiation protection and measurements. Besides that it also discusses on the choice of detectors suitable for radiation field involved.

References

Attix, F.H. 1986. *Introduction to Radiological Physics and Radiation Dosimetry*. New York: John Wiley.

Graham, D. T. & Cloke, P. 2003. *Principal of Radiological Physics.* New York: Churchill Livingstone Publications.

ICRU.1993. *Report 51 -Quantities and Units in Radiation Protection Dosimetry.*

ICRU. 1998. *Report 60 - Fundamental Quantities and Units for Ionising Radiation*.

Knoll, G.T. 2000. *Radiation Detection and Measurement*, 3rd Ed. New York: Wiley.

STSN6222 Internal Exposure Assessment

This course covers assessment of occupational exposure due to intakes of radionuclides. It also covers monitoring programmes, biokinetic models used by ICRP, calculations of committed effective dose, calibration and quality assurance.

References

IAEA. 1996. *IAEA, FAO, ILO, OECD, PAHO, WHO. 1996. Safety Series no 115. International Basic Safety Standards for Protection against Ionizing Radiation and fot the Safety of Radiation Sources*. IAEA. Vienna.

IAEA and ILO. 1999. *Safety Standards Series no. RS-G-1.3. Assessment of Occupational Exposure due to External Sources of Radiation.* IAEA. Vienna.

IAEA.2004. *Assessment of Occupational Exposure due to External Source of Radiation.* IAEA. Vienna.

ICRU. 1993. *Report no.51. Quantities and Units in Radiation Protection Dosimetry.*

ICRU. 1998. *Report no. 60. Fundamental Quantities and Units for Ionizing Radiation*.

STSN6312 Effect of Ionising Radiation on Biological Systems

This course covers the mechanism of the effects of radiation at molecular and cellular level. It is aim at presenting models used in determining the risk coefficients and estimating effects. This includes radiation effects at the molecular level, deterministic effect and stochastic effects.

References

Dahlgraad, H. (Editor). 1994. *Nordic Radioecology- The Transfer of Radionuclides Through Nordic Ecosystems to Man.* Elsevier, Amsterdam.

IAEA. 1998. *Safety Reports Series no. 2. Diagnosis and Treatment of Radiation Injuries*. IAEA. Vienna.

Pattenden, N. J. 2003. *Introduction to Radioecology*. Springer-Verlag.

Schultz, V. & F.W Whicker.1982. *Radioecological Techniques,* Plenum Press New York and London.

United Nations. 1994. *Report to the General Assembly. Sources and Effects of Ionizing Radiation. Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)* UN. New York.

STSN6322 Nuclear Safety, Security and Safeguards

This course covers introduction to national and regional systems for nuclear safety, physical protection of nuclear materials and facilities, detection and response, principles of nuclear safeguards, nuclear material accountacy,integrated safeguards, containment and surveillance, satellite monitoring and international law.

References

IAEA. 2004. Regulatory Control of Radiation Sources. Safety Guide No GS-G1.5. 2004

IAEA. 2003. Security of Radioactive Sources. IAEA-TecDoc. 1355. 2003

IAEA. 2004. Strengthening Control Over Radioactive Sources in Authorized Us and Regaining Control Over Orphan Sources.

IAEA. 2005. Nuclear Security, Global Directions for the Future. Proceedings of International Conference. London. March 2005.

IAEA. 2003. Nuclear Safety Review 2002. IAEA Publication.

STSN6412 Radioactive Waste Management

This course covers types of nuclear waste, waste classification and overall management like treatment and disposal of radioactive waste from NPP and treatment facilities, solididfication and volume reduction technology, package and transportation, interim storage and disposal repository, repository safety analysis, decommission and decontamination, and spent fuel management are treated in this course.

References

IAEA. 1995. *IAEA TECDOC -804- Methods to Identify and Locate Spent Radiation Sources*. IAEA. Vienna.

IAEA. 1999. *IAEA Training Course series no. 1- Safe Transport of Radioactive Materials.* IAEA. Vienna.

Kok, K. D. 2009. *Nuclear Engineering Handbook*. London: CRC Press.

