

## Universitas Negeri Surabaya Faculty of Mathematics and Natural Sciences Chemistry Masters Study Program

Document Code

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AUTHORIZAT	TON		SP Develo	per			•				urse C ordina	cluste itor	r	s	tudy F	Progra	m Co	ordinator
			Dr. I Gusti Made Sanjaya, M.Si								iek He I.Si.	erdyastuti,						
Learning model	Case Studies																	
Program Learning				ch is charged to the course														
Outcomes (PLO)	Program Object	,	,	•														
(1 20)	PO - 1	dynan	tering theoretical concepts, principles and methods in terms of structure and properties of unics as well as principles of synthesis, analysis, characterization of chemical compour emporary handling of their impacts on people's lives and the environment								matte nds, a	er, energy, as well as						
	PO - 2	Able t	o solve scie	ntific	probl	ems 1	hrou	gh an	inter	or m	ultidis	ciplina	ry approac	h tha	t is be	neficia	l for s	ociety and
	PO - 3	Has d	ata analysis	capa	oilities	s base	ed on	cher	nical i	nstrur	nents							
	PO - 4		ile and comr re based on					hts a	nd sc	ientific	argu	ments	responsibl	y reg	arding	cataly	sts an	d catalysis
	PLO-PO Matrix																	
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Short Course Description	The Catalyst cou analysis, perform chemistry needs.	nance e	amines the toward	theory nthes	/ and sis, cl	imple narac	emer teriza	tatior tion a	of cand u	atalys se cyc	ts and cle of	l catal cataly:	ysis related sts in every	d to t	he che life, ind	emical dustrial	mean need	ing, types, s or green
References	Main :																	
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- 1. Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis: mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.
- 2. Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.
- 3. Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.
- Punekar, N. S. 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.
   Twigg, M. V. and Spencer, M. S. 1994. Catalyst Characterization: Physical Techniques for Solid Materials. New York: Plenum Press.

## Supporters:

1. Artikel-artikel jurnal terkait katalis ataupun kataalisis

## Supporting lecturer

Dr. I Gusti Made Sanjaya, M.Si. Prof. Dr. Sari Edi Cahyaningrum, M.Si. Dr. Dina Kartika Maharani, S.Si., M.Sc.

		Final abilities of each learning	Eva	lluation	Stu	Help Learning, earning methods, dent Assignments, [ Estimated time]	Learning	Assessment
		stage (Sub-PO)	Indicator	Criteria & Form	Offline (	Online ( online )	materials [References]	Weight (%)
					offline )			
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1 1	Mastering	1 Evaluate the	Criteria:	discussion and	Material: -	5%
	theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2. Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	1 Evaluate the use of catalysts in irreversible reactions and reversible reactions 2 Detailing the performance of homogeneous catalysts, heterogeneous catalysts and enzymes	Criteria: Non test  Form of Assessment: Participatory Activities	discussion and question and answer	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature	5%

