IPB UNIVERSITY
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
DEPARTEMEN KIMIA

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SEMESTER COURSE PLAN

KIM359C
SYNTHESIS OF ORGANIC AND INORGANIC MATTER
3(3-0)

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Course Name	: Synthesis of Organic and Inorganic Materials
Code/Credit	: KIM359C 3(3-0)
Semester	: Even (Semester 6)/3(3-0)
Description	: This Organic and Inorganic Matter Synthesis course is a compulsory course of the Department of Chemistry. This course discusses the scope, design, and strategy in the synthesis of organic and inorganic materials, by paying attention to the aspects of green chemistry in the use of materials, processes, and applications. The scope of discussion and learning process is a combination of pulpit lectures and active learning through group discussions, cooperative learning, and presentations. The language of instruction used in this lecture is Indonesian.
Prerequisites course	:
Learning Outcomes	: 1. Can build a basic framework of organic and inorganic matter 2. Can insert and modify functional groups or active sites of organic and inorganic matter 3. Can explain the application of synthetic organic and inorganic materials 4. Can apply the principles of green chemistry in selecting materials and processes in the synthesis of organic and inorganic materials
Scope and Curriculum map of Royal Society of Chemistry Curriculum (RSC)	: 1. Organic synthesis; reactions of alkanes, alkenes, halogenoalkanes, alcohols, arenes, ketones, aldehydes, phenols, acyl chlorides, carboxylic acids, esters, amines, amino acids, amides, nitriles. 2. Synthetic techniques in organic and retrosynthesis 3. Inorganic synthesis 4. Synthesis of Nanocompositesand, Nanoparticles and Nanomaterials
Division/Field	: Cross Division (Organic Chemistry and Inorganic Chemistry)
Lecturers	: Division of Organic Chemistry and Inorganic Chemistry 1. Prof. Dr. Dra. Purwantiningsih Sugita, MS 3. Dr. Zaenal Abidin 2. Dr. Budi Arifin, S.Si., M.Si

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Table 1. BLENDED LESSON PLAN (Organic: 7× Offline and 1× Online)

