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## Universitas Negeri Surabaya Faculty of Engineering, Mechanical Engineering Undergraduate Study Program

Document Code

## SEMESTER LEARNING PLAN Compilation Date Courses CODE **Course Family Credit Weight** SEMESTER Basic chemistry 2120103110 Compulsory Study T=3 P=0 ECTS=4.77 1 October 3, 2022 AUTHORIZATION Course Cluster Coordinator SP Developer Study Program Coordinator Bellina Yunitasari, S.Si., M.Si Bellina Yunitasari, S.Si., M.Si. Ir. Priyo Heru Adiwibowo, S.T., M.T. Learning model **Project Based Learning** Program PLO study program that is charged to the course Learning Outcomes **PLO-14** Science and engineering knowledge (PLO) Program Objectives (PO) Demonstrate an understanding of chemistry and be able to explain the general principles, laws, and theories of chemistry basis for further study PO - 1 PO - 2 Be able to Use critical thinking and logic in the solution of chemistry problems. Able to formulate and solve chemical problems Apply learned chemistry skills to analyze new issue/ Able to analyze the relationship between molecular behavior and observable physical properties PO - 3 **PLO-PO** Matrix P.0 PLO-14 PO-1 PO-2 PO-3 PO Matrix at the end of each learning stage (Sub-PO) P.0 Week 1 2 4 5 7 3 6 8 9 10 11 12 13 14 15 16 PO-1 PO-2 PO-3 Introduction to chemistry, atomic structure, periodic table of elements, chemical bonds, stoichiometry, thermochemistry, chemical kinematics, chemical equilibrium, electrochemistry, polymers, fuel chemistry, and nuclear chemistry as well as basic chemical knowledge related to the field of mechanical engineering. Short Course Description References Main : 1. Petrucci, Ralph H., dkk. 2011. General Chemistry: Priciples and Modern Application. 10th ed. Pearson Prentice Hall: USA; 2 Laird, Brian B. 2009. University of Chemistry.New York: McGraw-Hil 3. Whitten KW, et. al. General Chemistry London, Saunders College 4 Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/details/books/chemistry-2e. Supporters: 1. Bellina, Yunitasari.2022. Buku Ajar Kimia Dasar Untuk Mahasiswa Teknik Mesin.Unipres, Unesa. Dr. Mohammad Effendy, S.T., M.T. Bellina Yunitasari, S.Si., M.Si. Hanna Zakiyya, S.T., M.T. Supporting lecturer Help Learning, Learning methods, Student Assignments, Final abilities of **Evaluation** each learning stage Learning materials Assessment Weight (%) Week [Estimated time] [References] (Sub-PO) Offline ( offline ) Indicator Criteria & Form Online ( online )

1	Understanding The Chemistry in Context, Classification of Matter and Physical and Chemical Properties	<ol> <li>Describe how chemistry and engineering helped transform aluminum from a precious metal into an inexpensive structural material.</li> <li>Explain the usefulness of the macroscopic, and symbolic perspectives in understanding chemical systems.</li> <li>Identify properties of and changes in matter as physical or chemical</li> <li>Identify properties of matter as extensive or intensive</li> <li>Draw pictures to illustrate simple chemical phenomena (like the differences among solids, liquids, and gases) on the molecular scale.</li> <li>Use appropriate ratios to convert measurements from one unit to another.</li> <li>Express the results of calculations using the correct number of significant figures.</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Aluminum The Study of Chemistry The Science of Chemistry: Observations and Models Numbers and Measurements in Chemistry Problem Solving in Chemistry and Engineering Material Selection and Bicycle Frames Phases and Classification of Matter Physical and Chemical Properties <b>References:</b> <i>Flower,</i> <i>Paul, et. al. Chemistry</i> <i>2e. OpenStax, Rice</i> <i>University.</i> <i>https://openstax.org/</i>	20%
2	Understanding The Atoms Structure, Molecules, and Ions	<ol> <li>Outline milestones in the development of modern atomic theory</li> <li>Summarize and interpret the results of the experiments of Thomson, Millikan, and Rutherford</li> <li>Describe the three subatomic particles that compose atoms</li> <li>Define isotopes and give examples for several elements</li> <li>Describe the Wave nature of light</li> <li>Describe the Bohr model of the hydrogen atom</li> <li>Extend the concept of wave-particle duality that was observed in electromagnetic radiation to matter as well</li> <li>Understand the general idea of the quantum mechanical description of electrons in an atom, and that it</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Atoms and Electronic Structure, Molecules, and Ions References: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	0%