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2	1.Mastering	1 Evaluate the	Criteria: Non test	discussion and question and answer	Material: - Catalysts and	5%
	theoretical	use of	14011 test	question and answer	Catalysis	
	concepts,	catalysts in	Form of Assessment :		Literature:	
	principles and	irreversible	Participatory Activities		Can Li and	
	methods in	reactions and			Yan Liu. 2014,	
	terms of	reversible			Bridging	
	structure and	reactions			Heterogeneous	
	properties of	<ol><li>Detailing the</li></ol>			and	
	matter, energy,	performance of			Homogeneous	
	dynamics as	homogeneous			Catalysis:	
	well as	catalysts,			Concepts,	
	principles of	heterogeneous			Strategies, and	
	synthesis,	catalysts and			Applications.	
	analysis,	enzymes			Germany:	
	characterization				Wiley-VCH	
	of chemical				Verlag GmbH	
	compounds, as				& Co.	
	well as					
	contemporary				Material: -	
	handling of their		1		Types of	
	impacts on				catalysts	
	people's lives		]		References:	
	and the				Bhaduri, S. and Mukesh, D.	
	environment				2014.	
	2.Able to solve				Homogeneous	
	scientific				catalysis :	
	problems				mechanisms	
	through an inter				and industrial	
	or				applications,	
	multidisciplinary				Second edition.	
	approach that is				United States	
	beneficial for				of America:	
	society and				John Wiley &	
	science				Sons, Inc.	
					Material: -	
					Types of	
					catalysts	
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					Schmal, M.	
					2016,	
					Heterogeneous	
					Catalysis and	
					its Industrial Applications.	
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					Publishing.	
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					Material: -	
					Enzyme	
					catalysts	
					References:	
					Punekar, NS	
					2018.	
					ENZYMES:	
					Catalysis,	
					Kinetics and	
					Mechanisms.	
					Singapore:	
					Springer	
					Nature	
					Singapore Pte	
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2	1 Moote vine	Develon problems	Criteria:	discussion and	Material:	50%
3	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Develop problems related to the implementation of catalysts and catalysis to solve authentic problems in everyday life or industrial environments	Criteria: Assessment of project problems  Form of Assessment: Participatory Activities, Practice/Performance	discussion and question and answer	Material: - Catalysts and Catalysts Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis: mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme  Material: - Enzyme	5%
					Material: -	

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4	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Planning projects related to catalyst development or catalyst implementation to solve authentic problems in everyday or industrial environments	Criteria: Project plan assessment:  Form of Assessment: Participatory Activities, Practice/Performance		discussion and question and answer	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysis References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysis References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysis References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	5%

