MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	**Optimization**			**Module Delivery**	
Module Type	**BASIC**			☒ Theory ☐Lecture ☐ Lab ☒ Tutorial ☐ Practical ☐ Seminar	
Module Code	**MS412**				
ECTS Credits	**6**				
SWL (hr/sem)	**150**				
Module Level	**4**		**Semester of Delivery**	**8**	
Administering Department	**Type Dept code**		**College**	**Type Dept code**	
Module Leader	**Basim Abbas Hassan**		**e-mail**	basimah@uomosul.edu.iq	
Module Leader's Acad. Title	**Professor**		**Module Leader's Qualification**	**Ph.D**	
Module Tutor			**e-mail**		
Peer Reviewer Name			**e-mail**		
Scientific Committee Approval Date	**15/9/2024**		**Version Number**	**1.0**	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module		**Semester**	
Co-requisites module		**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	1- This course deals with the basic concepts of unrestricted one-variable optimization problems. 2- Providing the student with skills in solving unrestricted optimization problems with one variable using different methods and finding the optimal solution to the problem. 3- Finding convexity, concavity, and maximum and minimum points for unrestricted problems with one variable. 4- Understanding and solving Taylor series with one variable
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Important: Write at least 6 learning outcomes, ideally equal to the number of weeks of study. 1- The student writes some terms 2- The student describes the model 3- To distinguish between the models 4- To explain the mathematical formula to the student 5- The student summarizes the steps for solving the mathematical formula 6- The student presents a problem from reality 7- That the student compare the methods of solution 8- To rearrange the solution method 9- To plan how to use the appropriate method in the solution 10- The student applies the model to a realistic situation 11- The student reveals the error in the form. 12- The student should schedule the results
Indicative Contents المحتويات الإرشادية	Basic concepts: Optimization, Statement of an optimization problem, One variable unconstrained optimization problem, Definition: local minimum value, local maximum value , global minimum value , global maximum value, Concave and convex functions of a one variable, Necessary and sufficient conditions of a one variable functions , Taylor' s series expansions [10 h] Methods of One variable unconstrained optimization problem Dichotomous method, introduction , Algorithm, examples. [10] Interval halving method , introduction , Algorithm, examples. [10] Fibonacci method, introduction , Algorithm, examples. [10] Golden section method , introduction , Algorithm, examples. [10] Newton method , introduction , Algorithm, examples. [5] Quasi newton method , introduction , Algorithm, examples. [6] Secant method , introduction , Algorithm, examples. [6]

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	Stimulating and encouraging students to understand the role of the game theory in the developed knowledge society and to become aware of the scientific applications of the competitive game theory using the computer through 1- Determine the scientific concepts and principles that will be learned and put forward in the form of a question or problem. 2- Preparing the educational materials needed to implement the lesson. 3- Formulating the problem in the form of sub-questions so as to develop the skill of imposing assumptions among the learners 4- Determine the discovery activities or experiments that the learners will carry out. 5- Evaluate learners and help them apply what they have learned in situations

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ أسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	63	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	4
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	87	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	6
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**150**		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment التقييم التكويني	Quizzes	3	15% (15)	4-6-10	LO #1, #2 and #7, #8
	Assignments	3	15 (15)	3-5-12	LO #3, #4 and #5, #6, #8
	Projects / Lab.				
	Report	1	10% (10)	13	LO #5, #7 and #8
Summative assessment التقييم التلخيصي	Midterm Exam	2hr	10% (10)	7	LO #1 - #8
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction unconstrained Optimization
Week 2	**Unconstrained Optimization in one dimension (necessary and sufficient conditions)**
Week 3	**Unconstrained Optimization in one dimension (necessary and sufficient conditions)**
Week 4	**Classification matrices**
Week 5	**Classification matrices**
Week 6	**Convexity of optimization and basic properties.**
Week 7	**Rate of convergence**