ICRP. 2000. *Protection of the Public in Situations of Prolonged Radiation Exposures*, ICRP Publication 82. 2000.

Kieffer, J. 1990. *Biological Radiation Effects*. Springer Verlag. Berlin.

Fenton, S. 2014. *Radioactive Waste: Sources, Management and Health Risks*. Nova Science Pub. Inc.

STSN6422 Principles and Radiation Protection

This course covers basic conceptual framework of International Commission on Radiological Protection (ICRP) and the role of other organizations or agencies such as International Organizations in Radiation Protection, International Atomic Energy Agency (IAEA), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), International Labour Organisation (ILO), World Health Organisation (WHO, Food and Agriculture Organisation of the United Nations (FAO), Nuclear Energy Agency of OECD (NEA/OECD) and Pan American Health Organization (PAHO) in radiation protection.

References

IAEA. 1997. *Safety Report Series no. 1 - Examples of Safety Culture Practices*. International Atomic Energy Agency. IAEA. Vienna.

ICRP. 1991. *Recommendations of the International Commission on Radiological Protection*, Publication No.60, Ann. ICRP 21 1–3, Pergamon Press.Oxford and New York

ICRU. 1993. *Report no 51. Quantities and Units in Radiation Protection Dosimetry*. International Atomic Energy Agency.

Shapiro, J. 2002. *Radiation Protection: A Guide for Scientists and Physicians.* Harvard Univ. Press

UNSCEAR. 1994. *Reports to the General Assembly. Sources and Effects of Ionizing Radiation*. International Atomic Energy Agency.

STSN6432 Training the Trainer and Technical

This course is aim at instilling skills in organizing trainings. It covers general consideration for individuals to be trained and the types of training, individual traits, how to teach in a group, course design and evaluation. This is a also include as an option a 2 weeks industrial visit to various industries, hospital and the regulatory board novel in the using or regulating the use of radioactive sources.

References

IAEA. 1989. *Safety Series No.91. Emergency Planning and Preparedness for Accidents Involving Radioactive Materials Used in Medicine, Industry, Research and Training.* International Atomic Energy Agency. IAEA. Vienna.

IAEA. 1996. *IAEA, FAO, ILO, OECD, PAHO, WHO. 1996. Safety Series No 115. International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.* International Atomic Energy Agency. IAEA. Vienna.

IAEA. 1999. *Draft Safety Guide I. Training in Radiation Protection and the Safety of Radiation Sources*. International Atomic Energy Agency. IAEA. Vienna.

IAEA. 2001. *Safety Standards Series RS.G-1.4. Building Competence in Radiation Protection and the Safe Use of Radiation Sources*. International Atomic Energy Agency. IAEA. Vienna.

STSN6512 Medical Exposure

This course covers scope and responsibilities, justification of medical exposures, optimization of protection for medical exposures, quality assurance and accidental exposures in medical applications. Beside these it also discusses cases of exposure accidents in the medical field.

References

Attix, F.H. 1986. *Introduction to Radiological Physics and Radiation Dosimetry*, John Wiley & Sons.

Ball, J. & Moore, A.D. 1998. *Essential Physics for Radiographers*, Blackwell Science Inc.

Knoll, G.F. 2010. *Radiation Detection and Measurement, Fourth Edition*. N. York: John Wiley & Sons.

Sharp, C., Schrimpton, J. A. & Bury, R.F. 2000. *Diagnostic Medical Exposures.* NRPB Publications.

Wagner, G. 1995. *Principles of Nuclear Medicines*, Saunders Pub., Philadelphia, USA.

STSN6522 Protection Against Occupational Exposure

This course covers organization and managements, methods of protection and safe use of radiation sources. It also covers individual and workplace monitoring, health surveillance and potential exposures. This includes protection against occupational exposure in industrial radiography, industrial irradiators and accelerator, gauging devices, well logging devices, radioisotope production plants, nuclear medicine.

References

Halmshaw, R. 1982. *Industrial Radiography; Theory and Practice*, Elsevier.