1	1					
		uses the notion				
		of three-				
		dimensional				
		wave functions,				
		or orbitals, that				
		define the				
		distribution of				
		probability to find				
		an electron in a				
		particular part of				
		space				
		9.List and describe				
		traits of the four				
		quantum				
		numbers that				
		form the basis				
		for completely				
		specifying the				
		specifying the				
		oloctron in an				
		electron in an				
		10 Write and				
		interpret oumbole				
		thet deniet the				
		that depict the				
		atomic number,				
		mass number,				
		and charge of an				
		atom or ion				
		11.Define the				
		atomic mass unit				
		and average				
		atomic mass				
		12.Derive the				
		predicted				
		ground-state				
		electron				
		configurations of				
		atoms				
		13.Identify and				
		explain				
		exceptions to				
		predicted				
		electron				
		configurations				
		for atoms and				
		ions				
		14.Relate electron				
		configurations to				
		element				
		classifications in				
		the periodic table				

3	Understanding The Periodic Table	1.Describe and explain the	Criteria: According to the	Lectures, discussions,	Lectures, discussions, questions and	Material: The Periodic Table	25%
		observed trends	Assessment Rubric	questions and answers,	answers, exercises and assignments	<b>References:</b> Flower, Paul, et. al. Chemistry	
		ionization	Form of	exercises and assignments	3 X 50	2e. OpenStax, Rice University.	
		electron affinity	Test	3 X 50		https://openstax.org/	
		of the 3.2 elements				Material: Periodic	
		2.State the periodic law and				Properties, Molecular	
		explain the organization of				Chemical	
		elements in the				Chemical Formulas	
		3.Predict the				References: Flower, Paul, et. al. Chemistry	
		general properties of				2e. OpenStax, Rice University.	
		elements based on their location				https://openstax.org/	
		within the					
		4.Identify metals,					
		metalloids by					
		their properties and/or location					
		on the periodic table					
		5.Define ionic and					
		(covalent)					
		6.Predict the type					
		of compound formed from					
		elements based on their location					
		within the					
		7.Determine					
		simple ionic					
		compounds 8.Derive names					
		for common types of					
		inorganic compounds					
		using a					
		approach					
		composition of					
		molecules using molecular					
		formulas and empirical					
		formulas					
		bonding					
		atoms within					
		molecules using structural					
		formulas					