WEEK OF	LEARNING OUTCOMES	TOPIC	METHOD	DURATION	STUDY EXPERIENCE	ASSESSMENT			REFERENCES
						CRITERIA	INDICATOR	WEIGHT (%)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Students can explain **Functionalization and interconversion of functional groups**	**A. Functionalization of functional groups** 1. Functionalization of alkane groups 2. Functionalization of alkene groups 3. Functionalization of alkyne groups 4. Functionalization of aromatic hydrocarbon groups 5. Functionalization of substituted benzene derivatives 6. Functionalization of simple heterocyclic compounds B. **Functional Group Interconversion**	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of Functionalization and Interconversion of Functional Groups 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	**Hard Skills:** Completeness and correctness of explanations about Functionalization and interconversion: 1. alkanes 2. alkenes 3. alkynes 4. aromatic hydrocarbons 5. substituted benzene derivatives 6. Simple heterocyclic compounds **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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2	Students can explain **the principles of forming C-C**	Basics of C-C bond formation strategies: 1. Strategy for designing a synthesis 2. Synthon disconnection and bonding 3. Electrophilic carbon species 4. Nucleophilic carbon species	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**2 × 50 min**	1. Gain insight and explanation of the principles of C-C formation 2. Interact with students and: • lecturer • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	***Hard skills:*** Completeness and correctness of explanation of the Strategy of designing a synthesis, disconnection, and entanglement of synthons, electrophilic carbon species, and nucleophilic carbon species correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**
2-3	Students can explain the **principle of forming C-C through the use of carbanions sourced from organometals**	1. Organolithium reagents 2. Organo magnesium reagents 3. Organotitanium reagents 4. Organocopper reagents	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion	**3 × 50 min**	1. Gain insight and explanation of the formation of C-C through the use of carbanions sourced from organometallics 2. Interact with students and:	***Hard skills:*** Completeness and correctness of explanations of Electrophilic and Grignard reagents, Electrophilic and other organometallic reagents correctly	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		5. Organozinc reagents	c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3		• Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	**Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
3-4	Students can explain **the principles of forming C-C using carbanion Stabilized and nucleophilic Related**	1. Stability of carbanions through two electron-withdrawing groups 2. Stability of carbanions through one electron-withdrawing group 3. Stability of carbanions through phosphorus and sulfur groups	***Asynchronous: Online via Zoom/WA/LMS)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**4 × 50 min**	1. Gain insight and explanation of C-C formation using stabilized and nucleophilic carbanions 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	***Hard skills:*** Completeness and correctness of explanations of the stability of carbanions through one and two electron-attracting groups and Stability of carbanions through phosphorus and sulfur groups correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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						questions and statements			
	EXAM I							**20**	
5	Students can explain **the principle of the formation of C-heteroatom**	Basics of the formation of C-heteroatom bonds: 1. C-halogen bonds 2. C-oxygen bonds 3. C–sulfur bonds 4. C-nitrogen bonds Exercise: Retrosynthesis of C-heteroatom	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of the principle of formation of C-heteroatom 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	***Hard skills:*** Completeness and correctness of the explanation of the Basics of the formation of C-heteroatom bonds C-halogen, C-oxygen, C - sulfur, and C-nitrogen correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**
6	Students can explain **the opening reaction and ring closure**	1. Basic principles of Cyclization through electrophilic-nucleophilic interaction 2. Cycloaddition reaction 3. Ring closure	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion	**2 × 50 min**	1. Gain insight and explanation of ring opening and closing reactions 2. Interact with students and: • Lecturers • Other students	***Hard skills:*** Completeness and correctness of the explanation of the Basic principles of Cyclization through electrophilic-nucleophilic interaction,	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		4. Ring opening	c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3		• Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	cyclization reactions correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
7	Students can explain the design of **molecular structures of organic based on the synthon approach**	**Review of organic reactions** in designing organic structures: substitution, elimination, addition, oxidation-reduction, etc. **Review of reagents** related to the synthesis of organic molecules: catalytic hydrogenation, reduction of metal hydrides, reduction of metal dissolution, protective groups,	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**4 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	***Hard skills:*** Completeness and correctness of the explanation of the Review of organic reactions in order to design organic structures: substitution, elimination, addition, **oxidation-reduction** correctly Completeness and correctness of explanation of Review of reagents related to organic molecular synthesis: catalytic	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		reagents of boron, phosphorous, silicone, etc. Example: synthesis of reaction of choice				hydrogenation, reduction of metal hydrides, reduction of metal dissolution**, protective groups**, boron, phosphorous, silicone reagents correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
EXAM II/MIDTERM								**20**	
8	Students can explain inorganic materials and their characterization (Introduction)	1. Concept of Nanotechnology 2. History of Nanotechnology 3. Classification of Nanomaterials 4. Synthesis of Nanostructures 5. Properties of Nanomaterials	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students	***Hard skills:*** Completeness and correctness of the explanation of inorganic materials and their characterization (Introduction) correctly **Soft Skills:** 1. Activeness	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		6. Characterization of Nanomaterials 7. Application of Nanomaterials 8. The Future and Risks of Nanotechnology [Appendix 1]	Task design: Tables 2 and 3		• Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
9	Students can explain the Methods for the Synthesis of Nanoparticles	1. Introduction 2. Synthesis of Nanoparticles 3. Synthesis of Nanocomposites [Appendix 1]	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	**Hard skills:** Completeness and correctness of the explanation of the *Methods for Synthesis of Nanoparticles* correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**
10	Students can explain the Synthesis of Nanocomposites	1. Introduction 2. Synthesis of Polymer Nanocomposite	***Synchronous Face-to-Face Lectures (Offline)***	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular	**Hard skills**: Completeness and correctness of the explanation of the *Synthesis of*	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		s 3. Synthesis of Ceramic Nanocomposites 4. Synthesis of Metal Matrix Nanocomposites [Appendix 1]	**Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3		structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	*Nanocomposites* correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
11	Students can explain the Green Synthesis of Nanomaterials	1. Introduction 2. Why Green Synthesis? 3. Synthesis of Nanoparticles 4. Applications of Nanoparticles [Appendix 1]	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint	***Hard skills:*** Completeness and correctness of explanation of *Green Synthesis of Nanomaterials* correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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					decision between lecturers and students	questions and statements			
12	Students can explain Metal Oxide Nanostructures	1. Introduction 2. Top-Down Fabrication Bottom-up Fabrication 3. General Applications of Metal Oxide Nanostructures [Appendix 1]	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	***Hard skills:*** Completeness and correctness of explanation of *Metal Oxide Nanostructures* correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**
13	Students can explain Nanoporous and nanoblock inorganic nanomaterials	1. Introduction 2. Theory of Nucleation and Growth 3. Nucleation and Growth in Zeolites 4. Synthesis of zeolite	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers	***Hard skills:*** Completeness and correctness of explanation of *Nano porous and nano block inorganic nanomaterials* correctly **Soft Skills:**	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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		5. Source of Si and Al 6. Surface properties 7. Nanoporous and nanoblock inorganic nanomaterials composite with other materials 8. Application of nanoporous and nanoblock inorganic nanomaterials	c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3		• Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between lecturers and students	1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering questions and statements			
14	Students can explain Layer, Tubular, and Spherical Inorganic Nanomaterials	1. Introduction 2. Synthesis of tubular and spherical material 3. Source of Si and Al 4. Surface properties 5. Tubular and spherical material composite with other material 6. Application of tubular and spherical material	***Synchronous Face-to-Face Lectures (Offline)*** **Activities** a. Lecture b. Class Interactive Discussion c. Review of Discussion Results d. Quizizz Task design: Tables 2 and 3	**3 × 50 min**	1. Gain insight and explanation of the design of organic molecular structures based on the synthon approach 2. Interact with students and: • Lecturers • Other students • Teaching materials 3. Gain conformity/ understanding, argue, and respect opinions for a joint decision between	***Hard skills:*** Completeness and correctness of explanation of *Layer, Tubular and spherical inorganic nanomaterials* correctly **Soft Skills:** 1. Activeness 2. Cooperation 3. Responsibility 4. Discipline 5. Accuracy and thoroughness in answering	Scoring rubrics: Tables 4, 5, and 6		**1, 2, 3**