IAEA. 1995. *Safety Series no. 111-F. The Principles of Radioactive Waste management*. International Atomic Energy Agency. IAEA. Vienna.

IAEA. 2001. *Draft Safety Guide - Occupational Radiation Protection*. International Atomic Energy Agency. IAEA. Vienna.

ICRP. 1997. *Protection from Potential Exposures: Application to Selected Radiation Sources*, Publication No. 76, Ann. ICRP 27 2, Elsevier Science Ltd, Oxford.

Rao, R., Majali, S., Despande, S.& Murthy, K. 1984. *Industrial Applications of Radioisotopes and Radiation*, John Wiley Publication.

STSN6614 Practical I

This course involves practical and demonstrations of each type of portable monitoring for α, β, γ radiations and description of each use, the use of manual equipment, the determination of the characteristics of GM detector, determining the level of background radiation. It also includes the measurement of beta radiation levels for beta emitter samples and determination of total efficiency, calibration gamma scintillation spectrometer in terms of energy and activity.

References

Annual Book ASTM Standards. 1992. *Nuclear, Solar and Geothermal Energy*. Philadelphia: American Society for testing and Materials.

Lowenthal, G. and Airey, P. 2001. *Practical Applications of Radioactivity and Nuclear Radiations*. Cambridge: Cambridge University Press.

IAEA. 1998. *IAEA Draft Safety Report, 1998 – Training courses in Radiation Protection Dosimetry*.

Tsoulfanidis, N. & Landsberger, S. 2011. *Measurement and Detection of Radiation*. London: CRC Press.

Knoll, G.F. 2010. *Radiation Detection and Measurement.* Singapore: John Wiley & Sons.

Leo, W. R. 1994. *Techniques for Nuclear and Particle Physics Experiments: A How-to Approach*. New York: Springer Science & Business Media.

STSN6624 Practical II

This course involves practical including inverse square law, the attenuation of gamma ray study, maximum energy level of beta radiation, isotope production, absorption of beta particles in different materials, complex gamma spectrum analysis using semiconductor detectors as well as field work, which involves sample collection.

References

Gilmore, G. & Hemingway, J. 2000. *Practical Gamma-ray Spectrometry*. John Wiley & Sons.

Lowenthal, G. and Airey, P. 2001. *Practical Applications of Radioactivity and Nuclear Radiations*. Cambridge: Cambridge University Press.

IAEA. 1998. *IAEA Draft Safety Report, 1998 – Training courses in Radiation Protection Dosimetry*.

Tsoulfanidis, N. & Landsberger, S. 2011. *Measurement and Detection of Radiation*. London: CRC Press.

Knoll, G.F. 2010. *Radiation Detection and Measurement.* Singapore: John Wiley & Sons.

Leo, W. R. 1994. *Techniques for Nuclear and Particle Physics Experiments: A How-to Approach*. New York: Springer Science & Business Media.

STSN6972 Research Project I

This course is aim at training students to study specific topics on radiation protection through extensive readings and guided research. Students are required to prepare a literature survey of a chosen topic and to prepare a proposal of the research that will be conducted in STSN6986 Research Projects II.

References

Day, R. A. 1998. *How to write & publish a Scientific Paper*. Ed. Ke 5 . Phoenix: Orxy Press.

Greenfield, T. 2001. *Research Methods for Postgraduates*. Ed. Ke 2. London: An Arnold Publication.

Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Graduate Studies Centre, UKM.

Ismail Ahmad. 1996. *Penulisan Saintifik*. Kuala Lumpur. Dewan Bahasa dan Pustaka.

Palya, W. L. 2000. *Research Methods Lecture Notes*. Ed. Ke 5 . Jacksonville. Alabama.

STSN6976 Research Project II

This course offers student the opportunity to do research on specific topics of interest under the supervision of one or a group of supervisors. The research can be conducted experimentally or analytically. Students are required to prepare a dissertation report on the research and will be asked to defend the results orally.