4	Geometry	<ol> <li>Explain the formation of cations, anions, and ionic compounds Predict the charge of common metallic elements, and write their electron configurations</li> <li>Describe the formation of covalent bonds Define electronegativity and assess the polarity of covalent bonds</li> <li>Write Lewis symbols for neutral atoms and ions Draw Lewis structures depicting the bonding in simple molecules</li> <li>Explain the concepts of polar covalent bonds and molecular polarity</li> <li>Assess the polarity of a molecule based on its bonding and structure</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Project Results Assessment / Product Assessment, Test	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Ionic Bonding, Covalent Bonding, Lewis Symbols and Structures, Molecular Structure and Polarity <b>References:</b> Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	25%
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5	Understanding The	1 Coloulata	Criteria:	Lectures	Lectures discussions	Material: Formula	0%
5	Composition of	formula masses	According to the	discussions,	questions and	Mass and the Mole	070
	Substances and	for covalent and	Assessment	questions and	answers, exercises and	Concept, Determining	
	3010110115	ionic compounds	Rubric	answers,	assignments	Empirical and	
		Define the	Form of	exercises and	3 X 50	Molecular Formulas,	
		amount unit	Assessment :	assignments		Molarity, Other Units	
		mole and the	Project Results	3 X 50		Concentrations	
		related quantity	Assessment /			References: Flower.	
		Avogadro's	Product			Paul, et. al. Chemistry	
		number	Assessment			2e. OpenStax, Rice	
		2.Explain the				University.	
		relationship				https://openstax.org/	
		between mass,					
		numbers of					
		atoms or					
		molecules, and					
		perform					
		calculations					
		deriving these					
		quantities from					
		one another					
		S.Compute the					
		composition of a					
		compound					
		4.Determine the					
		empirical formula					
		of a compound					
		5.Determine the					
		molecular					
		formula of a					
		6 Describe the					
		fundamental					
		properties of					
		solutions					
		7.Calculate					
		solution					
		concentrations					
		using molarity					
		8.Perform dilution					
		using the dilution					
		equation					
		9.Define the					
		concentration					
		units of mass					
		percentage,					
		volume					
		percentage,					
		nercentage					
		parts-nermillion					
		(ppm), and					
		parts-per-billion					
		(ppb)					
		10.Perform					
		computations					
		relating a					
		solution's					
		and its					
		components'					
		volumes and/or					
		masses using					
		these units					

6	Understanding The Stoichiometry of Chemical Reactions	<ol> <li>Derive chemical equations from narrative descriptions of chemical reactions.</li> <li>Write and balance chemical equations in molecular, total ionic, and net ionic formats.</li> <li>Define three common types of chemical reactions (precipitation, acid-base, and oxidation- reduction)</li> <li>Classify chemical reactions as one of these three types given appropriate descriptions or chemical equations</li> <li>Identify common acids and bases</li> <li>Predict the solubility of common inorganic compounds by using solubility rules</li> </ol>	Criteria: According to the Assessment Rubric Forms of Assessment : Project Results Assessment / Product Assessment, Practical Assessment	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Writing and Balancing Chemical Equations, Classifying Chemical Reactions, Reaction Stoichiometry, Reaction Yields Literature: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	0%
		inorganic compounds by using solubility rules 7.Compute the oxidation states for elements in					
		compounds 8.Explain the concept of stoichiometry as it relates to chemical reactions					
		9.Use balanced chemical equations to derive stoichiometric 10.factors relating					
		amounts of reactants and products 11.Perform stoichiometric calculations involving mass					
		moles, and solution molarity					

7	Understanding The Stoichiometry of Chemical Reactions	<ol> <li>Derive chemical equations from narrative descriptions of chemical reactions.</li> <li>Write and balance chemical equations in molecular, total ionic, and net ionic formats.</li> <li>Define three common types of chemical reactions (precipitation, acid-base, and oxidation- reduction)</li> <li>Classify chemical reactions as one of these three types given appropriate descriptions or chemical equations</li> <li>Identify common acids and bases</li> <li>Predict the solubility of common inorganic compounds by using solubility rules</li> <li>Compute the oxidation states for elements in compounds</li> <li>Explain the concept of stoichiometric</li> <li>Chactors relating amounts of reactants and products</li> <li>Perform stoichiometric calculations involving mass, moles, and solution molarity</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Project Results Assessment / Product Assessment	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Writing and Balancing Chemical Equations, Classifying Chemical Reactions, Reaction Stoichiometry, Reaction Yields Literature: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	0%
8	U.S.S	U.S.S	Criteria: According to the Assessment Rubric Form of Assessment : Test	SUB ASSESSMENT 3 X 50	SUB ASSESSMENT 3 X 50	Material: meeting material 1 to 7 References: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	0%

