Course Specification

RARD529: Electronics Instrumentation and Radiation Dosimetry

Institution Name: Mahidol University

Campus/Faculty/Department: Faculty of Medicine Ramathibodi Hospital, Department of Diagnostic and Therapeutic Radiology

Section 1: General information

1. ***Course number and name***
   Course number: RARD 529
   Course name: Electronics Instrumentation and Radiation Dosimetry

2. ***Credits: 3(2-3-5)***

3. ***Curriculum and type of course***

   3.1 Curriculum: Electronics Instrumentation and Radiation Dosimetry

   3.2 Type of course: Core course

4. ***Instructors***
   4.1 Course Coordinator: Lect.Dr.PuangpenTangboonduangjit
   4.2 Instructors

Asst.Prof.Suvit	Punnachaiya
Lect.Dr. Puangpen	Tangboonduangjit
Lect.Somnuk	Monthonjulkej

5. ***Semester/Year:*** 1st Semester, Academic Year 2020, 1st year students
6. ***Pre-requisite:*** None
7. ***Co-requisite:*** None
8. ***Classroom:*** To be announced
9. ***Revision Date:*** Nov 2019 ***By:*** Committee

   Note: Revised course learning outcome, course description, and evaluation

Section 2: Purpose and objective

1. Course Learning Outcomes

1.1 Understand the role of electronics technology and signal controls; the components and electronic board circuit in nuclear science instrument

1.2 Analyse the basic design of electronics circuit, classify and test the nuclear system

1.3 Apply electronics knowledge to the nuclear medicine instrument and radiation machine and aware of the maintenance and also detect some unusual signals

1.4 Define the definition of radiation dose and measurement unit and explain the basic principles of radiation measurement

1.5 Describe the principles of ionization for measuring the radiation dose and methods of benchmarking in photon and electron beams

1.6 Explain, analyze and compare the principle of radiation measurement of various types of detectors i.e., ionization chamber, TLD/OSLD, Diode, Film, and Fricke dosimeter

Section 3: Course details

1. Course description

Introduction to electronics, circuit analysis, electronic passive devices, electronic active devices, amplifying and switching principle, electronic circuits, time and frequency domain, analog signal system, amplitude and time measurement, digital signal system, nuclear radiation detection process, nuclear instrumentation, radiation machine principle, radiation quantities and units, charged particle equilibrium, cavity theory, calibration traceability, radiation dosimeters.

2. ***Hours per semester:*** Lecture 30 hours

Practice 30 hours

3. ***Assignment feedback:*** Within 2 weeks

Section 4: Course Learning Outcomes

Course level learning outcomes	Programme level learning outcomes	Methods	Assessment
1 Understand the role of electronics technology and signal controls; the components and electronic board circuit in nuclear science instrument	ELO 2, 4	- Lecture - Demonstration - Experiment	- Paper Examination - Rubric experiment report assessment
2 Analyse the basic design of electronics circuit, classify and test the nuclear system			
3 Apply electronics knowledge to the nuclear medicine instrument and radiation machine and aware of the maintenance and also detect some unusual signals			
4 Define the definition of radiation dose and measurement unit and explain the basic principles of radiation measurement	ELO 2, 5	- Lecture	- Paper examination
5 Describe the principles of ionization for measuring the radiation dose and methods of benchmarking in photon and electron beams	ELO 2, 4, 5	- Lecture - Demonstration - Experiment	- Paper/Oral examination - Rubric experiment report assessment - Rubric presentation
6 Explain, analyze and compare the principle of radiation measurement of various types of detectors i.e., ionization chamber, TLD/OSLD, Diode, Film, and Fricke dosimeter			