References

Day, R. A. 1998. *How to Write & Publish a Scientific Paper*. 5th. Ed. Phoenix: Orxy Press.
Greenfield, T. 2001. *Research Methods for Postgraduates*. 2nd. Ed. London: An Arnold Publication.
Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Graduate Studies Centre, UKM.
Ismail Ahmad. 1996. *Penulisan Saintifik*. Kuala Lumpur: Dewan Bahasa dan Pustaka.
Palya, W. L. 2000. *Research Methods Lecture Notes*. 5th. Ed. Jacksonville. Alabama.

MASTER OF SCIENCE (INDUSTRIAL SAFETY MANAGEMENT) - EXECUTIVE

Introduction

UKM is one of the pioneers in this field since 1999. The fundamental core knowledge in this programme includes Occupational Safety Management System, Risk and Hazard Assessment, Explosive and Fire Safety, Ergonomics, Organizational and Industrial Psychology, Radiation and Chemical Safety, Mechanical and Electrical Safety, Biological and Environmental Safety, and Environmental and Industrial Law.

Course content is delivered to students through lectures, practical, fieldwork, industrial visits and research projects. Course assessment is carried out in the form of examination and quizzes, assignments, practical reports, fieldwork reports, research project reports and oral presentations. This programme is offered in executive mode and only offered once in each academic session.

Entry Requirements

Candidates applying for the Master of Science (Industrial Safety Management) programme must have the following qualifications: -

a) Bachelors degree with a Cumulative Grade Point Average (CGPA) of 2.7 or above in the fields of Science, Technology or Engineering from UKM or its equivalent approved by the Senate;
   or
b) Graduate Diploma in Industrial Safety Management from UKM with a CGPA of 3.0 or above

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To produce a graduate with outstanding moral and character.
PEO 2: To produce a graduate who is able and competent
PEO 3: To produce a graduate who can apply knowledge of industrial safety management scientifically
PEO 4: To produce a graduate who is professional and commensurate with the demand of development in their time

PROGRAMME LEARNING OUTCOMES (PLO)

PLO1: Master the field of industrial safety

PLO 2: Applies practical skills in the field of industrial safety
PLO 3: Correlate ideas and expertise to current community issues
PLO 4: Carry out research with minimum supervision and abides by the law, etiquettes and codes of professional conduct
PLO 5: Displays leadership qualities through communication and effective cooperation amongst colleagues and stakeholders.
PLO 6: Propose solutions to problems with scientific skills and critical thinking
PLO 7: Manage related information for lifelong learning

Programme Structure

This programme is only offered in executive mode and is carried out in the semester system, which is 3 semesters executed at weekends. Students are required to register and pass core courses which overall carries 40 notional credits.

SEMESTER	PROGRAMME CORE COURSES	TOTAL
I	Z1LK 6023 Hazard Identification and Risk Assessment Z1LK 6033 Occupational Safety Management Z1LK 6063 Fire Prevention, Explosion and Toxic Release	9
II	Z1LK 6013 Environmental and Industrial Law Z1LK 6043 Advanced Organisational and Industrial Psychology Z1LK 6053 Occupational Health Management Z1LK 6073 Ergonomics Z1LK 6014 Research Project 1	16
III	Z1LK 6123 Mechanical and Electrical Safety Management Z1LK 6173 Radiation and Chemical Safety Management Z1LK 6193 Biological and Environmental Safety Management Z1LK 6016 Research Project 2	15
TOTAL CREDIT HOURS		**40**

Courses Offered

Z1LK 6013 Environmental and Industrial Law
Z1LK 6023 Hazard Identification and Risk Assessment
Z1LK 6033 Occupational Safety Management
Z1LK 6043 Advanced Organisational and Industrial Psychology

Z1LK 6053 Occupational Health Management
Z1LK 6063 Fire Prevention, Explosion and Toxic Release
Z1LK 6073 Ergonomics
Z1LK 6123 Mechanical and Electrical Safety Management
Z1LK 6173 Radiation and Chemical Safety Management
Z1LK 6193 Biological and Environmental Safety Management
Z1LK 6014 Research Project 1
Z1LK 6016 Research Project 2

Course Content

Z1LK 6013 Environmental and Industrial Law

This course discusses legal aspects related health and safety at work. Prior to discussion of the relevant legal provisions, students will be introduced to the general overview of the Malaysian legal system. Employer and employee responsibility related to workplace safety is also discussed. The aspect of environmental law is also given to the students.