9	Understanding The	1.Define	Criteria:	Presentations,	Presentations,	Material: Balancing	0%
	Electrochemistry	electrochemistry	According to the Assessment	Lectures, discussions,	Lectures, discussions, questions and	Oxidation-Reduction Reactions, Galvanic	
		important	Rubric	questions and	answers, exercises and	Cells, Standard	
		associated terms	Form of	answers, exercises and	assignments 3 X 50	The Nernst Equation,	
		reduction	Project Results	assignments		Batteries and Fuel	
		reactions into	Assessment /	3 × 50		Electrolysis	
		their oxidation half-reactions	Assessment			References: Flower,	
		and reduction				2e. OpenStax, Rice	
		half-reactions 3 Produce				University. https://openstay.org/	
		balanced				mips.//opensiax.org/	
		oxidation-					
		equations for					
		reactions in					
		solutions					
		4.Identify oxidizing					
		_ reducing agents					
		5.Use cell notation to describe					
		galvanic cells					
		6.Describe the basic					
		components of					
		galvanic cells 7.Determine					
		standard cell					
		potentials for oxidation-					
		reduction					
		reactions 8.Use standard					
		reduction					
		potentials to determine the					
		better oxidizing					
		or reducing agent from					
		among several					
		9.Relate cell					
		potentials to free					
		10.Use the Nernst					
		equation to					
		potentials at					
		nonstandard					
		11.Perform					
		calculations that					
		converting					
		between cell					
		energy changes,					
		and equilibrium					
		12.Classify					
		batteries as primary or					
		secondary					
		the					
		characteristics					
		batteries					
		14.Provides a					
		description of a					
		fuel cell					
		corrosion List					
		some of the					
		prevent or slow					
		corrosion					
		electrolytic cells					
		and their					
		galvanic cells					
		17.Perform					
		calculations					
		related to					
		CICCU OIYSIS	1				

10	Understanding The	1.Define	Criteria:	Presentations,	Presentations,	Material: Balancing	0%
	Electrochemistry	electrochemistry and a number of	According to the Assessment Rubric	Lectures, discussions,	Lectures, discussions, questions and	Oxidation-Reduction Reactions, Galvanic	
		important		questions and answers,	answers, exercises and assignments	Cells, Standard Reduction Potentials,	
		2.Split oxidation-	Form of Assessment :	exercises and	3 X 50	The Nernst Equation,	
		reduction	Project Results	3 X 50		Cells, Corrosion,	
		their oxidation	Product			Electrolysis References: Flower.	
		half-reactions	Assessment			Paul, et. al. Chemistry	
		half-reactions				University.	
		3.Produce balanced				https://openstax.org/	
		oxidation-					
		reduction equations for					
		reactions in					
		solutions					
		4.Identify oxidizing					
		reducing agents					
		5.Use cell notation to describe					
		galvanic cells					
		6.Describe the basic					
		components of					
		galvanic cells 7.Determine					
		standard cell					
		oxidation-					
		reduction					
		8.Use standard					
		reduction					
		determine the					
		or reducing					
		agent from					
		possible choices					
		9.Relate cell potentials to free					
		energy changes					
		equation to					
		determine cell					
		nonstandard					
		conditions 11.Perform					
		calculations that					
		converting					
		between cell					
		energy changes,					
		and equilibrium					
		12.Classify					
		batteries as primary or					
		secondary					
		the					
		characteristics and limitations of					
		batteries					
		14.Provides a general					
		description of a					
		15.Define					
		corrosion List					
		methods used to					
		prevent or slow corrosion					
		16.Describe					
		electrolytic cells and their					
		relationship to					
		17.Perform					
		various calculations					
		related to					
		electrolysis					

