Ministry of Higher Education and Scientific Research
Scientific Supervision and Scientific Evaluation Apparatus
Directorate of Quality Assurance and Academic Accreditation
Accreditation Department

ACADEMIC PROGRAM AND DESCRIPTION GUIDE POSTGRADUATE STUDIES/ MASTER'S DEGREE

TERM SYSTEM

2026-2025

Academic Program Description Form

University Name: Al-Nahrain University
Faculty/Institute: College of Sciences
Scientific Department: Department of Mathematics and Computer Applications
Academic or Professional Program Name: Master's
Final Certificate Name: Master's in Mathematics and Computer Applications
Academic System: Semester
Description Preparation Date: 2025-2026
File Completion Date: 28 / 10 / 2025

Signature:
Head of Department Name:
Prof. Dr. Fadhel Subhi Fadhel
Date: 25 / 11 / 2025

Signature:
Scientific Associate Name:
Assist. Prof. Dr. Manaf Adnan Saleh
Date: 25 / 11 / 2025

جامعة النهرين / كلية العلوم
قسم الرياضيات
و
تطبيقات الحاسوب

The file is checked by:
Department of Quality Assurance and University Performance
Director of the Quality Assurance and University Performance Department:
Lect. Dr. Orooba Nadhim Harbi
Date: 25 / 11 / 2025
Signature:

Approval of the Dean
Prof. Dr. Asmaa Hadi Mohammed

1. **Program Mission**
Program Vision
The department should be distinguished academically, in research, and in leadership to advanced levels.

2. **Program Mission**
Preparing academic staff members who emphasize the applied aspect and possess a distinguished level of education that aligns with quality standards and accreditation, through conducting research and studies, and providing consultations that contribute to serving both the university and the community. In addition to the student acquiring basic knowledge and concepts in mathematics and computer applications, enabling him to connect the applied academic sciences according to the needs of society.

3. **Program Objectives**
The department aims to produce cadres that can keep up to solve problems addressed to social life in a scientific manner based on applied mathematics for the success of work.

4. **Program Accreditation**
Does the program have program accreditation? And from which agency? -No

5. **Other external influences**
Is there a sponsor for the program? -There isn't any.

6. **Program Structure**

Program Structure	Number of Courses	Credit hours	Percentage	Reviews*
Institution Requirements	4	3	%8.33	
College Requirements	———	———	———	
Department Requirements	8	21	%58.33	
Thesis	1	12	%33.33	
Other	———	———	———	

* This can include notes whether the course is basic or optional.

7. Program Description

Year/Level	Course Code	Course Name	Credit Hours	
			theoretical	practical
Master	MATH514	Approximation Theory	3	
	MATH504	Numerical Solutions of Ordinary Differential Equations	3	
	MATH502	Integral Equations	3	
	MATH518	Calculus of Variation	3	
	MATH516	Mathematical Programming	3	
	UREQ 501	English Language I	2	
	UREQ 502	English Language II	2	
	MATH450	Control Systems Theory and Design	3	
	MATH512	Dynamical Systems	3	
	MATH501	Functional Analysis I	3	
	MATH517	Functional Analysis II	3	
	MATH507	Topics in Applied Mathematics	3	
	MATH520	Numerical Solutions of Partial Differential Equations	3	
	URSEM	Seminar	1	
	URMETHOM	Scientific Research Methodology	2	

8. Expected learning outcomes of the program

Knowledge	
Learning Outcomes 1	1- Creating a strong foundation for the student in the subject of pure and applied mathematics. 2- Creating advanced thinking in understanding most mathematics topics. 3- The student knows how to understand research methodology as theoretical and empirical analysis and make

	comparisons between them. 4- The student will acquire as much specialized terminology as possible and be able to convert practical applications to mathematical equations.
Skills	
Learning Outcomes 2	1- Injecting a fair amount of specialized information, terminology, and equations related to the scientific subject. 2- The student gains experience in evaluating research and the capability in enhancing the research. 3- Urging the student to analyze the results and make discussion. 4- To be guided by the department head and its council in this regard and to benefit from the experience of professors with long experience in the field of personal development.
Ethics	
Learning Outcomes 4	1- Increasing the student's cognitive and scientific awareness with scientific research integrity. 2- Enabling the student to use mathematical concepts, both applied and pure. 3- Understanding and solving life applications of various types through using innovative scientific methods. 4- The student's knowledge of linking mathematical concepts to each other.

