1.- GENERAL INFORMATION

Learning Unit	**Department**	**Format**
Organic Chemistry Theory III	Chemistry	Lecture

Prerequisites (P)	**Corequisites (CO)**	**Academy**	**Module**
Organic Chemistry Theory II	Organic Chemistry Theory Lab III	Organic chemistry	M2: Synthesis, purification and chemical transformation

Type	**Lecture hours**	**Practice hours**	**Total hours**	**Credits**
Basic, particular, mandatory.	4 hours per week.	0 hrs.	68 hrs.	9

Degrees in which this class is taught:		
B.S in Chemistry.	B.S. in Chemical Engineering	B.S. in Bio-pharmaceutical Chemistry

2.- GENERIC COMPETENCIES

-Problem solving
-Synthesis and analysis.
-Managing information
-Oral and written production
-Discerning and decision-making

Specific competencies
- Autonomous development of the acquired knowledge.
-Autonomy and teamwork.
-Application of knowledge in specific or complex situations.
-Ability to solve problems of organic chemistry.

3.- SPECIFIC CHARACTERISTICS OF THE COMPETENCY

Knowledge	Students… . Compare the physical and chemical properties of carbonyl compounds (aldehydes, ketones, and carboxylic acids). . Handle the nomenclature rules of carbonyl compounds aldehydes, ketones, carboxylic acids and their derivatives). . Identify the reactions of carbonyl compound obtaining. . Apply the main reactions of carbonyl reactions. . Apply the condensation and cyclization reactions of carbonyl compounds. . Identify the main heterocyclical compounds.

Skills	. Predict the variation of the boiling points of aldehydes, ketones, carboxylic acids and their derivatives. . Predict the displacements of acid-base reactions of amines and carboxylic acids. . Distinguish the polarity, acidity and reactivity of aldehydes, ketones carboxylic acids and their derivatives. . Know the priority order of the different organic species to name multifunctional compounds. . Know alternatives to replace compounds in synthesis routes. . Know how to apply knowledge about organic compound reactions in order to propose efficient and direct synthesis routes.
Aptitudes	. Propose methods to obtain molecules with carbonyl groups using the most appropriate reagents for each situation. . Propose efficient synthesis routes that take few steps in order to save resources. . Modify and optimize reactions choosing the most appropriate reaction mechanisms. . Make decisions based on the specific information of chemical compounds. . Develop analytical thinking that is necessary to synthesize new compounds. . Develop awareness to protect the environment.
Values	. Develop and reaffirm values such as responsibility, honesty, tolerance, solidarity, willingness, and positive attitude towards individual and group work.

4.- TRANSVERSAL COMPETENCIES

☑	Foreign Language (English)
☑	Critical, analytical and synthetic thinking.
☑	Oral and written expression
☑	Professional ethics
☐	Administration of human and material resources
☐	Leadership and sustainability
☐	Creativity, innovation and entrepreneurship
☐	Other

5.- COURSE CONTENT OF THE LEARNING UNIT

Unit 1: Aldehydes and ketones.