5	1.Mastering	Carrying out	Criteria:	discussion and	Material: -	5%
	theoretical	projects related to developing	Assessment of the	question and answer	Catalysts and	
	concepts,	catalyst	project implementation		Catalysis	
	principles and	prototypes or	process related to the		Literature:	
	methods in	implementing	development of		Can Li and	
	terms of	catalysts to solve	catalyst prototypes		Yan Liu. 2014,	
	structure and	authentic problems in			Bridging	
	properties of	everyday or	Form of Assessment :		Heterogeneous and	
	matter, energy,	industrial	Participatory Activities,		Homogeneous	
	dynamics as	environments	Practice/Performance		Catalysis:	
	well as				Concepts,	
	principles of				Strategies, and	
	synthesis,				Applications.	
	analysis,				Germany:	
	characterization				Wiley-VCH	
	of chemical				Verlag GmbH	
	compounds, as				& Co.	
	well as					
	contemporary				Material: -	
	handling of their				Types of	
	impacts on				catalysts	
	people's lives				References:	
	and the				Bhaduri, S. and Mukesh, D.	
	environment				2014.	
	2.Able to solve				Homogeneous	
	scientific				catalysis :	
	problems				mechanisms	
	through an inter				and industrial	
	or				applications,	
	multidisciplinary				Second edition.	
	approach that is				United States	
	beneficial for				of America:	
	society and				John Wiley &	
	science				Sons, Inc.	
					Material: -	
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					References:	
					Schmal, M.	
					2016,	
					Heterogeneous	
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					References:	
					Punekar, NS	
					2018.	
					ENZYMES:	
					Catalysis, Kinetics and	
					Mechanisms. Singapore:	
					Singapore: Springer	
					Nature	
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6	1 Mastaria	Carrying out	Criteria:	discussion and	Material: -	5%
9	1.Mastering theoretical	projects related to	Assessment of the	question and answer	Catalysts and	5%
		developing	project	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Catalysis	
	concepts,	catalyst	implementation		Literature:	
	principles and	prototypes or	process related to the		Can Li and	
	methods in	implementing	development of			
	terms of	catalysts to solve	catalyst prototypes		Yan Liu. 2014, Bridging	
	structure and	authentic problems in			5 5	
	properties of	everyday or	Form of Assessment :		Heterogeneous	
	matter, energy,	industrial	Participatory Activities,		and	
	dynamics as	environments	Practice/Performance		Homogeneous	
	•				Catalysis:	
	well as				Concepts,	
	principles of				Strategies, and	
	synthesis,				Applications.	
	analysis,				Germany:	
	characterization				Wiley-VCH	
	of chemical				Verlag GmbH	
	compounds, as				& Co.	
	well as					
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	contemporary				Types of	
	handling of their				catalysts	
	impacts on					
	people's lives				References:	
	and the				Bhaduri, S. and	
	environment				Mukesh, D.	
	2.Able to solve				2014.	
	scientific				Homogeneous	
	problems				catalysis:	
					mechanisms	
	through an inter				and industrial	
	or				applications,	
	multidisciplinary				Second edition.	
	approach that is				United States	
	beneficial for				of America:	
	society and				John Wiley &	
	science				Sons, Inc.	
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					Material: -	
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					catalysts	
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					2016,	
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7	1.Mastering	Carrying out	Criteria:	discussion and	Material: -	5%
	theoretical	projects related to	Assessment of the	question and answer	Catalysts and	
	concepts,	developing	project	·	Catalysis	
		catalyst	implementation		Literature:	
	principles and	prototypes or	process related to the		Can Li and	
	methods in	implementing catalysts to solve	development of		Yan Liu. 2014.	
	terms of	authentic	catalyst prototypes		Bridging	
	structure and	problems in				
	properties of	everyday or	Form of Assessment :		Heterogeneous	
	matter, energy,	industrial	Participatory Activities,		and	
		environments	Practice/Performance		Homogeneous	
	dynamics as	CITALIONING			Catalysis:	
	well as				Concepts,	
	principles of				Strategies, and	
	synthesis,				Applications.	
	analysis,				Germany:	
	characterization				Wiley-VCH	
					Verlag GmbH	
	of chemical				& Co.	
	compounds, as				& CO.	
	well as					
	contemporary				Material: -	
	handling of their				Types of	
	impacts on				catalysts	
	people's lives				References:	
					Bhaduri, S. and	
	and the				Mukesh, D.	
	environment				2014.	
	2.Able to solve				Homogeneous	
	scientific				catalysis :	
	problems					
	through an inter				mechanisms	
	_				and industrial	
	or				applications,	
	multidisciplinary				Second edition.	
	approach that is				United States	
	beneficial for				of America:	
	society and				John Wiley &	
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8	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Successfully developed homogeneous, or enzymatic catalyst prototypes	Criteria: Assessment of homogeneous, or enzymatic catalyst prototypes  Forms of Assessment: Participatory Activities, Project Results Assessment / Product Assessment, Practices / Performance	performance of project results related to prototypes related to catalysts or catalysis	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Behaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysis References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysis References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysis References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	10%

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9	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Characterizing project prototypes related to catalysts or catalysis	Criteria: Assessment of the results of characterization of project prototypes related to catalysts or catalysis  Form of Assessment: Participatory Activities, Practice/Performance	practice, discussion and question and answer	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis: mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	5%

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10	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Characterizing project prototypes related to catalysts or catalysis	Criteria: Assessment of the results of characterization of project prototypes related to catalysts or catalysis  Form of Assessment: Participatory Activities, Practice/Performance	practice, discussion and question and answer	Material: - Catalysis and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	5%

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11	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Characterizing project prototypes related to catalysts or catalysis	Criteria: Assessment of the results of characterization of project prototypes related to catalysts or catalysis  Form of Assessment: Participatory Activities, Practice/Performance	practice, discussion and question and answer	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysis References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018, ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	5%