9. Teaching and Learning Strategies

The teaching and learning strategy for postgraduate\ Master's degree focuses on thinking, in-depth research and analysis, and self-skill development. These strategies depend on several tools and manners that students follow them for gaining research Knowledge from published papers via honest academic websites.

Therefore, arranging these published papers as references in the author paper by using one of the available tools for research organizing, so the gaining of these skills during attending the seminars and workshops conducting about scientific research methodology. Additionally, the ability

of analyzing ang thinking of theoretical research and evaluate it scientifically and logically and solving complex problems.

Considering teamwork is one of the strategies that represents the improvement side for research outcomes and academic knowledge exchange among the researchers by sharing them through local and global conferences.

Moreover, the researcher should follow obvious scientific structure for writing research and restricting it to academic integrity in terms of subjecting it to scientific and linguistic review and plagiarism programs.

Besides, the time management policy plays an important role in teaching and learning strategies that enable the student to fulfil the research achievement correctly.

10. Evaluation methods

- Daily participation.
2- Daily exams.
3- Monthly exam.
4- Reports.
5- Discussion sessions (seminars).
6- Graduation projects.
7- Homework.

11. Faculty

Faculty Members

Name & Academic Position	Specialization		Special Requirements/Skills (if applicable)		Number of the teaching staff	
	General	Special			Staff	Lecturer
Professor	Mathematics	Applied Mathematics / Integral transform			1	
Professor	Mathematics	Numerical Analysis / Approximation Theory			1	
Professor	Mathematics	Fuzzy set Theory and its Applications			1	
Professor	Mathematics	Functional Analysis			1	
Professor	Mathematics	Operations Research			1	
Associate Professor	Mechanical Engineering	Operations Research			1	
Associate Professor	Mathematics	Dynamical Systems			1	
Associate Professor	Mathematics	Control Systems			1	
Lecturer	Mathematics	Numerical Control			1	
Lecturer	Mathematics	Functional Analysis			1	
Lecturer	Mathematics	Applied Mathematics			3	
Lecturer	Mathematics	Applied Mathematics			1	

Lecturer	Mathematics	Algebraic statement theory			1	
Lecturer	Mathematics	Complex Analysis			1	
Lecturer	Arabic Language	Arabic Language Grammer			1	
Lecturer	Mathematics	Stability of Fuzzy Differential Equations			1	
Lecturer	Mathematics	Mathematical Statistics			1	
Lecturer	Mathematics	Semi-Analytic Methods for Solving Differential Equations			1	
Lecturer	Mathematics	Numerical Solutions of Fractal partial Differential Equations			1	
Lecturer	Mathematics	Linear Programming			1	

Professional Development

Mentoring new faculty members

1- Integrating new recruits into the educational process by assigning them to deliver lectures in the Mathematics Department and other departments, in addition to committees and administrative work.

2- Involving them in scientific activities (conferences, training courses, workshops, and seminars).

3- Creating joint research groups.

4- Educational, professional, and academic qualification for new faculty members, including informing them of the goals, learning outcomes, and plans drawn up to achieve them.

Professional development of faculty members

1- Continuous academic development for faculty members to keep pace with modern developments in the field of specialization.

2- Communication between faculty members, the supporting staff, and the supporting technical and administrative staff.

3- Communication between faculty members and students.

4- The existence of an integrated system for periodically evaluating faculty members and promoting them.

5- The stability of the teaching staff and the rate of continuity in their work.

6- Participation of faculty members and supporting staff in conferences, scientific activities, and community service.

7- The freedom and responsibility of faculty members in evaluating and developing the curriculum.

8- Provides the environment and time for faculty members and supports staff for professional development and research activity.

12. Acceptance Criterion

Admission is through direct application to the Department of Mathematics and Computer Applications according to the students' Application Guide for postgraduate and the competition for study available seats through competitive examination.

13. The most important sources of information about the program

The department's website by the College of Science website.

- Faculty biographies

- The department's scientific activities within the Media Unit.