1.1 Introduction to carbonylic compounds.

1.2 Nomenclature of aldehydes and ketones.

1.2.1 IUPAC nomenclature of aldehydes and ketones

1.3 Physical properties of aldehydes and ketones.

1.4 Reactions to obtain aldehydes.

1.4.1 Oxidation of primary alcohols.

1.4.2 Reduction of acid chlorides.

1.4.3 Partial reduction of esters.

1.4.4 Ozonolysis of olefins.

1.4.5 Hydroboration of alkynes.

1.4.6 Oxidation of methylbenzene

1.4.7 Reimer-Tieman reaction

1.5 Reactions to obtain ketones.

1.5.1 Oxidation of secondary alcohols.

1.5.2 Reduction of chloride acids and diorganocopper

1.5.3 Friedel-Craft acylation

1.5.4 Alkyne hydration

1.5.5 Ozonolysis of olefins

1.5.6 From carboxylic acids

1.6 Aldehyde and ketone reactions

1.6.1 Oxidation and Tollen's test

1.6.2 Reduction

1.6.3 Cyanide addition

1.6.4 Addition of ammoniac derivatives.

1.6.5 Addition of alcohols.

1.6.6 Addition of Grignard reagents.

1.6.7 Wittig reaction

1.6.8 Cannizzaro reaction

Unit 2 Amines

2.1 The importance of amines

2.2 Properties of amines

2.3 IUPAC nomenclature of amines

2.4 Reactions to obtain amines

2.4.1 Reduction of nitro compounds

2.4.2 Reaction of halides

2.4.3 Reductive amination

2.4.4 Reduction of nitriles

2.5 SN2 reaction of amines

2.5.1 Acylation of amines with acid chlorides.

2.5.2 Sulphonamide formation.

2.5.3 Hoffman reaction

2.5.4 Hoffman elimination

2.5.5 Cope elimination

2.5.6 Reactions of diazonium salts.

Unit 3 Carboxylic acids

3.1 Introduction and importance of carboxylic acids

3.2 Properties of carboxylic acids

3.3 IUPAC Nomenclature of carboxylic acids

3.4 Reactions to obtain carboxylic acids

3.4.1 Oxidation of primary alcohols.

3.4.2 Oxidation of alkylbenzenes

3.4.3 Carbonatation of Grignard reagents.

3.4.4 Nitrile hydrolysis

3.4.5 Alkyne breaking

3.5 Reactions of carboxylic acids

3.5.1 Fisher esterification

3.5.2 Acid chloride esterification

3.5.3 Formation of amides with acid chlorides.

3.5.4 Direct formation of amides

3.5.5 Aldehydes reduction

3.5.6 Formation of ketones

3.5.7 Reduction of alcohols

Unit 4 Derivatives of carboxylic acids

4.1 Importance and uses of the main derivatives of carboxylic acids: acid halides, anhydrides, esters, amides, and nitriles.

4.2 IUPAC nomenclature of the derivatives of carboxylic acids: acid halides, anhydrides, esters, amides, and nitriles.

4.3 Interconversion of the derivatives of carboxylic acids.

4.4 Hydrolysis of the derivatives of carboxylic acids.

4.5 Reduction of derivatives of carboxylic acids

4.6 Reactions of the derivatives of carboxylic acids with organometallics.

Unit 5 Condensation and alpha substitution of carboxylic acids

5.1 Enols and enolates

5.1.1 Tautomerism of carboxylic compounds

5.1.2 Alkylation of enolate ions.

5.2 Alkylation of enamines

5.3 Alpha halogenation

5.4 Hell-Volhard-Zelinsky reaction

5.5 Aldol condensation of aldehydes and ketones

5.6 Crossed aldol condensation of aldehydes and ketones.

5.7 Claisen condensation of esters.

5.8 Dieckman condensation

5.9 Malonic synthesis

5.10 1, 2 and 1, 4 Michael's reactions.

5.11 Robinson ring formation

Unit 6 Introduction to heterocyclical compounds

6.1 Five atom rings

6.1.1 Synthesis of Paal-Knorr

6.1.2 Synthesis of Hinsberg

6.1.3 Electrophilic substitution reactions 6.2 Six atom rings

6.- ASSESSMENT	
☑	Numeric grade.
☐	
☐	

7.- GRADING CRITERIA OF THE LEARNING UNIT	
Indicator of evaluation	**Percentage**
Departmental exams	25
Partial exam	40
Homework	35
Research activities	10
Practice reports	0
Class participation	0

8.- REQUIRED MATERIAL (for students)	
☐	Calculator
☐	Periodic table
☐	Lab coat
☑	Text book
☐	Workbook
☐	

	9.-SPECIFIC CONTENT BY LEARNING UNITS					
Content unit	**Generic competency of the content unit**	**Topics**	**Class hours**	**Professor activities**	**Student activities**	**Bibliography**
Unit 1: Aldehydes and ketones.	Students… Relate the structural characteristics of aldehydes and ketones with their chemical and physical properties. Propose routes to obtain and convert aldehydes and ketones using reaction models. Know and apply the bases of reaction mechanisms.	1.1 Introduction to carbonylic compounds. 1.2 Nomenclature of aldehydes and ketones. 1.3 Physical properties of aldehydes and ketones. 1.4 Reactions to obtain aldehydes. 1.5 Reactions to obtain ketones. 1.6 Aldehyde and ketone reactions	1h 1h 4h 4h 5h	Professor… -Presents the introduction to the content unit, highlighting the importance of carbonylic compounds in chemistry. -Presents the main methods to obtain aldehydes and ketones. -Presents the main conversion reaction of aldehydes and ketones	Students… -Solve exercises to obtain aldehydes and ketones applying the models of the reactions. -Predict the majoritarian product from two or more reagents using reaction mechanisms. -Propose steps to obtain different functional groups using aldehydes and ketones.	Wade Jr. L. G. (2012). *Química orgánica Volume II* (7th edition). Pearson.

Unit 2 **Amines**	Students relate the characteristics, highlighting the nitrogen compounds with biological activity.	2.1 The importance of amines 2.2 Properties of amines 2.3 IUPAC nomenclature of amines 2.4 Reactions to obtain amines 2.5 SN2 reaction of amines	2h 3h 5h	Professor… -Presents the introduction to the content unit. -Presents the main methods to obtain amines. -Presents the main reactions to convert amines.	Students… -Name structures and propose formulas using the name of amines according to the IUPAC rules. -Solve exercises to obtain amines by applying the reaction models. -Predict the majoritarian product using two or more reagents, and taking into the account the reaction mechanisms. -Propose steps to obtain different functional groups based on amines.	