Week 8	Mid-term Exam
Week 9	**Methods of one dimension : Bisection method**
Week 10	**Newton's method**
Week 11	**Golden section method**
Week 12	**Fibonacci method**.
Week 13	**Lagrange method with examplesfor maxmine function .**
Week 14	**Kuhn –Tucker condition with examplesfor minima function .**
Week 15	**Methods of multi dimension : Steepest descent method**
Week 16	Preparatory week before the final Exam

Delivery Plan (Weekly Lab. Syllabus)

المنهاج الاسبوعي للمختبر

	Material Covered
Week 1	
Week 2	
Week 3	
Week 4	
Week 5	
Week 6	
Week 7	

Learning and Teaching Resources

مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts النصوص المطلوبة	Numerical optimization methods, Basim A. Hassan, (2024) Engineering Optimization Theory and Practice, Fourth Edition , Singiresu S. Rao, (2009)	Yes
Recommended Texts		
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A -** Excellent	امتياز	90 - 100	Outstanding Performanceأداء مذهل
	B - Very Good	جيد جدا	80 - 89	Above average with some errors فوق المتوسط مع بعض الأخطاء
	C - Good	جيد	70 - 79	Sound work with notable errors العمل السليم مع أخطاء ملحوظة
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings عادل ولكن مع نواقص كبيرة
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria العمل يلبي الحد الأدنى من المعايير
Fail Group (0 – 49)	**FX –** Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded مطلوب المزيد من العمل ولكن الائتمان الممنوح
	F – Fail	راسب	(0-44)	Considerable amount of work required قدر كبير من العمل المطلوب

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

Update :

Some methods to solve a Non-linear Programming Problem;Lagrange multipliers Kuhn-Tucker conditions in view of the requirements of thelabor market

Update :

Some methods to solve a Non-linear Programming Problem; Lagrange multipliers Kuhn-Tucker conditions

Course Description

1. Course Name:
Function analysis1/ The fourth stage
2. Course Code:
CM MS 21 F 441
3. Semester / Year:
2024-2025
4. Description Preparation Date:
1/10//2025
5. Available Attendance Forms:
Attendance in the classroom according to the announced weekly class schedule
6. Number of Credit Hours (Total) / Number of Units (Total)
Four theoretical lessons per week / 3 units
7. Course administrator's name (mention all, if more than one name)
Name: DR.AHMED AMER Email: :aahmedamer68@uomosul.edu.iq

8. Course Objectives

Course Objectives	• Students will study a new spaces, its properties and different type of operators

9. Teaching and Learning Strategies

Strategy	Vector, normed and Banach spaces Linear, bounded and continuous operators

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method

١	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, Examples and some properties of vector spaces**	Learn the methods of evaluating and analyzing the types of roads found in the urban and rural road network and how to determine their capacity and level of service.	According to the tasks assigned to the student, such as daily preparation, daily, oral, monthly, written and reports exams.
٢	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Linear combination, span set, linearly independence, finite and infinite dimension,**		
٣	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, sum and intersection of subspace, direct summand**		
٤	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, Minkowski's inquality, Cauchy Schwartz inequality, some properties of normed spaces**		
٥	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Metric space, convergent sequence and Cauchy sequence**		
6	2	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, The space C[a,b]**		

٧	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Open and Closed set, subspace of Banach space**		
٨	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Domain, Range of the operator, Null space, differentiation operator , integration operator**		
٩	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition , composite of two operators**		
١٠	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, sylvester's law**		
١١	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, Finite dimension Theorem**		
١٢	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition, continuity and boundedness Theorem**		
١٣	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition of functional, linear functional, examples**		

١٤	٢	My presence in the classroom and through the educational tools available inside the classroom, with some site visits	**Definition , Theorem**		
15			Definition and some examples		

11. Course Evaluation

Distributing the score out of 100 according to the tasks assigned to the student such as daily preparation, daily oral, monthly, or written exams, reports ..... etc

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	
Main references (sources)	
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description