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12	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science 3.Compile the results of scientific thoughts and arguments responsibly regarding catalysts and catalysis and are based on academic ethics.	Prepare project results reports related to catalysts or catalysis	Criteria: Assessment of project results reports related to catalysts or catalysis  Form of Assessment: Participatory Activities, Practice/Performance	presentations, discussions and questions and answers	Material: - Catalysts and Catalysts Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and	5%
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13 1.Mastering theoretical concepts, principles and methods in terms of structure and properties of Prepare project results reports related to catalysis  1.Mastering theoretical concepts, principles and methods in terms of structure and properties of Prepare project results reports related to catalysts or catalysis  1.Mastering theoretical concepts, principles and methods in terms of structure and properties of Prepare project results reports related to catalysts or catalysis  1.Mastering Prepare project results reports related to catalysts or catalysis  2. Catalysts and Catalysis  2. Catalysts and catalysis  3. Form of Assessment : Participatory Activities, Practice/Performance	Assessment of project results reports related to catalysis or catalysis  Form of Assessment: Participatory Activities, Practice/Performance  discussions and questions and answers  Catalysis  Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH
dynamics as well as principles of synthesis, analysis,  Catalysis: Concepts, Strategies, and Applications. Germany:	Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis: mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS

14	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science 3.Communicate ideas, thoughts and scientific arguments responsibly regarding catalysts and	Communicate project results related to catalysts or catalysis	Criteria: Assessment of communication of project results related to catalysts or catalysis  Form of Assessment : Participatory Activities, Practice/Performance	presentations, discussions and questions and answers	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis: mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016,	5%
	and scientific arguments responsibly regarding				Types of catalysts <b>References:</b> Schmal, M.	
					Material: - Enzyme catalysts References: Punekar, NS 2018. ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Ltd.	

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15	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science 3.Communicate ideas, thoughts and scientific arguments responsibly regarding catalysts and catalysis and are based on academic ethics.	Communicate project results related to catalysts or catalysis	Criteria: Assessment of communication of project results related to catalysts or catalysis  Form of Assessment: Participatory Activities, Practice/Performance	presentations, discussions and questions and answers	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and its Industrial Applications. Switzerland: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018. Singapore: Springer Nature Singapore Pte Lttd.	5%

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16	1.Mastering theoretical concepts, principles and methods in terms of structure and properties of matter, energy, dynamics as well as principles of synthesis, analysis, characterization of chemical compounds, as well as contemporary handling of their impacts on people's lives and the environment 2.Able to solve scientific problems through an inter or multidisciplinary approach that is beneficial for society and science	Produce project output related to catalysts or catalysis with good character	Criteria: Assessment of projects for making homogeneous, heterogeneous or enzymatic catalysts with good characteristics  Forms of Assessment: Participatory Activities, Project Results Assessment / Product Assessment, Practices / Performance	performance of catalyst or catalysis project results in solving daily environmental or industrial problems	Material: - Catalysts and Catalysis Literature: Can Li and Yan Liu. 2014, Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications. Germany: Wiley-VCH Verlag GmbH & Co.  Material: - Types of catalysts References: Bhaduri, S. and Mukesh, D. 2014. Homogeneous catalysis : mechanisms and industrial applications, Second edition. United States of America: John Wiley & Sons, Inc.  Material: - Types of catalysts References: Schmal, M. 2016, Heterogeneous Catalysis and italysts References: Schmal, M. 2016, Heterogeneous Catalysis and italysis References: Schmal, M. 2016, Heterogeneous Catalysis and italysis References: Schmal, M. 2016, Heterogeneous Catalysis and italysis References: Springer International Publishing.  Material: - Enzyme catalysts References: Punekar, NS 2018, ENZYMES: Catalysis, Kinetics and Mechanisms. Singapore: Springer Nature Singapore Pte Lttd.	20%

**Evaluation Percentage Recap: Case Study** 

No	Evaluation	Percentage
1.	Participatory Activities	50%
2.	Project Results Assessment / Product Assessment	10%
3.	Practice / Performance	40%
		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.
- 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.
- 8. 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, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
- 10. Learning materials are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
- 11. 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.