spontaneous.	spontaneous.	a reaction will be	11	Understanding The Entropy and the Second Law of Thermodynamics	<ol> <li>1.describe the scientific and economic obstacles to more widespread recycling of plastics</li> <li>2.explain the concept of entropy in your own words. deduce the sign of DS for many chemical reactions by examining the physical state of the reactants and products</li> <li>3.state the second law of thermodynamics in words and equations and use it to predict spontaneity.</li> <li>4.states the third law of thermodynamics.</li> <li>5.use tabulated data to calculate the entropy change in a chemical reaction.</li> <li>6.derive the relationship between the free energy change of a system and the entropy change of the universe.</li> <li>7.use tabulated data to calculate the free energy change of a system and the entropy change of the universe.</li> <li>8.explain the role of temperature in determining whether a reaction.</li> <li>8.explain the role of temperature in determine the temperature in de</li></ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Material: Recycling of Plastics Spontaneity Entropy, The Second Law of Thermodynamics, The Third Law of Thermodynamics, Gibbs Free Energy, Free Energy and Chemical Reactions <b>References</b> : <i>Flower</i> , <i>Paul, et. al. Chemistry</i> <i>2e. OpenStax, Rice</i> <i>University.</i> <i>https://openstax.org/</i>	0%
a reaction will be	a reaction will be				range for which					
range for which a reaction will be	range for which a reaction will be	range for which			temperature					
temperature range for which a reaction will be	temperature range for which a reaction will be	temperature range for which			determine the					
determine the temperature range for which a reaction will be	determine the temperature range for which a reaction will be	determine the temperature range for which			data to					
data to determine the temperature range for which a reaction will be	data to       determine the       temperature       range for which       a reaction will be	data to determine the temperature range for which			9.use tabulated					
9.use tabulated data to determine the temperature range for which a reaction will be	9.use tabulated       data to       determine the       temperature       range for which       a reaction will be	9.use tabulated data to determine the temperature range for which			spontaneous.					
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12	Understanding Thermochemistry	<ol> <li>Define energy, distinguish types of energy, and describe the nature of energy changes that accompany chemical and physical changes</li> <li>Distinguish the related properties of heat, thermal energy, and temperature</li> <li>Define and distinguish</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Material: Energy Basics, Calorimetry, Enthalpy References: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/ Material: Thermochemistry Bibliography: Laird, Brian B. 2009. University of Chemistry. New York: McGraw-Hil	0%
		<ul> <li>4. Perform <ul> <li>calculations</li> <li>involving heat,</li> <li>specific heat,</li> <li>and temperature</li> <li>change</li> </ul> </li> <li>5. Explain the <ul> <li>technique of</li> <li>calorimetry and</li> <li>Calculate and</li> <li>interpret heat</li> <li>and related</li> <li>properties using</li> <li>typical</li> <li>calorimetry data</li> </ul> </li> <li>6. State the first <ul> <li>law of</li> <li>thermodynamics</li> </ul> </li> <li>7. Define enthalpy <ul> <li>and explain its</li> <li>classification as</li> <li>a state function</li> </ul> </li> <li>8. Write and <ul> <li>balance</li> <li>thermochemical</li> <li>equations</li> </ul> </li> <li>9. Calculate <ul> <li>enthalpy</li> <li>changes for</li> <li>various chemical</li> <li>reactions</li> </ul> </li> <li>10. Explain Hess's <ul> <li>law and use it to</li> <li>compute</li> <li>reaction</li> <li>enthalpies</li> </ul> </li> </ul>					

13	Understanding the Chemical Kinetics	<ol> <li>explain the role of chemical kinetics in the formation and destruction of ozone in the atmosphere.</li> <li>define the rate of a chemical reaction and express the rate in terms of the concentrations of individual reactants or products</li> <li>use the method of initial rates to determine rate laws from experimental data.</li> <li>use graphical methods to determine rate laws from experimental data</li> <li>explain the role of a catalyst in the design of practical chemical reactions</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Presentations, discussions, questions and answers, exercises and assignments 3 X 50	Material: Ozone Depletion, Rates of Chemical Reactions, Rate Laws and the Concentration Dependence of Rates, Catalysis Literature: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/	0%
14	Understanding the chemical equilibrium	<ol> <li>explain that equilibrium is dynamic and that at equilibrium, the forward and backward reaction rates are equal. State these ideas in your own words.</li> <li>write the equilibrium constant expression for any reversible reaction.</li> <li>calculate equilibrium constants from experimental data.</li> <li>calculate molar solubility from Ksp or vice versa.</li> <li>write equilibrium constants for the dissociation of weak acids and weak bases and use them to calculate pH or the degree of ionization.</li> <li>calculate the new equilibrium composition of a system after an applied stress</li> <li>explain the importance of both kinetic and equilibrium considerations in the design of industrial chemical processes.</li> <li>list important chemical reaction and weak thering of concrete</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Lectures, discussions, questions and answers, exercises and assignments 3X 50	Lectures, discussions, questions and answers, exercises and assignments 3X 50	Material: Chemical Equilibrium Equilibrium Constants Equilibrium Concentrations LeChatelier's Principle Solubility Equilibria Acids and Bases Free Energy and Chemical Equilibrium Concrete Production and Weathering Borates and Boric Acid <b>Reference</b> : <i>Flower</i> , <i>Paul</i> , et. al. Chemistry <i>2e. OpenStax</i> , <i>Rice</i> <i>University</i> . <i>https://openstax.org/</i> <b>Material:</b> Chemical Equilibrium Equilibrium Concentrations LeChatelier's Principle Solubility Equilibria Acids and Bases Free Energy and Chemical Equilibrium Concrete Production and Weathering Borates and Boric Acid <b>Bibliography:</b> <i>Laird</i> , <i>Brian B. 2009.</i> <i>University of</i> <i>Chemistry. New York:</i> <i>McGraw-Hil</i>	0%

