TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

HEALTH PHYSICS AND RADIATION PROTECTION

by

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UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
PHYSICS UNDERGRADUATE STUDY PROGRAM

TEACHING INSTRUCTIONAL DESIGN

Course Name	Health Physics and Radiation Protection	**Credit(s)**	**Prerequisite course(s)**	**Requisite for course(s)**	**Integration Between Other Courses**
Course Code	SCPH603719	2	Introduction to Nuclear Physics	None	None
Relation to Curriculum	Elective				
Semester	6/7				
Lecturer(s)	Lukmanda Evan Lubis, M.Si.				
Course Description	After completing this course, medical physics and biophysics students are able to apply radiation protection principles to the use of ionizing and non-ionizing radiation in healthcare services according to the standards of the medical physicist profession. Teaching method will be carried out using the case-based learning method and small group discussion with group discussions and presentations. This course will be taught in Indonesian.				

Program Learning Outcome (PLO)	
PLO-1	Applying concepts of medical physics and biophysics
PLO-2	Formulate physics problems and its solutions and application, as well as interdisciplinary problems related to science and mathematics critically, creatively, and innovatively.
PLO-3	Demonstrate attitude and skills that support success at work and in participating in community

	activities.
Course Learning Outcome (CLO)	
CLO-1	After completing this course, medical physics and biophysics students are able to apply radiation protection principles to the use of ionizing and non-ionizing radiation in healthcare services according to the standards of the medical physicist profession.
Sub-CLO(s)	
Sub-CLO 1	Students are able to explain the use of ionizing and non-ionizing radiation in health services and their regulations.
Sub-CLO 2	Students are able to explain the principles of protection against ionizing radiation in health services.
Sub-CLO 3	Students are able to explain the principles of protection against non-ionizing radiation in health services.
Sub-CLO 4	Students are able to apply the principle of protection against ionizing radiation in health services.
Sub-CLO 5	Students are able to apply the principle of protection against non-ionizing radiation in health services.
Study Materials	1. Introduction and historical perspective (discovery and early application of ionizing radiation, observation of radiation injury, recommended radiation protection practices of pre-regulated radiation protection initiatives). 2. Operational dosimetry (unit, kerma and absorbed dose, equivalent dose, recent ICRU recommendations on neutron quality factors). 3. Radiation detection instrumentation (ionometry including proportional counters and Geiger-Mueller, scintillation detectors and TLD devices, equivalent dose instrumentation). 4.Radiation shielding: properties and design (direct ionizing particles, indirect ionized particles, build-up parameterization, stochastic sampling: Monte Carlo, particle accelerator, NCRP recommendation on radiation shielding calculation. 5. Statistics (statistical interpretation of instrument responses, experimental design, stochastic and

	non-stochastic error analysis, interpretation of experimental results). 6. Personnel radiation monitoring (instrumentation and engineering, internal and active devices, dynamic range and response sensitivity, film, TLD, Lexan, OSL, and CR-39, ionization booths and GM counters, pregnant workers and fetal dose limits). 7. Internal exposure (ICRP 26, ICRP 2A recommendation, internal medical radiation dose dosimetry, MIRD), radiation monitoring and control, biological testing, spread in the work environment, permissible intake limits and concentrations of air (or water). 8. Biological effects (basic radiation biology, non-stochastic and stochastic responses, biological experimental database of radiation injury, BEIR (Biological Effects of Ionizing Radiation) and UNSCEAR (United Nations, Scientific Committee on the Effects of Atomic Radiation), 9. Patient and fetal dosage. 10. Regulations. 11. Non-ionizing Radiation.
Reading List	1. ICRP No. 60. 1990 Recommendations of International Commission on Radiological Protection, Elsevier Science, 1990. 2. Herman Cember, Introduction to Health Physics. 2nd ed., Pergamon Press Inc. New York, NY. 1983. 3. RL. Kathren, Radiation Protection, Adam Hilger LTD., Bristol, 1985. 4. D. A. Gollnick. Basic Radiation Protection Technology. 2nd ed., Pacific Radiation Corporation, Altadena, CA, 1993. 5. C. J. Martin and D. G. Sutton, Practical Radiation Protection in Healthcare, Oxford: Oxford University Press, 2015 6. EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, Vienna: IAEA, 2014