References

Ahmad Ibrahim & Ahilemah Joned. 1995. *The Malaysian Legal System (2nd. edition).* Kuala Lumpur: Dewan Bahasa dan Pustaka.

Francis McManus 1994, *Environmental Health Law, Blackstone*, London.

IT. Smith & J.C. Wood, 1986, *Industrial Law*, Butterworth, London.

Jamaluddin Md. Jahi (ed.). 2000. *Pengurusan Persekitaran Di Malaysia: Isu Dan Cabaran*. Bangi: Pusat Pengajian Siswazah, Universiti Kebangsaan Malaysia.

Jamaluddin Md. Jahi. 1999. *Striking A Balance Between Environment And Development: Is Malaysia Prepared To Manage The Environment To Face Challenges In The Next Millennium*. Centre for Graduate Studies, Universiti Kebangsaan Malaysia. Bangi.

John Munkunan, 1990, *Employer's Liability, at Common Law*, Butterworth, London.

Richard Johnstone, 1997, *Occupational Health and Safety, Law and Policy, LBC Information Services,* New South Wales.

Welford, R. 1996. *Corporate Environmental Management: Systems and Strategies*. London: Earthscan Publications Limited.

IT. Smith & J.C. Wood, 1986, *Industrial Law*, Butterworth, London.

Richard Johnstone, 1997, *Occupational Health and Safety, Law and Policy, LBC Information Services,* New South Wales.

John Munkunan, 1990, *Employer's Liability, at Common Law*, Butterworth, London.

Z1LK 6023 Hazard Identification and Risk Assessment

This course covers topics, which include Introduction to Hazard System, Methods of Analysing Process Hazards, Potential Assessment due to Hazards, and determination and assessment of risk from the industry. Topics of discussion in this course include Hazards and the Hazard System; Methods of analysing process hazards such as checklist, what-if analysis, hazard rating, failure mode and effect analysis, HAZOP, fault tree and event tree; and estimation and assessment of risk.

References

CCPS, 2008, *Guidelines for Hazard Evaluation Procedures,* AIChE, New York

CCPS, 1999, *Guidelines for consequence analysis of chemical releases,* AIChE, New York

Charles A. Wentz, (1998), "*Safety, Health and Environmental Protection",* McGraw Hill, Singapore.

Crowl, D.A & Louvar, J.F., (1990), *"Chemical Process Safety: Fundamentals with Applications*", Prentice Hall, USA.

Hyatt, N. 2003, *Guidelines for process hazard analysis, hazard Identification and Risk Analysis*, Daydem Press, Toronto, Canada

Lees, F.P (1996), "*Loss Prevention in the Process Industries, Vol. 1, 2, 3",* 2nd. Ed., Butterworth-Hinemann, UK

Marshall, V. & Ruhemann, S. (2001), "*Fundamentals of Process Safety*", IChemE, UK

Z1LK 6033 Occupational Safety Management

This course will focus on important aspects in general occupational safety and health management system especially OHSAS 18001 and MS1722. Discussions will inlude topics, including the formulation and realization of the safety and health policy, organisation and arrangements. Occupational safety and health management will be discussed as an important and integral part of total management taking into consideration the relevant legislative requirements. All the above discussions will be based on the principle of self-regulation to ensure efficient and effective continuous management.

References

Ismail, B. (2006) *Pengurusan Keselamatan dan Kesihatan Pekerjaan.* McGraw Hill (Malaysia)

Bahr, N.J. (1997) *System Safety Engineering and Risk Assessment: A Practical Approach.* Taylor & Francis.

Keller, J.J. and Associates Inc. (1999) *Safety Manager's Handbook.* American Management Association International. Safety Management Series.

