1. Datos de identificación:

Name of the learning unit:	**Calculus**
Guided time (theory and practice):	**80 hours**
Guided time per week:	**4 hours**
Total autonomous time:	**40 hours**
Modality:	**Scholarized**
Number and type of academic period:	**2° semester**
Type of learning unit:	**Mandatory**
Cycle:	**First**
Curricular area:	**Initial Disciplinary Training (ACFI-D)**
UANL credits:	**4**
Elaboration date:	**20/05/2020**
Responsible for elaboration:	**MC. Rodrigo Sepúlveda Saá**
Date of last actualization:	**Does not apply**
Responsible for actualization:	**Does not apply**

2. Presentation:

The Calculus learning unit consists of four phases, which are integrated and provide the basis for the student to be able to perform in the field of natural sciences. During phase 1 "Functions", the student will learn to identify a function and its limit, in addition, it will check if the function is continuous at a certain point. Later in phase 2 "Derivative", the student will associate the concept of the derivative of a function as an instantaneous change ratio, which will allow him to distinguish the rules of the derivation. This will allow

(1) Biólogo, Licenciado en biotecnología Genómica, Licenciado en Ciencias de Alimentos, Chemistry, Bacteriology and Parasitology, Ingeniero en Manejo de Recursos Naturales, Ingeniero Forestal, Ingeniero Geólogo e Ingeniero Geólogo Mineralogista.

you in phase 3 "Behavior of graphs of polynomial functions", to distinguish the behavior of functions, so that you are able to explain the critical points of a function and thereby be able to infer on how to optimize processes through functions. Finally, within phase 4 "Integration", the student will exemplify the relationship between the derivation and the integration rules, which will allow him to calculate the area of a flat region. Within this learning process, the student will be able to transfer the concepts of calculus to the problems that require data collection in the work of the natural sciences, which are directly related to decision-making. The student will achieve learning through evidence that develops their logical thinking, as well as the acquired skills, which will allow them to carry out the integrative product of learning, which consists of solving a series of cases of interest in the natural sciences, where calculus is applied as a method of solution and decision-making.

3. Purpose:

The purpose of this learning unit (UA) is that the student infers about the behavior of a function through the concept of the limit, the derivative and the integral, to optimize biological, agricultural, forestry, natural and industrial resource management processes that generate a positive impact in the area of development of the natural sciences.
It is related in an antecedent way with the knowledge acquired in the UA of the baccalaureate that offers the UANL, particularly with the UA of the disciplinary fields of Mathematics and Experimental Sciences since it is in these where the student acquires the bases that will allow him to course the UA of Calculus with focus towards the Natural Sciences. In addition, it relates to subsequent UA of the discipline by building and developing the basic concepts of differential and integral calculus, to address problems specific to the area that will help decision-making during their professional development.
The UA contributes to the development of the general competences of the UANL, by promoting in the student the knowledge the data on the events and situations that surround him through theoretical exercises related to the natural sciences (2.1.2), as well as to achieve the show interest in the events and problems that surround him when solving cases based on real events of his environment (10.1.1) , as well as the ability to establish agreements among their colleagues that allow to generate a collaborative and equitable work environment, through examples of biological situations that will be solved as a team (14.1.3). In addition, this UA contributes to

the branch of natural sciences knowledge such as the management and interpretation of functions, which are necessary to evaluate results in experiments or processes of the natural sciences.

4. Competencies of the graduation profile:

General competences to which this learning unit contributes:

Instrumental competences:
2. Use logical, formal, mathematical, iconic, verbal and nonverbal languages according to their stage of life, to understand, interpret and express ideas, feelings, theories and currents of thought with an ecumenical approach.

Personal and social interaction skills:

10. Intervene in the face of the challenges of contemporary society locally and globally with a critical attitude and human, academic and professional commitment to contribute to consolidating general well-being and sustainable development.

Integrative competences:

14. Resolve personal and social conflicts, in accordance with specific techniques in the academic field and your profession for proper decision-making.

Specific competences to which the learning unit contributes:

The contribution to specific competences is given from the disciplinary context in which this learning unit is located.

5. Phase structure:

Phase 1: Functions

Element of competence: Identify the limit of a function, using algebraic rules to determine the continuity of the function.