1. Course Name:
Function analysis2/ The fourth stage
2. Course Code:
CM MS 22 F 442
3. Semester / Year:
2024-2025
4. Description Preparation Date:
1/10//2025
5. Available Attendance Forms:
Attendance in the classroom according to the announced weekly class schedule
6. Number of Credit Hours (Total) / Number of Units (Total)
Four theoretical lessons per week / 3 units
7. Course administrator's name (mention all, if more than one name)
Name: DR.AHMED AMER Email: :aahmedamer68@uomosul.edu.iq

8. Course Objectives

Course Objectives	• Students will study a new spaces, its properties and different type of operators

9. Teaching and Learning Strategies

Strategy	Inner product space, Hilbert space, orthogonal complements, Representation of functional on Hilbert spaces, Hilbert adjoint operator

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method

١	٢	Definition and some examples	**Definition, Examples and some properties of vector spaces**	Learn the methods of evaluating and analyzing the types of roads found in the urban and rural road network and how to determine their capacity and level of service.	According to the tasks assigned to the student, such as daily preparation, daily, oral, monthly, written and reports exams.
٢	٢	Definition and some examples	**Linear combination, span set, linearly independence, finite and infinite dimension,**		
٣	٢	Some theorem and proposition	**Definition, sum and intersection of subspace, direct summand**		
٤	٢	Schwarz inequality, parallelogram equality polarization identity	**Definition, Minkowski's inquality, Cauchy Schwartz inequality, some properties of normed spaces**		
٥	٢	Theorem and Examples	**Metric space, convergent sequence and Cauchy sequence**		
6	2	Orthogonal element to element Orthogonal element to set Orthogonal set to set	**Definition, The space C[a,b]**		

٧	٢	Definition, examples, theorem	**Open and Closed set, subspace of Banach space**		
٨	٢	Definition, examples, Gram–schmidt process	**Domain, Range of the operator, Null space, differentiation operator , integration operator**		
٩	٢	Theorem and Examples	**Definition , composite of two operators**		
١٠	٢	Definition, examples,	**Definition, sylvester's law**		
١١	٢	Theorem and Examples	**Definition, Finite dimension Theorem**		
١٢	٢	Definition, examples,	**Definition, continuity and boundedness Theorem**		
١٣	٢	Theorem and Examples	**Definition of functional, linear functional, examples**		

١٤	٢	Self adjoint,Unitary ,Normal operators	**Definition , Theorem**		
15	2		Definition and some examples		

11. Course Evaluation

Daily attendance and preparation = 3 marks. Daily homework and exam = 5 marks. Reports = 2 marks. Monthly exams = 30 marks. Final exam = 60 marks.

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	
Main references (sources)	
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description Form

University: Mosul **College:** Computer Science and Mathematics **Department:** Mathematics

1. Course name and academic level	
Mathematical Transforms / 4th Class	
2. Course Code:	
CM MS 25 F 437	
3. Semester / Year:	
First Semester 2024-2025	
4. Description Preparation Date:	
18/09/2024	
5. Available Attendance Forms:	
Attendance in the classroom according to the announced weekly class schedule.	
6. Number of Credit Hours (Total) / Number of Units (Total)	
4 Hours of theory per week / 3 units	
7. Course administrator's name (mention all, if more than one name)	
Dr. Waleed Mohammed Al-Hayani Dr. Mohammed Omar Al-Amr	waleedalhayani@uomosul.edu.iq alamr@uomosul.edu.iq
8. Course objectives	
Course Objectives	1. Developing students' problem-solving skills through mathematical transformation techniques. 2. Introducing students to the wide applications of transformations in various scientific fields. 3. Simplifying solutions to complex problems using transformation methods. 4. Strengthening fundamental understanding of concepts and definitions related to mathematical transformations. 5. Training students to use transformations in solving differential equations. 6. Highlighting the importance of transformation methods as a crucial mathematical tool for scientists and researchers.
9. Teaching and Learning Strategies	
Interactive Lectures	Explaining fundamental concepts of mathematical transforms with practical examples
Problem-Based Learning (PBL)	Solving real-world problems using mathematical transforms
Collaborative Learning	Group work to solve complex problems using mathematical transforms