15	Understanding of Nuclear Chemistry	<ol> <li>Describe nuclear structure in terms of protons, neutrons, and electrons</li> <li>Explain trends in the relative stability of nuclei</li> <li>Write and balance nuclear equations</li> <li>Recognize common modes of radioactive decay</li> <li>Identify common particles and energies involved in nuclear decay reactions</li> <li>Calculate kinetic parameters for decay processes, including half-life</li> <li>Relate the concepts of critical mass and nuclear chain reactions</li> <li>Summarize basic requirements for nuclear fission and fusion reactors</li> <li>List of common applications of radioactive isotopes</li> <li>Describe the biological impact of ionizing radiation Define units for measuring radiation exposure Explain the operation of common tools for detecting radioactivity</li> </ol>	Criteria: According to the Assessment Rubric Form of Assessment : Test	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Nuclear Structure and Stability Nuclear Equations Radioactive Decay Transmutation and Nuclear Energy Uses of Radioisotopes Biological Effects of Radiation Bibliography: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/ Material: Nuclear Structure and Stability Nuclear Equations Radioactive Decay Transmutation and Nuclear Energy Uses of Radioisotopes Biological Effects of Radiation Bibliography: Laird, Brian B. 2009. University of Chemistry. New York: McGraw-Hil	0%
16	Understanding of Nuclear Chemistry		Criteria: According to the Assessment Rubric Form of Assessment : Project Results Assessment / Product Assessment	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Lectures, discussions, questions and answers, exercises and assignments 3 X 50	Material: Nuclear Structure and Stability Nuclear Equations Radioactive Decay Transmutation and Nuclear Energy Uses of Radioisotopes Biological Effects of Radiation Bibliography: Flower, Paul, et. al. Chemistry 2e. OpenStax, Rice University. https://openstax.org/ Material: Nuclear Structure and Stability Nuclear Equations Radioactive Decay Transmutation and Nuclear Energy Uses of Radioistopes Biological Effects of Radiation Bibliography: Laird, Brian B. 2009. University of Chemistry. New York: McGraw-Hil	30%

## Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Project Results Assessment / Product Assessment	42.5%
2.	Test	57.5%
		100%

Notes

- Learning Outcomes of Study Program Graduates (PLO Study Program) are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
- 2. The PLO imposed on courses are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
- 3. Program Objectives (PO) are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
- 4. **Subject Sub-PO** (Sub-PO) is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
- 5. Indicators for assessing ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
- 6. Assessment Criteria are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
- 7. Forms of assessment: test and non-test.
- Forms of learning: Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
   Learning Methods: Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative
- Learning Methods: Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
- 10. Learning, consolitative cearning, contextual cearning, roject based cearning, and other equivalent metricus. topics.
- The assessment weight is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
- 12. TM=Face to face, PT=Structured assignments, BM=Independent study.