Evidence	Performance criteria	Learning activities	Content	Resources
1. Questionnaire of functions, limits and continuity.	• Write your answers in an orderly, clear, and concise manner. • Includes personally identifiable data. • Present your questionnaire in a handwritten and/or resolved way on a digital platform in a timely and clean manner. • He presents his work in the	• At the beginning of the learning unit, the student supports a diagnostic test. • The student investigates the algebraic and transcendental functions and exposes as a team the characteristics of these. • The teacher uses a flowchart with the contents of the learning unit to plan and describe each of the learning unit's activities. • The teacher explains through the use of the blackboard, through tables and graphs, the concept of limit.	Characteristics of some algebraic and transcendent functions. The concept of Limit, its value and its geometric interpretation. Boundary properties. Indeterminate boundaries. • Continuity of a function at a point.	• Leithold, L. (1999). Chapter 1. • Matthiopoulos, J. (2011). Chapters 1-3 questionnaire blackboard • **Interactive software:** 1. Nexus Platform 2. TEAMS Platform - Plataforma Thatquiz • Mathematical (2020). • WolframAlpha (2020).

	format established by the teacher. • It includes all the operations necessary to arrive at the answer in each of the questions. • Identifies algebraic and transcendent functions. • Identifies the concept of boundary and its geometric interpretation. • Resolves the boundary of a function. • Identifies an indeterminate boundary.	• Students research theorems to calculate limits, to brainstorm in the classroom. • The student investigates individually the different ways of calculating the limits of the zero form on zero, performs a synthesis of the concepts and procedures to obtain them. • The students as a team investigate the concept of infinity and make an oral presentation in front of their group, supported by a PowerPoint presentation that includes limits to infinity of the form ∞/∞ (infinite on infinity). • Individual students solve infinity boundary exercises. • The teacher raises on the blackboard different cases of graphs of functions to induce the concept of unilateral		• Geogebra (2020). • Xrjunque (2020).

	• Correctly resolves the questions of functions, limits, and continuity. • Determines whether a function is continuous. • Interprets continuity meaning • Attach your questionnaire on the university digital platform Nexus or MS Teams, within the delivery time.	limits, students in turn perform the calculation for these limits. • The student solves interactive exercises on digital platforms (e.g., MS TEAMS) on the concept of unilateral limits. • From graphic cases the student explains the concept of continuity of a function at a given point. • Students through digital platforms (e.g., ThatQuiz, MS TEAMS), will solve exercises on boundaries. • The student identifies the limit as well as the continuity of functions using the different interactive software platforms. • The student presents the first written midterm exam: functions, limits and continuity **(weighted activity 1.1)**		

Phase 2: Derivada

Elemento de competencia: Reconocer las reglas de derivación de una función para determinar los valores máximos o mínimos relativos en datos científicos.

Evidence	Performance criteria	Learning activities	Content	Resources
2. Laboratory of derivation exercises.	• Includes identification data. • He presents his work in the format established by the teacher. • It presents its procedures and	• The professor exposes the concept of derivative and its interpretations through graphs on the blackboard. • The students present orally and as a team the derivation theorems for the functions that the teacher indicates, previously investigated.	The derivative as a reason for change. Derived from algebraic functions. Derived from trigonometric functions.	• Ledder, G. (2013). Chapter 1. • Leithold, L. (1999). Chapter 2. • Matthiopoulos, J. (2011). Chapter 4. laboratory

	results in an orderly, clear and concise manner. • Deliver your exercise laboratory in a handwritten and/or resolved manner on a digital platform in a timely manner and cleanly. • It presents correctly resolved all the exercises provided in the laboratory. • It includes all the operations necessary to arrive at the answer in each of the exercises. • Identifies the rule of the derivative	• Students form a table with the derivation rules for each type of function. • Students perform derivation exercises, with the table generated by themselves. • The students present their doubts in a group way, while the teacher presents derivation exercises on the blackboard. • The students expose their doubts in a group way while the teacher exemplifies on the blackboard, the doubts generated in the procedures. • Weekly, in extra-classroom hours, students through digital platforms (e.g., ThatQuiz), will solve referral exercises. • Students in teams solve exercises interactively through interactive software platforms. • The student presents the second written partial exam:	Derived from transcendental functions. • Derivation theorems.	blackboard • Interactive software: • Plataforma Nexus • Thatquiz Platform • TEAMS Platform • Khan Academy (2020). • WolframAlpha. (2020).

	that you will use in the exercises. • Gets the derivative of a function through derivation theorems. • Correctly solves the derivative of algebraic, trigonometric and transcendental functions.	derivation **(weighted activity 2.1)**		

Phase 3: Behavior of graphs of polynomial functions.

