IPB UNIVERSITY
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
DEPARTEMEN KIMIA

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SEMESTER LEARNING PLAN

COURSE CODE
CHEMICAL EQUILIBRIUM
2 (2–0)

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Instructional Analysis

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SEMESTER LEARNING PLAN

Course Name	:	Chemical Equilibrium
Code/Credit	:	KIM.1242/2(2-0)[1)]
Semester	:	IV (four)
Description	:	This course is an application of thermodynamic concepts to the physical transformation of material in various cases found in chemistry, in general, and physical chemistry in particular. The tendency of physical transformation of pure and mixed materials is viewed from the equilibrium criterion based on the thermodynamic parameters of free energy, as well as chemical potential, activity, and activity coefficient. This course discusses the physical transformation of materials, phase diagrams, solution properties, chemical and electrochemical equilibrium, as well as explanations of cases found in chemistry based on a thermodynamic approach. The scope of discussion and learning process is to use active learning through small group discussions, cooperative learning, and assignments
Prerequisite course	:	Thermodynamics Chemistry
Learning outcomes	:	1 Can understand the physical transformations of pure compounds and mixtures that include phase diagrams, phase stability, phase boundaries. 2 Can understand colligative properties and electrochemical events, based on thermodynamic equilibrium approaches using criteria of chemical potential, activity ,and activity coefficient. 3 Can understand the implications of thermodynamics and equilibrium on the development of material technology such as supercritical fluids, liquid crystals, and supramolecules
Scope and Curriculum Map of Royal Society of Chemistry (RSC)[2)]	:	• Entropy; as a description of disorder in a system (solid, liquid, and gas) • Calculate the change in the entropy of a system • Deriving the Boltzmann entropy formula • Feasibility using entropy and enthalpy • Statistical thermodynamics; laws of thermodynamics (zeroth, first, second, third), statistical
Division/Field	:	Physical Chemistry
Lecturers	:	Dr. Komar Sutriah, Dr. Henny Purwaningsih, Dr. Betty Marita

[1)]Tutorial/practicum activities are expressed in credits, not in the number of hours
[2)]See the Excel of RSC Chemistry Curriculum Map

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I LEARNING PLAN

Week of	Learning Outcome	Topic	Method	Duration	Student Experience	Assessment			Reference
						Criteria	Indicator	Weight (%)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1–5	Can: a Explain and apply the concepts of Gibbs free energy, chemical potential, and equilibrium to the phase transformation process of pure substances and simple mixtures b Explain and apply the concepts of Gibbs free energy, chemical potential, and equilibrium to the mixing process and their implications on the physical properties of mixtures (colligative properties).	a. Gibbs free energy and chemical potential, phase diagram of pure substances, phase limit stability, Clapeyron and Clausius Clapeyron equations, first-order and second-order phase transitions. b. Thermodynamics of mixing: partial molar quantities, Gibbs Duhem equations, Δ*G*, Δ*H*, Δ*S* mixing liquids. c. Properties of solutions: mixed liquids, colligative properties, solvent and solute activity, Rault's law, and Henry's law.	Synchronous-Face-to-Face Online/Offline Lectures include: a Lecture b Class Interactive Discussion c Review of Discussion Results	15 × 50 min	a Gain insight and explanation of Gibbs free energy and chemical potential, phase diagrams of pure substances, phase limit stability, Clapeyron and Clausius Clapeyron equations, first-order and second-order phase transitions. b Gain insight and explanation of mixing thermodynamics: partial molar quantities, Gibbs Duhem equations, Δ*G*, Δ*H*, Δ*S* of mixing liquids. c Gain insight and explanation of the properties of solutions: mixed liquids, colligative properties, solvent and solute activity, Rault's law, and Henry's law.	**Hard Skills:** Completeness and correctness about: a Thermodynamics as a science/tool predicts the occurrence of material transformation processes. b ΔG and chemical potential at phase change of pure substances c Change in chemical potential of substances by temperature d The boundary profiles of solid, liquid, and gaseous phases, melt, evaporate, and sublimate. e Phase diagram of water, CO_2, carbon, and helium	a >90% of students answered correctly about the relationship between ΔG, and its potential with material transformation b >90% of students correctly answered the question / example case of the relationship of ΔG, with a phase change of pure substance. c >90% of students answered correctly the questions/examples of potential changes by temperature. d >90% of students answered correctly about phase change: melting, boiling, and sublimating. e >90% of students answered correctly	30	1, 2, 3, 4