14. Program Development Plan

Based on the results and statistics of the surveys and feedback from students and employers, the following are part of the department's plan to update and develop the program:

1- Twinning between the department and the peer departments in the other Iraqi, regional and international Universities.
2- Achieving the connection between the academic and applied sciences according to the society needs and according to the development centers in Iraq.
3- Initiating new subdivisions of the department, namely: Statistics, operations Research, and Pure Mathematics.

Program Skills Outline															
				Required program Learning outcomes											
Year/Level	Course Code	Course Name	Basic or optional	Knowledge				Skills				Ethics			
				A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Master	MATH514	Approximation Theory	Optional\Dep. Requirement	X	X		X	X				X		X	X
	MATH504	Numerical Solutions of Ordinary Differential Equations	Basic\Dep. Requirement	X	X		X	X				X		X	X
	MATH502	Integral Equations	Optional\ Dep. Requirement	X	X		X	X				X		X	X
	MATH513	Fuzzy theory	Optional \Dep. Requirement	X	X		X	X				X		X	X
	MATH516	Mathematical Programming	Optional \Dep. Requirement	X	X		X	X				X		X	X
	UREQ 501	English Language I	Basic\ Un. Requirement		X							X		X	X
	UREQ 502	English Language II	Basic\ Un. Requirement		X							X		X	X
	MATH450	Control Systems Theory and Design	Optional \Dep. Requirement	X	X		X	X				X		X	X
	MATH512	Dynamical Systems	Optional \Dep. Requirement	X	X		X	X				X		X	X
	MATH501	Functional Analysis I	Basic\Dep. Requirement	X	X		X	X				X		X	X

	MATH517	Functional Analysis II	Basic\Dep. Requirement	X	X		X	X				X		X	X
	MATH507	Topics in Applied Mathematics	Optional \Dep. Requirement	X	X		X	X				X		X	X
	MATH520	Numerical Solutions of Partial Differential Equations	Optional \Dep. Requirement	X	X		X	X				X		X	X
	URSEM	Seminar	Basic\Dep. Requirement	X		X			X	X	X	X	X	X	X
	URMETHOM	Scientific Research methodology	Basic\Dep. Requirement	X		X			X	X	X	X	X	X	X

Please tick the boxes corresponding to the individual program learning outcomes under evaluation

Master\ First Term
Course Description Form

1. Course Name:
Approximation Theory
2. Course Code:
MATH508
3. Semester / Year:
First 2025-2026
4. Description Preparation Date:
24/9/2025
5. Available Attendance Forms:
Attendance lectures in the classroom
6. Number of Credit Hours (Total) / Number of Units (Total)
60/4
7. Course administrator's name (mention all, if more than one name)
Name: Dr. Osama Hameed Mohammad Email: Osama.hameed@nahrainuniv.iq
8. Course Objectives

Course Objectives	• be able to use and analyze the basic methods for polynomial approximations (interpolation, least squares, piecewise approximations, Hermite interpolation) • understand and use the theory of convergence (Weierstrass) and best approximations for continuous functions as well as error estimates for smooth functions. • understand and use the theory of stability and conditioning for polynomial approximation methods, including its relation to interpolation points via Lebesgue constants. • have a good understanding of a couple of current topics in approximation theory, with a deeper knowledge of at least one of them.
9. Teaching and Learning Strategies	
Strategy	1- Lecture strategy. 2- Discussion strategy. 3- Cooperative education. 4- Provide illustrative examples. 5- Conclusion. 6- Brainstorming.

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	4	Polynomial interpolat	Basic facts about polynomial interpolati and divided differenc	Attendance interac lectures	Ask questions and give assignments
2	4	Polynomial interpolat	Basic facts about polynomial interpolati and divided differenc	Attendance interac lectures	Ask questions and give assignments
3	4	Piecewise Linear Approximation	The essential features piecewise polynomia approximation	Attendance interac lectures	Ask questions and give assignments
4	4	Piecewise Cubic Interpolation	Describe various schen for piecewise cubic interpolation	Attendance interac lectures	Ask questions and give assignments
5	4	Best Approximatio properties of comple Cubic spline interpolation and it error	Describe the minimur norm property	Attendance interac lectures	Ask questions, give assignments,
6	4	Parabolic spline interpolation	Interpolation by parabo splines	Attendance interac lectures	Ask questions and give assignments and make a 1st attence mid exam
7	4	A representation for piecewise polynomial functions	Discuss the ways to represent piecewise polynomial functions arbitrary order in compu	Attendance interac lectures	Ask questions and give assignments
8	4	Truncated power basi	Smoothing a histogra	Attendance interac lectures	Ask questions and give assignments
9	4	A representation of functions by B-spline	Defining the k-th order spline and its related theorems	Attendance interac lectures	Ask questions and give assignments
10	4	A representation of functions by B-spline	Defining the k-th order spline and its related theorems	Attendance interac lectures	Ask questions and give assignments
11	4	The stable evaluation B-splines	Discuss the properties B-splines that is linea combination of B-splin or the B-splines serie	Attendance interac lectures	Ask questions and give assignments
12	4	Approximations	Definitions and theore	Attendance interac	Ask