Competency element: Calculate the critical points of the function using the first and second criteria of the derivative to analyze its behavior in situations related to the natural sciences.

Evidence	Performance criteria	Learning activities	Content	Resources
3. Case resolution report of increasing and decreasing	• Write your report in an orderly, clear,	• The teacher exposes the concept of the minimum and maximum value through graphs on the blackboard, so that students	• Relative maxima and minis of a function.	• Ledder, G. (2013). Chapter 1

intervals, concavity, inflection points and graphs.	and concise manner. • Includes personally identifiable data. • It presents its case resolution report in a handwritten and/or resolved manner on a digital platform in a timely and clean manner. • Includes all the contents covered in this Phase. • He presents his work in the format established by the teacher.	respond to the type of function, as well as the characteristics contained in it through brainstorming. • Students will make a list of steps (using the two derivative criteria) to optimize functions. • Students, individually, present and solve optimization problems. • Students expose in front of class, in teams, the parts of a growing and decreasing function, as well as the together of concavity and inflection. • The students expose their doubts in a group way while the teacher models exercises of graphs of the functions. • Students solve team exercises, guided by the teacher to get critical points from a function. • Weekly, in extra-classroom hours, students through digital platforms (e.g., ThatQuiz), will solve antiderivation exercises	• Applications of the derivative in the optimization process. • (First Criterion of the derivative and Second Criterion of the derivative). • Intervals where the function is increasing and decreasing. • Concavity and turning points of a function. • Plots of features.	• Leithold, L. (1999). Chapter 3 • Matthiopoulos, J. (2011). Chapter 4 • Software interactivo: - Plataforma Nexus - Plataforma Thatquiz - Plataforma TEAMS • WolframAlpha (2020). • Khan Academy (2020). blackboard • Case Resolution Report.

	• Use the nexus or MS Teams university digital platform to document your evidence. • It includes all the operations necessary to arrive at the answer in each of the exercises. • Gets the minimums and maximums of a function. • Optimizes processes through the derivative. • It uses the first and second criteria of the derivative.	(indefinite or defined), in order to integrate knowledge. • At the end of the stage, the student simulates the optimization of the functions through the interactive software • The student presents the third written partial exam: behavior of functions **(weighted activity 3.1)**		

	• Identify tipping points. • Determines whether the function is increasing or decreasing at a given point. • Plot the graph of the functions. • Interprets the resolution of the case.			

Phase 4: integration.

Element of competence: Employ the indefinite integral and defined from the integration of polynomial and transcendental functions to apply the results in problems related to natural sciences.

Evidence	Performance criteria	Learning activities	Content	Resources
4. Learning resolution report	• Write your report in an orderly,	• The professor exposes the concept of the antiderivative on	Antiderivation.	Ledder, G. (2013). Chapter 1.

based on integration issues.	clear, and concise manner. • Includes personally identifiable data. • Present your evaluation report in a handwritten and/or digital platform in a timely and clean manner. • Includes all content covered at this stage. • He presents his work in the format established by the teacher. • Includes all the operations necessary to arrive at the	the blackboard through graphs, so that through questions the students infer how to obtain the primitive integral. • Students investigate the rules of the primitive integral and a comparative table with the information obtained. • Students discuss the relationship of the integral to the derivative in the classroom. • Individually, students explain an example with the integration rules collected in the previous activity on the blackboard. • Students investigate the concept of area under the curve, make a summary of the information collected, while the teacher in class poses the problem of calculating the area under a curve as an induction to the defined integral. • Students propose a method to calculate the area under the	Rules for indefinite integrals. • Direct integration of algebraic functions. • Direct integration of trigonometric functions (sine and cosine). • Direct integration of exponential function (basis e). • Integration technique by substitution (variable change).	Steward, L. (2011). Chapter 9. Leithold, L. (1999). Chapter 4. Matthiopoulos, J. (2011). Chapter 5. Whitty, C. J. M. (2017). blackboard Problem report **Interactive software:** American Meteorological Society. (2020) Mathematical (2020). WolframAlpha. (2020). Nexus Platform Plataforma Thatquiz TEAMS Platform