Wentz, C. A (1999) *Safety, Health, and Environmental Protection*. McGraw Hill International Editions

Occupational Safety and Health Act, 514, (1994) and all Regulations and Order made under it

Z1LK 6043 Advanced Organisational and Industrial Psychology

This course focuses on the two main branches of organisational and industrial psychology, which is organisation, and personnel psychology. Personnel psychology/ human resource management covers topics of occupation analysis, performance assessment, training and development, and personnel choice. Organisation psychology will include topics related to motivation, leadership, personality, and work satisfaction, communication, decision-making and stress and worker wellbeing. To ensure the diverse roles of organisational and industrial psychology is understood, students are asked to organise workshops/seminars/field training, with the purpose of applying the learned topics into the field of worker safety.

Refernces

Aamodt, M.G. 2010. *Applied Industrial/Organizational Psychology*. 6th Edition. Pacific Grove: Brooks/Cole

Landy, F.J. & Conte, J.M. 2004. *Work in the 21st Century: An Introduction to Industrial and Organizational Psychology.* Pacific Grove: Brooks/Cole.

Muchinsky, P.M. 2006. *Psychology Applied to Work: An Introduction to Industrial and Orgnizational Psychology*. 6th Edition.Pacific Grove: Brooks/Cole

Riggio, R.E. 2000. *Introduction to Industrial/Organizational Psychology*. 3rd Edition. Upper Saddle River, New Jersey: Prentice Hall.

Schultz, D. & Schultz, S.E. 2002. *Psychology and Work Today: An Introduction to Industrial and Organizational Psychology*. 8th Edition. Upper Saddle River, New Jersey: Prentice Hall.

Z1LK 6053 Occupational Health Management

This course basically covers preventive diagnosis, treatment and rehabilitation of occupational diseases, which are caused by biological, physical, chemical or psychological factors at the work place. Management of diseases related to occupation is emphasised.

References

LaDou, J. 2006. *Current Occupational and Environmental Medicine*, 4th Edition. New York: J. McGraw-Hill/Appleton & Lange Medical Books.

Adams PH, Baxter PJ Aw TC & Cockrof Harrington JM. 2000. *Hunter's Diseases of Occupations,* 9th Ed. Oxford University Press.
Glass LS, ed. 2004. *Occupational Medicine Practice Guidelines*, 2nd Ed.
Hendrick D, Beckett W, Burge PS, Churg A. 2002. *Occupational Disorders of the Lung*.
Nordin M, Andersson G, Pope M. 2007 *Musculoskeletal Disorders in the Workplace: Principles and Practice*. 2nd Ed.
Marks JG, Elsner P, DeLeo VA. 2002.*Contact and Occupational Dermatology*, 3rd Ed.

Z1LK 6063 Fire Prevention, Explosion and Toxic Release

This course gives a clear view of the concepts related to fire prevention, explosion and toxic release. Topics discussed are related to the basic principles of flame and fire, which is the main cause of fire, explosion and toxic released incidents. Even though incidents of explosions and toxic release can occur without the presence of fire, it may in the result in a fire accident. Consequently, topics related to introduction to fire, explosion and toxic release prevention and how to carry out prevention, which includes the management that is the safe workflow and safety planning. At the end of the course, students will be exposed to the need of an emergency response plan and accident investigation.

References

James G.Quintire 1998, *Principles of Fire Behavior*.
Paul Stollard and John Abrahams 2006, *Fire from first Principles, A design guide to building fire Safety*.Daniel A Crowl/Joseph F. Louvar 2002, Chemical Process Safety, Fundamentals with Application.
Randall Noon 1995, *Enginering Analysis of Fire and Explosions*.
R. Craig Schroll 2002, *Industrial Fire Protection Handbook*.
Raymond Friedman 1998, *Priciples of fire protection Chemistry and physics*.
Norman Thomson 2002, *Fire Hazards In Industry*
Dr. Donald W.Walsh 2005, *National Incident Management System, Priciples and Practice.*

Z1LK 6073 Ergonomics

This course highlights the important issues regarding occupational health and safety regulations to operators/workers when designing workplace and equipment. This course discusses the application of antropometry or designing workplace, which is suitable for humans (i.e height of the chair, head and neck posture, movement space). It will start with the definitions in ergonomics (for example: human-machine interface, displays and controls for operation). It will also discuss issues related to ergonomic environmental principles regarding lighting, noise and thermal regulation at the workplace. Finally, the course will cover work stress, boredom and mental/physical fatigue, capability and limits of human operators/workers while carrying out manual material handling.