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					lecturers and students	questions and statements			
EXAM III/FINAL EXAM								**40**	

Table 2. Assignment Design for Interactive Discussion in Class and Quizizz (Weeks of 1-7)

Week of	Material	Task Objectives	Task Description	Assessment Criteria
2	Meetings 1 to 4	Train students to achieve the final ability to meet subjects 1 and 2	The list of questions (problem sets) of the subjects of meetings 1 and 2 submitted via LMS/WA a week before the meeting, was done in groups	Accuracy, completeness, and clarity of individual answers
3		Train students to achieve the final ability of meeting subjects 2 and 3	The list of questions (problem sets) of the subjects of meetings 2 and 3 submitted via LMS/WA a week before the meeting, was done in groups	
4		Train students to achieve the final ability to meet subjects 3 and 4	The list of questions (problem sets) of the subjects of meetings 3 and 4 submitted via LMS/WA a week before the meeting, was done in groups	
Exercise I via LMS (Meeting material 1 to 4)				
EXAM 1 (Meeting materials 1 to 4)				
5	Meetings 5 to 7	Train students to achieve the final ability of meeting subject 5	The list of questions (problem sets) of the subjects of meeting 5 submitted via LMS/WA a week before the meeting, was done in groups	Accuracy, completeness, and clarity of individual answers
6		Train students to achieve the final ability of meeting subject 6	The list of questions (*problem sets*) of the subjects of meeting 6 submitted via LMS/WA a week before the meeting, was done in groups	
7		Train students to achieve the final ability of meeting subjects 7 and 8	The list of questions (*problem sets*) of the subjects of meetings 7 and 8 submitted via LMS/WA a week before the meeting, was done in groups	
Exercise II via LMS (Meeting material 5 to 7)				
EXAM 2/Midterm (Meeting material 5 to 7)				

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8	Meetings 8 to 11	Train students to achieve the final ability to meet subject 8	The list of questions (problem sets) of the subjects of meeting 8 submitted via LMS/WA a week before the meeting, was done in groups	Accuracy, completeness, and clarity of individual answers
9		Train students to achieve the final ability to meet subject 9	The list of questions (problem sets) of the subjects of meeting 9 submitted via LMS/WA a week before the meeting, was done in groups	
10		Train students to achieve the final ability to meet subject 10	The list of questions (problem sets) of the subjects of meeting 10 submitted via LMS/WA a week before the meeting, was done in groups	
11	Meetings 12 to 14	Train students to achieve the final ability to meet subject 11	The list of questions (problem sets) of the subjects of meeting 11 submitted via LMS/WA a week before the meeting, was done in groups	Accuracy, completeness, and clarity of individual answers
12		Train students to achieve the final ability of meeting subject 12	The list of questions (problem sets) of the subjects of meeting 12 submitted via LMS/WA a week before the meeting, was done in groups	
13		Train students to achieve the final ability of meeting subject 13	The list of questions (problem sets) of the subjects of meeting 13 submitted via LMS/WA a week before the meeting, was done in groups	
14		Train students to achieve the final ability of meeting subject 14	The list of questions (problem sets) of the subjects of meeting 14 submitted via LMS/WA a week before the meeting, was done in groups	
EXAM 4/Final (Meeting materials 8 to 14)				

Table 3. Comprehensive Training Task Plan via LMS (4x)

Week of	Comprehensive exercise of	Task Objectives	Task Description	Assessment Criteria
1-4	I	Train students to achieve the final ability to meet subjects 1 to 4	List of questions (problem set) of the subject matter of meetings 1 to 4	Accuracy, completeness, and clarity of answers
5-7	II	Train students to achieve the final ability to meet subjects 5 to 7	List of questions (problem set) of the subject matter of meetings 5 to 7	Accuracy, completeness, and clarity of answers
8-14	III	Train students to achieve the final ability to meet subjects 8 to 14	List of questions (problem set) of the subject matter of meetings 8 to 14	Accuracy, completeness, and clarity of answers