Continuous Assessment	Periodic quizzes, weekly assignments, and comprehensive final examination

10. Course Structure

Week	Hours	Required learning outcomes	Unit or subject name	Learning method	Evaluation method
1	4	Learn about the Laplace transform, its properties, and some applications in solving differential equations and integrals.	Introduction and definitions, Kernal, Definition of Laplace integral	Presence in the classroom	According to the tasks assigned to the student, such as daily preparation, daily, oral, monthly and written exams.
2	4		Laplace transformation, Properties, Theorems, Examples		
3	4		Laplace Transform of derivatives and integrals, Theorems		
4	4		Inverse transform of Laplace, Method of evaluating inverse		
5	4		Convolution theorem, Properties, Examples		
6	4		Step, Impulse and periodic functions,		
7	4		Mid-term Exam + solving exercises		
8	4		Fourier series, Definitions, Properties		
9	4		Using Properties of sine and cosine		
10	4		Evaluation of Fourier coefficients, Properties, Examples		
11	4		Even and Odd functions, Definitions, principles, Examples		
12	4		Complex form of the Fourier series, Definitions, Examples		
13	4		Z-Transformation, Definitions, Theorems, properties		
14	4		Properties of Z-transform, Theorems, Examples		
15	4		Inverse of Z-transform, Definitions, methods, applications		

11. Course Evaluation and Grade Distribution

Midterm exam = 30 Degrees. Attendance and preparation = 5 Degrees.

Daily exam = 5 Degrees. Final exam = 60 Degrees.

12. Learning and Teaching Resources

Required textbooks (methodology books if any)	Indeterminate
Main References (Sources)	• Ladis, D Kovach, Advance Engineering Mathematics, 5th Edition, Addison Wesley Publishing Com., 2011.

Recommended supporting books and references (scientific journals, reports...)	• Gupta, Parmanand. *Topics in Laplace and Fourier transforms*. Laxmi Publications Pvt Limited, 2019. • Zill, Dennis G., and Michael R. Cullen. Differential equations with boundary-value problems. 7th Edition. Cengage Learning, 2008. • Spiegel, Murray R. *Schaum's Outline of Laplace Transforms*. McGraw Hill Professional, 1965.
Electronic References, Websites	Indeterminate
Curriculum or description update rate	10%

Lecturer Coordinator	Head of the Department
Assist. Prof. Dr. Waleed Mohammed Al-Hayani	Prof. Dr. Abdulghafor Jassim Salim

Course Description

1. Course Name:
Cryptography
2. Course Code:
CMMS24F456
3. Semester / Year:
2023-2024
4. Description Preparation Date:
1/9/2023
5. Available Attendance Forms:
In classroom of mathematical department
6. Number of Credit Hours (Total) / Number of Units (Total)
4 hours in every week/ 3 units
7. Course administrator's name (mention all, if more than one name)
Name: Dr. Ban Ahmed Hasan Mitras Email: banah.mitras@uomosul.edu.iq

8. Course Objectives	
Course Objectives	* Recognize on cryptography and its algorithms. *Study of classical encryption algorithms. * Study of modern encryption algorithms.

9. Teaching and Learning Strategies	
Strategy	Methods and algorithms of modern and classical cryptography

10. Course Structure					
	Hours	**Required Learning**			**Evaluation**

Week		Outcomes	Unit or subject name	Learning method	method
1	4		**General definitions**		
2	4		**Transposition Encrypt Algorithm**		
3	4		**Route transposition (zig-zag, anti zig-zag, horizontal, vertical)**		
4	4		**Clock-wise, anti-clock, diagonal route**		
5	4		**Double column transposition algorithm**		
6	4		**Polyliteral Transposition Algorithm**		
7	4		**Substitution Cipher Algorithm**		
8	4		**Direct(Additive) Cipher Algorithm**		
9	4		**Multiplicative Cipher Algorithm**		
10	4		**Affine Cipher Algorithm**		
11	4		**Stream –modern Encrypt Algorithms**		
12	4		**Encrypt Algorithms by ASCCI code**		
13	4		**Mathematical models to cryptography**		
14	4		**Morse Cipher Algorithm**		
15	4		**Beal's homophonic cipher algorithm**		