References

Kroemer, K.H.E. and Grandjean, E. 2008. *Fitting The Task To The Human - A Textbook of Occupational Ergonomics*, 6th Edition, Taylor & Francis.
Bridger, R.S. 2008. *Introduction to Ergonomics*, 3rd Edition, CRC Press.
Wickens, C. D., Lee, J.D., Liu, Y. and Becker, S.E.G. 2004. *Introduction to Human Factors Engineering*, 2nd Edition, Pearson-Prentice Hall.
Kroemer, K., Kroemer, H. and Kroemer-Elbert, K. 2001. *Ergonomics: How to Design for Ease & Efficiency*, Prentice Hall.
Pulat, B. M. 1997. *Fundamentals of Industrial Ergonomics*, Waveland Press, 2nd Edition.

Z1LK 6123 Mechanical and Electrical Safety Management

This course introduces the concept of management and safe use of electrical and mechanical equipment, mechanical and electrical protection system, and safety procedures while using electrical and mechanical equipment. This course will also discuss the aspects of mechanical and electrical safety, which needs to be known, understood and applied, in line with the Regulation and Acts gazetted by the government, including codes of conduct that are accepted internationally. More specifically, this course will cover the mechanical and electrical safety procedures related to the Electricity Supply Act 1990, Electricity Regulation 1994 and Malaysia's Factories and Machinery Act 1967.

References

Adams, J.M. 1994. *Electrical Safety*. IEE Power Series 19.

BSI. 1988. BS5304 *Code of Practice for Safety of Machinery*. British Standard Institution. London.

Cadick, J., Capelli-Schellpfeffer, M., Neitzel, D. and Winfield, A. 2012. *Electrical Safety Handbook*, 4th Edition.

Geddes, L.A. 1994. *Handbook of Electrical Hazards and Accidents*, CRC Press.

Goetsch, D. L. 1999. *The Safety and Health Handbook*

Z1LK 6173 Radiation and Chemical Safety Management

This course gives an overview of chemical and radiation (ionising and non-ionising) safety management aspect. Chemical safety management focuses on chemical classification, risk, material safety data sheet (MSDS) and aspects related to chemical safety management during normal handling, emergencies, transport, storage and disposal. Lectures will focus on relating the chemical safety management to the requirements of the Control of Industrial Major Accidents Hazards (CIMAH 1996), Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulation 2013, Introduction to Use and Standards of Exposure to Chemical Hazardous to Health regulations 2000 (USECHH 2000) and Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease (NADOPOD 2004). Ionising radiation safety will be divided into radioactivity and radiation source, the effects of ionising radiation on humans, radiation exposure dose, radiological safety management, responsibilities of a Radiation Protection Officer (RPO), emergency response plan, radiation protection programme and ACT 304. Meanwhile, non-ionising radiation safety will focus on safety aspects of ultraviolet (UV), Infrared (IR), LASER, Microwave (MW), Radiofrequency (RF) and Extremely Low Frequency (ELF).

References

MINT, 2001. *Chemical Safety*, MINT.

Furr, A.K., 1990. *CRC Handbook of Industrial Safety*, CRC Press 3rd Ed.

Scott, R.M, 1989. *Chemical Hazards in the Workplace*, Lewis Publisher

Wentz. C.A., 1989. *Hazardous Waste Management*, Mc Graw Hill.

Akta Keselamatan dan Kesihatan Pekerjaan dan Peraturan-Peraturan, Akta 514, MDC Publishers, Kuala Lumpur.

Akta Perlesenan Tenaga Atom, 1984 dan Peraturan-Peraturan serta Perintahnya

ICRP, 2007, *The 2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication No. 103, Elsevier.