Unit 3 Carboxylic acids	Students Relate the structural characteristics of carboxylic acids with their chemical and physical properties. Propose routes to obtain and convert carboxylic acids using reaction models. Know and apply the bases of reaction mechanisms.	3.1 Introduction and importance of carboxylic acids 3.2 Properties of carboxylic acids 3.3 IUPAC Nomenclature of carboxylic acids 3.4 Reactions to obtain carboxylic acids 3.5 Reactions of carboxylic acids	1h 1h 2h 2h 4h	Professor… -Presents the introduction to the content unit. -Presents the main methods to obtain carboxylic acids. -Presents the main reactions to convert carboxylic acids.	Students… Predict the reaction equilibrium of acid-base reactions of carboxylic acids based on pKa tables. -Solve exercises to obtain carboxylic acids applying the models of the reactions. -Predict the majoritarian product from two or more reagents using reaction mechanisms. -Propose steps to obtain different functional groups using carboxylic acids.	

Unit 4 Derivatives of carboxylic acids	Students Relate the structural characteristics of the derivatives of carboxylic acids with their chemical and physical properties. Propose routes to obtain and convert carboxylic acids and their derivatives using reaction models. Know and apply the bases of reaction mechanisms.	4.1 Importance and uses of the main derivatives of carboxylic acids: acid halides, anhydrides, esters, amides, and nitriles. 4.2 IUPAC nomenclature of the derivatives of carboxylic acids: acid halides, anhydrides, esters, amides, and nitriles. 4.3 Interconversion of the derivatives of carboxylic acids. 4.4 Hydrolysis of the derivatives of carboxylic acids. 4.5 Reduction of derivatives of carboxylic acids 4.6 Reactions of the derivatives of carboxylic	1h 2h 1h 2h 2h	Professor… -Presents the introduction to the content unit, mentioning the main functional groups as byproducts of carboxylic acids -Establish the priority of the functional groups in the nomenclature of multifunctional molecules. - Present the main interconversion reactions among the derivatives of carboxylic acids. - Present the main reactions of hydrolysis and reduction of the derivatives of carboxylic acids.	Students… -Carry out a bibliography investigation about the main uses and applications of the derivatives of carboxylic acids. -Name structures and propose formulas based on the name of multifunctional molecules, applying the priority rules. -Solve interconversion exercises of the derivatives of carboxylic acids, applying the reaction models. -Solve exercises of hydrolysis and	

		acids with organometallics.			reduction of the derivatives of carboxylic acids applying the reaction models.	
Unit 5 Condensation and alpha substitution of carboxylic acids	Students understand the principle pf the condensation reactions based on the reactivity of the carbonyl group. State the mechanism of the different condensation reactions to predict the main product.	5.1 Enols and enolates 5.2 Alkylation of enamines 5.3 Alpha halogenation 5.4 Hell-Volhard-Zelinsky reaction 5.5 Aldol condensation of aldehydes and ketones 5.6 Crossed aldol condensation of aldehydes and ketones. 5.7 Claisen condensation of esters. 5.8 Dieckman condensation 5.9 Malonic synthesis 5.10 1, 2 and 1, 4 Michael's reactions.	15 min 45 min 2h 2h 2h 1h 1h 1h	Professor… -Presents the main condensation reactions of carbonylic compounds. -Explains the bases of the reaction mechanisms of condensation.	Students -Solve exercises of the different condensation reactions of carbonylic compounds applying the reaction models. -Propose mechanisms that justify the formation of alpha-beta unsaturated compounds.	

		5.11 Robinson ring formation.				
Unit 6 Introduction to heterocyclical compounds	Students know the structures of the different heterocyclical compounds	6.1 Five atom rings 6.2 Six atom rings	2h 2h	Professor… -Presents the main heterocyclical compounds of 5 and 6 atoms. - Presents the synthesis reactions of 5 and 6 atom heterocycles.	Students Relate the aromaticity of heterocycles with their main reactions.	Paquette Leo A. (2014). Fundamentos de Química heterocíclica, Ed. Limusa.

COURSE EVIDENCE
(Deliverables)

- Partial Exams
- Departmental exam
- Research homework.
- Problem solving exercises for homework.

10.-PROFESSOR'S PROFILE

Bachelor of Sciences, Masters or PhD in Chemistry or similar degrees.

Specific knowledge in organic chemistry

Teaching experience in organic chemistry

11.-AUTHOR OF THE LEARNING UNIT

Roberto Eduardo San Juan Farfán

12.-MODIFICATION AND UPDATE

March 6, 2017

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