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Table 4. Assessment Design

Learning Outcomes	Interactive Discussions, Quizizz, and Comprehensive Exercises	Test			
		Exam I	Exam II (Midterm)	Exam III	Final
1. Can build a basic framework of organic and inorganic matter	√	√	√	√	√
2. Can insert and modify functional groups or active sites of organic and inorganic matter	√	√	√	√	√
3. Can explain the application of synthetic organic and inorganic materials	√	√	√	√	√
4. Can apply the principles of green chemistry in selecting materials and processes in the synthesis of organic and inorganic materials	√	√	√	√	√

Table 5. Assessment Weights

Assessment Criteria	Score Range	Weight (%)	Information
Weekly Task Assessments, Quizizz, and Comprehensive Exercises Small group presentations: 1. Systematics and content of presentation; 2. Ability to respond to questions (whether or not appropriate); 3. Clarity of presentation (voice volume and intonation). Small group discussions and cooperative learning: 1. Communication Aspect: provides specific and easy-to-understand explanations; uses methods/tools (body movements, analogies, and concept maps) to help comprehension of messages by colleagues; use constructive ways of expressing opinions and reasoning. 2. Discussion Aspect: does not dominate the discussion and contributes actively. 3. Openness aspect: ask for feedback on himself and value colleagues' opinions; use the knowledge and experience of other members in the group as a source of knowledge.	55-100	20	Individual score

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4. Other aspects of Behavior: work together to develop a group work plan and conduct evaluations; willing to accept specific tasks/roles and share responsibilities..			
▪ Exam I ▪ Exam II (Midterm) ▪ Exam III (Final) I**norganic Division**	0-100 0-100 0-100	20 20 40	Individual score Individual score Individual score Individual score
Grade of KIM359C 3(3-0)		**100**	

Table 6. Interactive Discussion Assessment Criteria

Score Range	Group Discussion Assessment Criteria
90-100	If students can provide specific and easy-to-understand explanations, use methods/tools (body movements, analogies, and concept maps) to help the understanding of messages by colleagues and use constructive ways in expressing opinions and reasoning. Students can contribute actively, respect the opinions of colleagues, work together, and conduct evaluations in groups.
80--<90	If students can provide specific and easy-to-understand explanations, use methods/tools (body movements, analogies, and concept maps) to help the understanding of messages by colleagues and use constructive ways in expressing opinions and reasoning. Students can contribute actively and value the opinions of colleagues in the group.
70--<80	If students can provide specific and easy-to-understand explanations, use ways/tools (body movements, analogies, and concept maps) to help understand messages by colleagues and use constructive ways of expressing opinions and reason. Students can contribute actively.
60--<70	If students can provide specific and easy-to-understand explanations, use methods/tools (body movements, analogies, and concept maps) to help to understand messages by colleagues and use constructive ways in expressing opinions and reason.
55--<60	If students can provide specific explanations but are less easy to understand, use methods/tools (body movements, analogies, and concept maps) to help the understanding of messages by colleagues and use constructive ways in expressing opinions and reason.
	Material Presentation Assessment Criteria
90-100	If students can present material with good systematics, timeliness of delivery, good language use, ability to answer questions well / precisely, good and clear material delivery attitude

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Required and Supporting Textbooks

1. R.K. Mackie and D.M. Smith, "Guidebook to Organic Synthesis", Longman Scientific & Technical
2. Modern Organic Synthesis an Introduction. 2007. George S. Zweifel, Michael H. Nantz. Freeman & Company, USA
3. Organic Synthesis: The Disconnection Approach. 2008. Stuart Warren and Paul Wyatt. John Wiley & Sons, Inc
4. Xu R., Pang W., Huo Q. Aplin KP, Brown PR, Jacob J, Krebs CJ, Singleton GR. 2011. Modern Inorganic Synthetic Chemistry. Elsevier.
5. Shriver, Atkins. 2006. Inorganic Chemistry. Oxford University Press. 882p.
6. Errington, RJ, 1997. Advanced Practical Inorganic and metalorganic chemistry. Blackie academic and professional.
7. Angelici, R. J. 1977. Synthesis and Technique in Inorganic Chemistry. W. B. Saunders Co. USA
8. Breck WD. 1974. Zeolite Molecular Sieves. New York: John Wiley & Sons, Inc.
9. Bhagyaraj S.H, Oluwafemi O.S., Kalarikkal N, Thomas S. 2018. Synthesis of Inorganic Nanomaterials. Elsevier.