IAEA, 1990, *Safety Series No. 102. Recommendation, Emergency Planning and Preparedness for Accident Involving Radioactive Materials Used in Medicine, Industry, Research and Teaching*, IAEA.

Repacholi, M.H., 1988. *Non-Ioning Radiations: Physical Characteristics, Biological Effects and Hazard Assssment, Internal Radiation Protection Association*.

Z1LK 6193 Biological and Environmental Safety Management

This course will discuss and focus on the important aspects in the management of biological and environmental safety, with added impetus to preventive action. These aspects include types of pollution caused by disposal of dangerous solid and liquid waste, their threat to human health and safety, their effect to the environment, related regulations, measurement and analysis of pollution level, management steps to prevent, reduce and treat pollution. This course is also important for all workers in laboratories using biological materials, and covers the dangers, practice and equipment needed for the various biosafety levels.

References

Peavy H.S., Rowe D.R & Tchonoglous G. 1987. *Environmental Engineering,* New York: McGraw Hill.

Wentz, C.A. 1989. *Hazardous Waste Management.* New York: Mc Graw Hill.

Liberman D.F. 1995. *Biohazard Management Handbook.* New York: Marcell and Decker

Brock T.D & Madigan M.T 1991. *Biology of Microorganism 6th Edition*. New Jersey: Prentice Hall,

Atlas, R.M. 1986. *Microbiology – Fundamentals & Application: Instructor's Manual.* London & New York: Macmillan Publishing Co.

Gardner, J.F and Peel, M.M 1986. *Introduction to Sterilization and disinfection.* New York: Churchill Livingstone.

Casey, A, Underwood, R & Viner, D. 1997. *Plant Safety – Managing Plant Hazards at the Workplace.* Australia: CCH Publisher.

Haski, R, Cardilini, G & Bartolo W.C.F 1992. *Laboratory Safety Manual.* Australia: CCH Publisher.

IAEA. 2008. Nuclear Security Culture, IAEA Nuclear Security Series No. 7, IAEA, Vienna (2008).

Z1LK 6014 Research Project 1

The purpose of this course is to train students to carry out research for a specified topic of choice in the field of occupational safety and health through reading and focused self-research. Students are required to do a literature review of a particular topic of interest and prepare a proposal for the research that will be carried out in the Z1LK 6016 Research Project 2 course.

References

Day, R. A. 1998. *How to write & publish a Scientific Paper*. Ed. Ke 5 . Phoenix: Orxy Press.

Greenfield, T. 2001. *Research Methods for Postgraduates*. Ed. Ke 2. London: An Arnold Publication.

Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Graduate Studies Centre, UKM.

Ismail Ahmad. 1996. *Penulisan Saintifik*. Kuala Lumpur. Dewan Bahasa dan Pustaka.

Palya, W. L. 2000. *Research Methods Lecture Notes*. Ed. Ke 5. Jacksonville. Alabama

Pusat Pengurusan Siswazah Panduan penulisan tesis gaya UKM Edisi semak kedua Tahun 2010 percetakan Watan Sdn Bhd

Z1LK 6016 Research Project 2

(Pre-requisite: Passed Z1LK 6014 Research Project 1)

This course is offered with the purpose of allowing students to experience carrying out research in a topic of their interest under the guidance of a supervisor or a panel of supervisors. The research can be experimental or analytical by nature. Students are required to prepare a significant research project dissertation based on the findings of their research and present their findings in an oral defence.

Reference

Day, R. A. 1998. *How to write & publish a Scientific Paper*. Ed. Ke 5. Phoenix: Orxy Press.

Greenfield, T. 2001. *Research Methods for Postgraduates*. Ed. Ke 2. London: An Arnold Publication.

Hafriza Burhanudeen (Editor). 2005. *The UKM Style Guide*. Graduate Studies Centre, UKM.

Ismail Ahmad. 1996. *Penulisan Saintifik*. Kuala Lumpur. Dewan Bahasa dan Pustaka.

Palya, W. L. 2000. *Research Methods Lecture Notes*. Ed. Ke 5. Jacksonville. Alabama