Section 5: Lesson plan and assessment

1. Lesson plan

Time	Topics	Instructors	Method	Assessment
1	Basic circuit analysis - **Lab** : Introduction	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
1	Electronic passive devices -**Lab 1**: Practical use of test instruments	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
1	Electronic active devices -**Lab 2**: Transistor voltage amplifier	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Amplifying and switching principle -**Lab 3**: Rectifier, filter and voltage multiplier	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Electronic circuits I - **Lab 4**: Voltage regulated power supply	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Electronic circuits II -**Lab 5**: Operational amplifier	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Analog signal system - **Lab 6**: Frequency generator	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Amplitude and time measurement -**Lab 7**: Ratemeter	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Digital signal system -**Lab 8: Logic gates and decoder**	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
2	Analog-digital conversion -**Lab 9**: Flip-Flop and counter	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report
1	Basic nuclear instrumentation -**Lab 10**: Nuclear counting system	Asst.Prof.Suvit, Lect.Somnuk	Lecture/ Experiment	Paper exam/Rubric Report

Time	Topics	Instructors	Method	Assessment
2	Basic concept of radiation dosimetry I/II	Dr. Puangpen	Lecture	Paper/Oral exam
2	Radiation quantities and units	Dr. Puangpen	Lecture	Paper/Oral exam
2	Basic concept of radiation dosimetry I/II	Dr. Puangpen	Lecture	Paper/Oral exam
2	Radiation dosimeters (Ionization chamber) and Reference measurement **Lab 11**: Leakage testing and Sr-90 time check	Dr. Puangpen	Lecture/ Experiment	Paper /Oral exam/Rubric Report
2	Calibration of photon beams with cavity chamber	Dr. Puangpen	Lecture/Demonstration	Paper/Oral exam
2	Chemical dosimetry and calorimetry **Lab 12**: Chemical dosimetry	Dr. Vitit	Lecture/ Experiment	Paper exam/ Rubric Report
1	Semiconductor dosimeters	Dr. Nauljun	Lecture	Paper exam
1	Passive dosimeters	Dr. Suphaluck	Lecture/Demonstration	Paper exam
3	Student's journal presentation	Dr. Puangpen		

2. Measurement and Evaluation of Student Achievement

2.1	Theory (short answer questions)	60%
2.2	Experiment report	20%
2.3	Assignment	10%
2.4	Behavior/Discipline	10%

Section 6: Assessment and improvement of the course operation

1. Strategies to assess the effectiveness of the courses by the students
    - Assessment of instructor's teaching by student

2. Strategy to assess the instruction
    - Assessment of students' learning records
    - Assessment of instructor's teaching by student

3. Improvement of Instruction

- Consider the students' learning records
- Consider the students' assessment of instructor's teaching
- Consider the program committee's comment

4. Verification of student achievement in the subject

- By program committee and faculty-level academic committee

5. Review and action plan to improve the effectiveness of the course

- Using the results from 1 - 4 as inputs to the instruction improvement

Learning Resources

Thai language

1. สุวิทย์ ปุณณชัยยะ. เอกสารประกอบการสอน วิชา อิเล็กทรอนิกส์และอุปกรณ์ทางนิวเคลียร์: ภาควิชาวิศวกรรมนิวเคลียร์ คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, ๒๕๕๐.

English language

1. Freeman S. Electronics devices: discrete and integrated. New Jersey: Prentice-Hall,1990.

2. Braneal D. Analog and digital electronics for scientific application. North Scituate, Breton publisher, 1982

3. Knoll GF. Radiation detection and measurement. 3rd edition, New York, John Wiley & sons, 2000.

4. Nicholson P.W. Nuclear Electronics. New York, John Wiley & sons, 1974.

5. Philip Mayles, Alan Nahum, Jean-Claude Rosenwald. Handbook of radiotherapy physics therory and practice: Talor & Francis Group; 2007.

6. Faiz M. Khan. The Physics of Radiation Therapy: Lippincott Williams & Wilkins, a Wolters Kluwer business, 4th edition; 2010.

7. Frank H. Attix. Introduction to radiological physics and radiation dosimetry. John Wiley & Sons; 1986.

8. Pedro Andreo, Davis T.Burns, Alan E. Nahum, Jan Seuntjens, and Frank H. Attix. Fundamentals of ionizing radiation dosimetry: Wiley-VCH; 2017.