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						f Dependence of chemical potential on temperature g The equations of Clapeyron and Clausius Clapeyron, and the construction of phase diagrams h First-order and second-order phase transformations i Partial molar quantity: partial molar volume j ΔG, ΔH, ΔS of mixing k Chemical potential of liquid mixtures, ideal solutions, Rault's law, Henry's law l Real, Non-Ideal Solutions and Excess Functions m Colligative properties and solubility **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility	about the phase diagram of water, CO_2, carbon, and helium f >80% of students answered correctly about changes in chemical potential by temperature. g >80% of students answered correctly the question of constructing a phase diagram based on the Clausius Clapeyron equation h >90% of students answered correctly about partial molar magnitude and partial molar volume i >90% of students answered correctly the mixing thermodynamics cases j >90% of students correctly answered the ideal solution case, Rault's and Henry's laws k >90% of students answered correctly the questions/examples		

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						4 Discipline accuracy and thoroughness in making questions and statements during interactive discussions	of non-ideal solution cases, and the function of advantages. l >90% of students answered correctly the questions/examples of cases of colligative properties of solutions and solubility.		
6–9	Can: a Explain the concepts of phases, components, and degrees of freedom/variance of systems in thermodynamics b Apply phase rules to a one-component phase diagram c Explain the concept of a two-component phase diagram d Explain the concept of a three-component phase diagram	a Definition of phases, components, and free degrees b Phase rules c Vapor pressure diagram d Composition-temperature diagram e Liquid-liquid phase diagram f Liquid-solid phase diagram g Triangular phase diagram h Partially mixed liquid i The role of added salt	Synchronous-Face-to-Face Online/Offline Lectures include: a Lecture b Class Interactive c Review of Discussion Results	12 × 50 min	a Gain insight and explanation of Phase Diagrams through visual learning b Interact with students and: • Lecturers • Other students • Teaching materials c Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	**Hard Skills:** Completeness and correctness about: a Definition of phases, components, and free degrees b Phase rules c Steam Pressure Diagram: Steam Composition d Vapor Pressure Diagram: Diagram Interpretation e Steam Pressure Diagram: Lever Rule f Composition-Temperature Diagram: Distillation of Mixtures	a >90% of students answered correctly about the definition of phases, components, and degrees of freedom b >90% of students answered correctly about the phase rules c >80% of students answered correctly the Steam Pressure Diagram: Steam Composition d >80% of students answered correctly the Vapor Pressure Diagram: Diagram Interpretation question e >80% of students correctly answered the Vapor Pressure	40	1, 2, 3, 4

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						g Temperature-Composition diagram: Azeotrope h Temperature-Composition Diagram: Immiscible Liquids i Liquid-liquid phase diagram: phase separation j Liquid-liquid phase diagram: critical temperature k Liquid-Liquid Phase Diagram: Partially mixed liquid distillation l Liquid-Solid Phase Diagram: Eutectic m Liquid-Solid Phase Diagram: Reactive Systems n Liquid-Solid Phase Diagram: Incongruent melting o Three-component phase diagram	Diagram: Lever's Rule question correctly f >80% of students correctly answered the Temperature-Composition Diagram: Mixed Distillation g >80% of students answered correctly the Temperature-Composition Diagram: Azeotrope h >80% of students answered correctly the Temperature-Composition Diagram question: Liquids do not dissolve each other i >80% of students answered correctly the question Liquid-Liquid Phase Diagram: Phase Separation j >80% of students correctly answered the Liquid-Liquid Phase Diagram: Critical Temperature question k >80% of students answered correctly		

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						p Three-Component Phase Diagram: Liquids of Partially Miscible q Three-Component Phase Diagram: The Role of Added Salt **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline accuracy and thoroughness in making questions and statements during interactive discussions	the Liquid-Liquid Phase Diagram: Distillation of Partially Mixed Liquids l >80% of students answered correctly the Liquid-Solid Phase Diagram: Eutectic question m >80% of students correctly answered the question Liquid-Solid Phase Diagram: Reactive Systems n >80% of students answered correctly the Liquid-Solid Phase Diagram: Incongruent melting o >80% of students answered correctly the Three-Component Phase Diagram question p 80% of students correctly answered the Three-Component Phase Diagram question: Liquids Can Mix Partially q 80% of students answered correctly the question Three-		