Transposition Encrypt Algorithm

11. Course Evaluation

Daily=10; monthly=30; finally=60

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	
Main references (sources)	**1-technology of information security and protection by Alaa Al-Hamamy & Saad Al-AAni, (2007)** **2-التشفير وامن المعلومات تاليف علي محمد دهب رحمة ،(2013).**
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description

University : Mosul
Department or Branch: Mathematics
College : Computer Science and Mathematics

1. Course Name / Class	
Graph Theory / 4th Class	
2. Course Code:	
CMMS 25_F4031	
3. Semester / Year:	
2nd Semester / 2024 - 2025	
4. Description Preparation Date:	
1 / 9 / 2024	
5. Available Attendance Forms:	
Classroom according to the announced weekly lesson schedule	
6. Number of Credit Hours (Total) / Number of Units (Total)	
4 hours per week / 3 units	
7. Course administrator's name (mention all, if more than one name)	
Name: ***Dr. Raghad A. Mustafa***	**Email:** ***raghad.math@uomosul.com***
Lecturer: Asmaa S. Aziz	***smaas982@uomosul.edu.iq***
8. Course Objective	
Course Objective	Identification of graph, directed graph and some special graph. Tracks, paths, and circuits, connected graph, distance in the graph and on the tree, planner graph, and graph immersion are also identified. genus, thickness, number of intersections, and some related results and theorems are identified.
9. Teaching and Learning Strategies	
Strategy	The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students. And knowing the basis of the concepts and where they came from and taking realistic applications on that

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or Subject Name	Learning Method	Evaluation Method
1	4	Understand the basic concepts of graph theory.	Introduction to the theory of graphs and its importance to other sciences	The course will be delivered through in-person lectures held in the Mathematics Department classroom, supplemented by online activities, resources, and assignments provided via the Google Classroom platform.	Students will be evaluated based on their performance in assigned tasks, including daily preparation, participation in daily and oral assessments, monthly and written examinations, and the submission of reports.
2	4		Basic Concepts in Graph theory.		
3	4		Directed graphs with some special graphs		
4	4		Connected and distance in graph		
5	4		Trees and forest with some theorems		
6	4	The ability to apply graph theory in different fields.	Planner graph		
7	4		Closed and oriented surfaces		
8	4		Mid-Exam		
9	4		Thickness, genus and number of crosses		
10	4		Kurtovsky's theorem and some theorems		
11	4	These skills help students excel in computing, artificial intelligence, statistical analysis, and other related fields.	Eid al-Fitr		
12	4		graph coloring		
13	4		Some applications of graph theory		
14	4		Review		
15	4		Final-Exam		

11. Course Evaluation

Daily exams: 10 points , Monthly exams: 30 points , Final exam: 60 points

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	علي عزيز علي ، " مقدمة في نظرية البيان " وزارة التعليم العالي والبحث العلمي ، الجمهورية العراقي جامعة الموصل 1983.

Main references (sources)	Chartrand , G. and Lesniak , L.; (2016). Graphs and Digraphs,6th ed.,Wadsworth and Brooks/Cole, California
Recommended books and references (scientific journals, reports, …)	[1].Bondy, J.A. and Murty, U.S.R.; (2008). Graph Theory, Library of Congress Control Number: 2007940370. [2].Diestel , R. . (2005). Graph Theory , Springer – Verlag Heidelberg , New York 2005. [3].Douglas , B. W.; (2002). Introduction in Graph Theory , printed in India by Rashtriya printers. [4].Fournier , J.C. ; (2009). Graph Theory and Applications, John Wiley & Sons, Inc. 111 River Street . USA.
Electronic References, Websites	https://en.wikipedia.org/wiki/Graph_theory
Curriculum or description update rate	10 %