	response in each of the exercises • Identifies and uses all rules to resolve undefined integration exercises. • It employs the direct integration of algebraic, trigonometric, and transcendental functions. • It correctly solves the exercises through the variable change technique. • Calculates the area of a flat region and interprets the problem solution.	curve, making use of the rules of integration. • The student solves examples of integration on the blackboard and applies it to calculate the area under a curve. • Students perform anti-derivation exercises, indefinite integrals, definite integrals, and areas under the curve, individually. • Students guided by the teacher solve exercises related to the area of study of the natural sciences, either by the traditional method or through interactive software. • Weekly, in extra-classroom hours, students through digital platforms (e.g., ThatQuiz), will solve exercises according to the theme seen in class, in order to integrate knowledge. • The student presents the fourth written partial exam:	• Integral defined. • The area of a flat region. • Mathematical Models. • Application of the derivative and the integral defined in the Natural Sciences.	

		integration **(weighted activity 4.1).** • The student presents the practical examination of cases of importance in the natural sciences, based on the behavior of their functions for decision-making **(weighted activity 4.2)**		

6. Learning evaluation:

Phase	Activities and evidences:	Ponderación
Phase 1	Evidence 1. Questionnaire of functions, limits and continuity.	5%
	Weighed activity 1.1. First written midterm exam: functions, limits and continuity.	10%
Phase 2	Evidence 2. Laboratory of derivation exercises.	5%
	Weighable activity 2.1: Second written partial examination: Derivation	11%
Phase 3	Evidence 3. Learning resolution report based on cases of increasing and decreasing intervals, concavity, inflection points and graphs.	5%
	Weighable activity 3.1. Third written partial exam: Behavior of functions.	12%
Phase 4	Evidence 4. Learning resolution report based on integration problems.	5%
	Weighed activity 4.1: Fourth written mid-exam: Integration	12%
	Weighed activity 4.2: Practical examination based on cases of application in natural sciences.	15%
	Integrative learning product	20%
	Total:	100%

7. Integrative learning product:

Written report on resolution of boundary and continuity cases, derivation rules, critical and graphical points, indefinite and defined integral, as well as application problems in the natural sciences (see annex 1).

8. Literature:

American Meteorological Society. (2020) AMS. Obtenido de https://journals.ametsoc.org/ (Base de datos de la biblioteca digital de la UANL).

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Ledder, G. (2013). Mathematics for the Life Sciences. Ed. 1. Editorial Springer-Verlag New York.

Leithold, L. (1999). El Cálculo, 7 ed. Oxford University Press. México.

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Matthiopoulos, J. (2011). *How to be a quantitative ecologist: The A to R of green mathematics and statistics*. Wiley-VCH.

Steward, L. (2011). *The mathematics of life*. Basic Books.

Whitty, C. J. M. (2017). The contribution of biological, mathematical, clinical, engineering and social sciences to combatting the West African Ebola epidemic. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1721). https://doi.org/10.1098/rstb.2016.0293

WolframAlpha. (2020). *WolframAlpha.* Obtenido de http://www.wolframalpha.com/

Xrjunque. (2020). *Xrjunque*. Obtenido de https://xrjunque.nom.es/polycalc.aspx

Annex 1

Integrative learning product: Written report on solving cases of limits and continuity, derivation rules, critical and graphical points, indefinite and defined integral, as well as application problems in the natural sciences.	
Instructions:	The students will carry out a series of cases, where the contents learned in each of the Phases of the learning unit are applied in a real context, these cases will be provided by the professor.
Value:	20 points
Evaluation criteria:	• The integrative learning product has the following features: • The number of exercises requested by the teacher. • The procedures of all the exercises ordered. • Deliver in physical and / or electronic format as requested by the professor of the UA. • Include the identification data of the equipment. • Actively collaborate with the members of your work team. • Submit the PIA on time. • Attach the final project on the Institutional Digital platform, either NEXUS or MS Teams. • Identify the nature of the problem. • Propose a methodology to solve the case. • Correctly resolve each exercise.
Mode:	Team

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Aprobada por el H. Consejo Universitario, el 16 de julio de 2020</td><td rowspan="3">Vo. Bo.

Dr. Gerardo Tamez González
Director del Sistema de Estudios de Licenciatura</td></tr>
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