		normed linear spaces	that talking about the conditions of best approximations	lectures	questions, give assignments, and make a 2nd attendance mid exam
13	4	Approximations normed linear spaces	Definitions and theore that talking about conditions of l approximations	Attendance interac lectures	Ask questions and give assignments
14	4	Applications	Spline interpolat numerical solutions ordinary differer equations by colloca method using spline	Attendance interac lectures	Ask questions and give assignments
15	4	Applications	Spline interpolat numerical solutions partial differer equations by colloca method using spline	Attendance interac lectures	Ask questions give assignmer

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	1. A practical guide to splines. By Carl DeBoor 2. Approximation theory and numerical methods. By G.A.Wttson
Main references (sources)	
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description Form

1. Course Name:	
Numerical solutions of ODEs	
2. Course Code:	
MATH504	
3. Semester / Year:	
First / 2025-2026	
4. Description Preparation Date:	
23-9-2025	
5. Available Attendance Forms:	
Attendance lectures in the classroom	
6. Number of Credit Hours (Total) / Number of Units (Total)	
45 hours/3 units	
7. Course administrator's name (mention all, if more than one name)	
Name: Asst. Prof. Dr. Fadhel Subhi Fadhel Email: fadhel.subhi@nahrainuniv.edu.iq	
8. Course Objectives	
Course Objectives	• Study the numerical solutions of ordinary differential equations using multi-step methods (including the theoretical aspect as well) • Using Range-Kutta methods to find the numerical formulae to solve this type of equations. • Study the numerical stability, convergence and consistency of the methods that were derived previously (in the two methods above) • Apply these methods to find the numerical solutions of systems of differential equations. • Study the numerical solutions of boundary value problems • Studying approximation methods for solving ODEs
9. Teaching and Learning Strategies	
Strategy	The teaching and learning strategy is considered a set of tools and practices carried out by both the teacher and the student in order to comprehend the academic material or course, which is the numerical solutions to ordinary differential equations in the best possible way. This depends on two basic factors: good transmission by the subject teacher, which is supported by teaching strategies, and good reception by the student, which is supported by learning strategies. Teaching strategies include a set of organized plans and methods followed by the subject teacher in order to guide students towards achieving learning goals, including cognitive goals for numerical analysis, skill goals for finding numerical solutions, including programming using computers, and emotional and value goals through sensory perception of the nature

	of the problem and how to deal with it. This is done. Through specific teaching and learning methods in order for the student to acquire transferable general and qualifying skills.

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	4	Distinguish between different numerical effects	Numerical operators	Attendance interactive lectures	Ask questi and g assignments
2	4	Learn to solve finite difference equations analytically and numerically	Finite difference equations	Attendance interactive lectures	Ask questions and give assignments
3	4	Finding a solution to differential equations numerically	Solving Differential Equations Using Taylor Methods	Attendance interactive lectures	Ask questions and give assignments
4	4	Theoretical study and derive the method order	Euler's method	Attendance interactive lectures	Ask questions and give assignments
5	4	Theoretical study and derive the method order	Euler's method	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attence mid exam
6	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Linear multistep methods	Attendance interactive lectures	Ask questions and give assignments
7	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Linear multistep methods	Attendance interactive lectures	Ask questions and give assignments
8	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Linear multistep methods	Attendance interactive lectures	Ask questions and give assignments
9	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Linear multistep methods	Attendance interactive lectures	Ask questions and give assignments
10	4	Study the methods	Runge-Kutta	Attendance	Ask questions and

		of derivation to find the order of error and study the stability of the numerical method	methods	interactive lectures	give assignments
11	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Runge-Kutta methods	Attendance interactive lectures	Ask questions and give assignments
12	4	Study the methods of derivation to find the order of error and study the stability of the numerical method	Runge-Kutta methods	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd attendance mid exam
13	4	Using the shooting method	Boundary value problems	Attendance interactive lectures	Ask questions and give assignments
14	4	Using the finite difference method and the collocation method	Boundary value problems	Attendance interactive lectures	Ask questions and give assignments
15	4	Studying the approximation methods	Variational Iteration Method	Attendance interactive lectures	Ask questions and give assignments

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.