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							Component Phase Diagram: The Role of Added Salt		
10-14	Can: a Explain the spontaneity of chemical reactions b Describe equilibrium responses to conditions c Explain equilibrium in electrochemistry	a Minimum Gibbs energy b Description of equilibrium c How equilibrium responds to pressure d Equilibrium response to temperature e Impact on metal extraction techniques from their oxides f Half-reaction and electrodes g Cell types h Electromotive force i Potential standard j Potential applications of the standard k Influence of electrochemistry on biochemistry	Synchronous-Face-to-Face Online/Offline Lectures include: a Lecture *b* Class Interactive Discussion *c* Review of Discussion Results		a Gain insight and explanation of chemical equilibrium and electrochemical equilibrium b Interact with students and: • Lecturers • Other students • Teaching materials c Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	**Hard Skills:** Completeness and correctness about: a Gibbs minimum energy definition b Description of equilibrium c How equilibrium responds to pressure d Equilibrium response to temperature e Impact on metal extraction techniques from their oxides f Half-reaction and electrode g Cell types h Electromotive force i Potential standard j Potential applications of the standard	a >90% of students answered correctly about Gibbs' definition of minimum energy b >90% of students answered correctly about the Equilibrium description c >80% of students answered correctly about the equilibrium response to pressure d >80% of students answered correctly about the equilibrium response to temperature e >80% of students answered correctly about the impact on metal extraction techniques from their oxides f >90% of students answered correctly the half-reaction and electrode questions	30	1, 2, 3, 4

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						k Effects of electrochemistry on biochemistry **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline accuracy and thoroughness in making questions and statements during interactive discussions	g >90% of students answered correctly about cell variation h >80% of students answered correctly about electromotive force i >80% of students answered correctly about potential standard questions j >80% of students answered correctly about the potential application of the standard k >80% of students answered correctly about the effect of electrochemistry on biochemistry		

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II. ASSESSMENT DESIGN

No	Learning Outcomes Courses	Assignments (Resume/Papers/Presentations/Small Projects, others)[3)]	Quiz	Exam		
				Exam 1	Exam 2	Exam 3
1	Application of thermodynamics to the phase transformation of substances, and the mixing of substances		xxx	√	xxx	xxx
2	Phase Diagram	Group assignments to answer the questions	xxx	xxx	√	xxx
3	(Chemical Equilibrium and Electronic Equilibrium---Period Weeks 11 to 14)		xxx	xxx	xxx	√

[3)]Choose one

III. ASSESSMENT WEIGHTS

Assessment Criteria	Score Range	Score Weight (%)	Information
Assignment	70–100	10	Group score
Quiz	0–100	xxx	Individual score
Tuition Assessment:			
Exam 1	0–100	30	Individual score
Exam 2	0–100	30	Individual score
Exam 3	0–100	30	Individual score
Practicum/Assessment	0–100	xxx	Individual score
Total		**100**	

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IV. ASSESSMENT RUBRIC [4)]

Grade	Group Exam and Resume Assessment Criteria
A	If students can: - Complete group tasks on time - Tasks are carried out neatly, clearly, and systematically in the stages of work - All tasks are done 100% correctly - Complete exams 1, 2, and 3 (≥ 80%)
AB	If students can: - Complete group tasks on time - Tasks are carried out neatly, clearly, and systematically in the stages of work - Complete exams 1, 2, and 3 (66 to 79%) - All tasks are done 80-99% correct Complete exams 1, 2, and 3 *66 to 79%)
B	If students can: - Complete group tasks **beyond** the agreed time - Tasks **are not** done neatly, clearly, and systematically in the stages of work - The correctness of the task is 50-80% correct - Complete exams 1, 2, and 3, ≤ 65%
Not marked	Late submission and correctness are below < 50%

[4)]The grading rubric can be adjusted to the assigned task

V. REFERENCES

1 Atkin P, Paula J.D. 2010, Physical Chemistry 9th Ed, Oxford University Press, New York: WH Freeman and Co
2 Atkin P, et al, 2006, Student's Solution Manual to Accompany Physical Chemistry 8th Ed, Oxford University Press.
3 Metz C R, 1989, Theory and Problem of Physical Chemistry Second Ed, McGraw-Hill
1. Open sources from websites, scientific articles from related scientific journals or magazines