	7. ICRP, The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4), 2007. 8. Undang-Undang No.10 Tahun 1997 tentang Ketenaganukliran 9. Peraturan Pemerintah No.33 Tahun 2007 tentang Keselamatan Radiasi Pengion dan Keamanan Sumber Radioaktif 10. Peraturan Pemerintah No.29 Tahun 2008 tentang Perizinan Pemanfaatan Sumber Radiasi Pengion Dan Bahan Nuklir 11. Peraturan Presiden RI No.80 Tahun 1993 tentang Pengesahan Amendment of Article VI of The Statute of The International Atomic Energy Agency 12. D. G. Sutton et al., Radiation Shielding for Diagnostic Radiology, London: The British Institute of Radiology, 2012 13. NCRP, Report No. 147 - Structural Shielding Design for Medical X-Ray Imaging Facilities, Bethesda: NCRP, 2004 14. NCRP, Report No. 151 - Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities, Bethesda: NCRP, 2005 15. P. H. McGinley, Shielding Techniques for Radiation Oncology Facilities, Madison: Medical Physics Publishing, 2002

I. Teaching Plan

Week	Sub-CLO	Study Materials [with reference]	Teaching Method [with est. time]	Learning Experiences (*O-E-F)	Sub-CLO Achievement Indicator		Sub-CLO Weight on Course (%)
					General	Specific	
1	1	Use of radiation in healthcare services a. Introduction to diagnostic radiologi and interventional facility b. Introduction to radiotherapy facility c. Introduction to nuclear medicine facility Radiation protection regulation for healthcare services a. ICRP 103 b. International Regulation (IAEA Basic Safety Series) c. National Regulation (UU, Peraturan Presiden, BAPETEN) References: [5]-[11]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading regulation references (40%) Exercise: Making regulation summary (40%) Feedback: Discussion with lecturer (20%)	Able to explain the use of radiation in medicine and aspect of regulation in radiation protection	Able to classify types of radiation used in medicine and sort the regulation hierarchy of radiation protection from international to national	7.14%
2	2	Theory and principle of radiation protection in healthcare a. Principle of clinical radiation protection (justification, optimization, and limitation) b. Dose limit and limitation	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through	Orientation: Watching lecture video and reading references (40%)	Able to explain principle of radiation protection	Able to classify principle of radiation protection and staff classification	7.14%

		c. ALARA Principle d. Risk of radiation Operational radiation protection program a. Determination of radiation area b. Classification of staff and public area in clinical service References: [5]	msTeams 100 minutes	Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)			
3	2	Personal dose monitoring a. Theory and units b. Personal dosimetry service prerequisite c. External radiation monitoring with TLD, OSL, film, and electronic d. Radiation monitoring of eyes and extremities e. Internal radiation monitoring References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of personal dose monitoring	Able to classify units and quantities of radiation dose, equipment, and dosimeter calibration	7.14%
4	2	Radioactive substance control in healthcare service a. Storage and uses of radioactive source b. Radioactive waste c. Environmental effect of	Asynchronous: Lecture videos 1 Week Synchronous: Discussion	Orientation: Watching lecture video and reading references (40%)	Able to explain principle of radioactive substance control	Able to classify radioactive substance control in clinics	7.14%

		radioactive waste d. Radioactive waste transportation e. Injection of radionuclides f. Radiation accidents in clinics References: [5]	through msTeams 100 minutes	Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)			
5	3	Principle of radiation protection for non-ionizing therapy equipment a. Biological effect and protection of LASER b. Biological effect and protection of optical non-coherence radiation c. Biological effect and protection of electromagnetic field References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of radiation protection for non-ionizing radiation therapy	Able to identify effects of radiation and its limitation for non-ionizing radiation therapy	7.14%
6	3	Principle of radiation protection for non-ionizing diagnostic equipment a. Biological effect and protection of MRI b. Biological effect and protection of USG References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion	Able to explain principle of radiation protection for diagnostic non-ionizing radiation	Able to identify effects of radiation and its limitation for diagnostic non-ionizing radiation	7.14%