Name and Signature of the Course Instructor

Dr. Raghad Abdulazeez Mustafa

Name and Signature of the Head of Department of Branch

Prof. Dr. Abdulghafoor J. Salim

Course Description

University: Mosul
College: Computer Science and Mathematics
Department or Branch: Mathematics

1. Course Name / Class	
Dynamical Systems / 4th Class	
2. Course Code:	
CM MS 24 F 466	
3. Semester / Year:	
1st Semester / 2023 - 2024	
4. Description Preparation Date:	
18 / 09 / 2024	
5. Available Attendance Forms:	
Classroom according to the announced weekly lesson schedule, electronically on Google Classroom platform.	
6. Number of Credit Hours (Total) / Number of Units (Total)	
4 hours per week / 3 units	
7. Course administrator's name (mention all, if more than one name)	
Name: Dr. Salma Muslih Faris Email: salma_muslih67@uomosul.edu.iq	
8. Course Objectives	
Course Objectives	− Develop the theory of iterative problem-solving and understand the fundamental ideas of dynamical systems. − Understand iterations, fixed points, and periodic points. − Study the basic concepts of dynamical systems. − Explore fundamental theories such as bifurcation theory and chaos theory. − Study dynamical systems in Euclidean and complex settings. − Examine advanced types of chaos (e.g., expanding functions).
9. Teaching and Learning Strategies	
Strategy	Type something like: The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.
10. Course Structure	

Week	Hours	Required Learning Outcomes	Unit or Subject Name	Learning Method	Evaluation Method
1	4	Understand the basic concepts of dynamical systems, including fixed points, periodic points, orbits, attraction, and repelling; explore SDIC, density, and topological transitivity; and apply examples and theorems related to these concepts.	Basic Definition of Dynamical Systems (DS): Fixed points, periodic points, orbits, attraction, and repelling.	The course will be delivered through in-person lectures held in the Mathematics Department classroom, supplemented by online activities, resources, and assignments provided via the Google Classroom platform.	Students will be evaluated based on their performance in assigned tasks, including daily preparation, participation in daily and oral assessments, monthly and written examinations, and the submission of reports.
2	4		Study of some examples in DS with special families.		
3	4		Definitions of SDIC (Sensitive Dependence on Initial Conditions), density, and topological transitivity.		
4	4		Examples and theorems related to the above concepts.		
5	4	Understand the concept of bifurcation, identify and distinguish between saddle-node, pitchfork, and Hopf bifurcations, and analyze examples illustrating each type.	Definition of Bifurcation.		
6	4		Study of types of bifurcation: saddle-node / pitchfork bifurcation.		
7	4		Pitchfork bifurcation and Hopf bifurcation.		
8	4		Examples for all the mentioned types of bifurcation.		
9	4	Understand the definition of chaos, recognize key chaotic families such as the logistic and tent maps, explore other chaotic functions, and explain the relationship between bifurcation and chaos.	Definition of Chaos.		
10	4		The most famous chaotic families: logistic map, tent map, etc.		
11	4		Other chaotic functions.		
12	4		The relationship between bifurcation and chaos.		
13	4	Understand dynamical systems in high-dimensional Euclidean spaces, analyze complex dynamical systems including Julia and Fatou sets, and explore the behavior of expanding functions.	Dynamical systems on high-dimensional Euclidean spaces.		
14	4		Complex dynamical systems (Julia sets and Fatou sets).		
15	4		Expanding functions.		

11. Course Evaluation

Daily attendance and preparation: 2.5 points , Homework: 2.5 points
Daily exams: 5 points , Monthly exams: 30 points , Final exam: 60 points

12. Learning and Teaching Resources	
Required textbooks (curricular books, if any)	Introduction to Chaotic dynamical Systems. R.L. Devaney
Main references (sources)	Encountered with Chaos, Gulic.
Recommended books and references (scientific journals, reports, …)	
Electronic References, Websites	
Curriculum or description update rate	10 %

Name and Signature of the Course Instructor

Dr. Salma M. Faris

Name and Signature of the Head of Department or Branch

Prof. Dr. Abdulghafoor Jasim Salim