				(40%) Feedback: Report discussion result to lecturer (20%)			
7	4	Shielding calculation and patient dosimetry in radiology diagnostic and interventional facility a. Methods of shielding calculation for planar radiography, general radiography, mobile radiography, and mammography b. Methods of shielding calculation for dental radiography, fluoroscopy conventional and interventional References: [5] & [12]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of basic radiation shielding	Able to identify factors affecting radiation shielding calculation for diagnostic radiology equipment	7.14%
8	Mid-Term Exam						
9	4	Shielding calculation and patient dosimetry in diagnostic radiology and interventional facility a. Method of shielding calculation for Computed Tomography b. Dose calculation and measurement concept for diagnostic radiology patient	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion	Able to explain principle of radiation shielding and basic dosimetry	Able to identify factors affecting radiation shielding calculation for CT and dose estimation	7.14%

		References: [5] & [13]		(40%) Feedback: Report discussion result to lecturer (20%)			
10	4	Shielding calculation and patient dosimetry for radiotherapy facility a. Method of shielding calculation for Cobalt-60 b. Method of shielding calculation for LINAC References: [5] & [14]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of radiation shielding for radiotherapy	Able to identify factors affecting radiation shielding calculation for Co-60 and LINAC	7.14%
11	4	Shielding calculation and patient dosimetry for radiotherapy facility a. Method of shielding calculation for brachytherapy b. Dose calculation and measurement concepts for radiotherapy patient References: [5 & [15]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback:	Able to explain principle of radiation shielding for brachytherapy	Able to identify factors affecting radiation shielding calculation for brachytherapy and patient dosimetry	7.14%

				Report discussion result to lecturer (20%)			
12	4	Shielding calculation and patient dosimetry for nuclear medicine facility a. Method of shielding calculation for gamma camera and SPECT b. Method of shielding calculation for PET References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of radiation shielding for nuclear medicine	Able to identify factors affecting radiation shielding calculation for gamma camera, SPECT, and PET.	7.14%
13	4	Shielding calculation and patient dosimetry for nuclear medicine facility a. Radiation protection principle for radionuclide laboratory (hot lab) b. Nuclear medicine patient internal dose calculation and measurement concept References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer	Able to explain principle of radiation shielding for nuclear medicine and internal dosimetry	Able to identify factors affecting radiation shielding calculation for hot lab and internal dosimetry	7.14%

				(20%)			
14	5	Calculating biological effect of non-ionizing therapy equipment a. Calculation of nominal ocular hazard distance of LASER b. Calculaton of radians, flux radians, and radian intensity for non-coherent optical radiation c. EM Field and SAR Dosimetry Refereneces: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of biological effect calculation for non-ionizing therapy equipment	Able to identify factors affecting NOHD, radian fluks, and SAR calculation	7.14%
15	5	Calculating biological effect of non-ionizing diagnostic equipment a. SAR calculation for RF in MRI b. Acoustic pressure calculation for USG References: [5]	Asynchronous: Lecture videos 1 Week Synchronous: Discussion through msTeams 100 minutes	Orientation: Watching lecture video and reading references (40%) Exercise: Case discussion (40%) Feedback: Report discussion result to lecturer (20%)	Able to explain principle of biological effect calculation for diagnostic non-ionizing radiation equipment	Able to identify factors affecting acoustic pressure and SAR calculation	7.14%
16	Final Exam						

II. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
1	Essay	1	Make summary about radiation protection regulation in Indonesia and compare it to international regulation/guidelines	Radiation protection and nuclear application in Indonesia and international	Individual Assignment	1 week	Essay
2	Scientific Papers	2, 3	Make summary about principle and theory of radiation protection for ionizing and non-ionizing radiation	Principle and theory of radiation protection for ionizing and non-ionizing radiation for diagnostic radiology, radiotherapy, and nuclear medicine.	Group Assignment	5 weeks	Scientific Papers
8	Exercise 1	4	Shielding calculation for diagnostic radiology in NCRP Report 147	Problem sets from NCRP Report 147	Individual Assignment	1 week	Answer sheet
10	Exercise 2	4	Shielding calculation for radiotherapy in NCRP Report 151	Problem sets from NCRP Report 151	Individual Assignment	1 week	Answer sheet
12	Exercise 3	4	Shielding calculation for nuclear medicine in AAPM TG 108	Case Studies	Individual Assignment	1 week	Answer sheet
13	Exercise 4	5	Problem sets from Chapter 21-25 from Reference [5] for risk quantity calculation	Chapter 21-25 from Reference [5]	Individual Assignment	1 week	Answer sheet

III. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Essay	1	Rubric 1	1x	20%
Scientific Paper	2, 3	Rubric 2	1x	20%
Exercises	4, 5	Rubric 3	4x	20%
Mid-Term Exam	1, 2, 3	Rubric 4	1x	20%
Final Exam	4, 5	Rubric 4	1x	20%
			Total:	100%

IV. Rubric(s)

This rubric is used as a guideline for assessing or giving levels of student performance results. a rubric usually consists of assessment criteria that include the dimensions / aspects that are assessed based on indicators of learning achievement. This assessment rubric is useful for clarifying the basics and aspects of the assessment so that students and lecturers can be guided by the same thing regarding the expected performance demands. Lecturers can choose the type of rubric according to the assessment given.

A. Conversion of the student's final score

Score	Grade	Equivalent
85 - 100	A	4.00
80 - < 85	A-	3.70
75 - < 80	B+	3.30
70 - < 75	B	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	C	2.00
40 - < 50	D	1.00
< 40	E	0.00

B. Assessment rubric: project report and papers

Rubric 1 (Essay)

Aspek	Skor	Indikator
Completeness	3	Includes IAEA recommendation, ICRP, UNSCEAR, dan regulation from UU and BAPETEN RI
	2	Include regulation from UU and BAPETEN RI
	1	Include regulation from UU or BAPETEN RI
Content	4	Summarize international recommendation as well as its application to national regulation
	3	Summarize the content of regulation without connection between points
	2	Discuss about the content of regulation
	1	Mention the main point of the regulation

Systematic	3	Includes title, introduction, content, and conclusion.
	2	Include title and content
	1	Include content only

Rubric 2 (Scientific Paper)

Aspek	Skor	Indikator
Completeness	3	Include application of ionizing radiation and non-ionizing radiation in diagnostic radiology, radiotherapy and nuclear medicine in clinics
	2	Include 2 out of 3 of application of ionizing radiation and non-ionizing radiation in clinics
	2	2 out of 3 of application of ionizing radiation or non-ionizing radiation in clinics.
	1	Include 1 out of 3 of application of ionizing radiation and non-ionizing radiation in clinics
	1	1 out of 3 of application of ionizing radiation or non-ionizing radiation in clinics.
Content	4	Include 4 aspect: modality, regulation, theory of radiation effect, and calculation of radiation effect.
	3	Contain 3 out of 4 aspects
	2	Contain 2 out of 4 aspects
	1	Contain 1 out of 4 aspects
Systematic	3	Includes title, introduction, content, and conclusion.
	2	Include title and content
	1	Include content only

Rubric 3 (Exercise)

Aspek	Skor	Indikator
Answer quality	5	Calculation in order accompanied by explanation at each step and answer is accurate and correct
	4	Calculation in order and answer is accurate and correct
	4	Calculation have explanation at each step and answer is correct
	3	Calculation in order and answer is correct
	2	Answer is accurate and correct
	1	Answer is correct
Tidiness	5	Answer can be read clearly, easy to understand, good and interesting illustration
	4	Answer can be read clearly, easy to understand, and have illustration

	3	Answer can be read clearly and easy to understand
	2	Answer can be read clearly
	1	Answer cannot be read clearly

Rubric 4 (Mid-Term Exam and Final Exam)

1) Able to write down their ideas and use it to solve a problem (25%);

2) Able to use the correct concept in solving the problem (35%);

3) Able to formulate the final result correctly (30%);

4) Able to use the appropriate dimension, units, and significant figures (10%);