20% monthly written exams

10% daily and oral exams, homework's, and class activities

70% written final exam

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	1. Lambert J. D., "Computational Methods in Ordinary Differential Equations", John Wiley and Sons, Ltd., 1973. 2. Burden R. L. and Faires J. D., "Numerical Analysis", 3rd Edition, PWS, 1985.
Main references (sources)	Butcher, J. C. (1987). The numerical analysis of ordinary differential equations: Runge-Kutta and general linear methods. Wiley-Interscience.
Recommended books and references (scientific journals, reports...)	Ph.D. and M.Sc. Theses of Al-Nahrain university
Electronic References, Websites	Online lectures recorded on YouTube by the lecturer.

Course Description Form

1. Course Name: Integral Equations

2. Course Code: MATH502

3. Semester / Year: First / 2025-2026

4. Description Preparation Date: 2025-9-10

5. Available Attendance Forms: Class Attendance

6. Number of Credit Hours (Total) / Number of Units (Total): 45

7. Course administrator's name (mention all, if more than one name)

Name: Prof.Dr. Ali Hassan Nasser Al-Fayadh
Email: ali.hassan@nahrainuniv.edu.iq

8. Course Objectives

Course Objectives	By the end of the course the students will learn the following main concepts: • Some numerical methods for solving Volterra and Fredholm integral Equations, as well as the Integro-differential equations. • Techniques for solving Volterra integral equation of the first kind. • Treatment of Fredholm integral equation with Singular kernel. • An overview of Nonlinear Volterra and Fredholm integral equations, as well as the mixed type of these equations.

9. Teaching and Learning Strategies

Strategy	• Lectures. • Tutorials. • Discussion. • Problem solving. • Home work. • Exam.

10. Course Structure

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

1	3	•Have understanding regarding different types of integral equations.	Introduction: The basic concept of integral equations with respect to its formulas and kernels.	Attendance interactive lectures	Ask questions and give assign-ments.
2	3	• Apply analytical methods and a range of theorems to treat problems involve integral equations.	Some analytic methods For solving integral equations: Review some different methods for solving Volterra and Fredholm integral equations of the second kind with continuous kernels, using some analytic methods.	Attendance interactive lectures	Ask questions and give assign-ments.
3	3	• Apply numerical methods to treat problems involve integral equations.	Numerical methods: Some numerical methods for solving Volterra integral equation with continuous kernels	Attendance interactive lectures.	Ask questions and give assign-ments.
4	3	• Apply numerical methods to treat problems involve integral equations.	Numerical methods **(cont.)** Some numerical methods for solving Fredholm integral equation with continuous kernels.	Attendance interactive lectures.	Ask questions and give assign-ments.
5	3	• Apply numerical methods to treat problems involve Integro-differential equations.	Numerical methods **(cont.)** Some numerical methods for solving Integro-differential equations	Attendance interactive lectures.	Ask questions and give assign-ments.
6	3	• How to convert Volterra integral equation of the first kind to a second type and apply	Volterra integral equation of the first kind: The solution of Volterra integral	Attendance interactive lectures.	Ask questions and give assign-ments.

		numerical methods to treat these problems.	equation of the first kind using Laplace transformation.		
7	3	•Have understanding Abel's integral equation.	Abel's equations: Abel's integral equation in general form	Attendance interactive lectures.	Ask questions and give assign-ments.
8	3	•Have solving Abel's integral equation by different approaches.	Abel's equations **(cont.)** Dynamical systems and Abel integral equation, • **Midterm exam (1)**	Attendance interactive lectures.	Ask questions and give assign-ments.
9	3	•Have understanding Abel's integral equation in fractional integral.	Abel's equations **(cont.)** Abel equations in view of fractional integral	Attendance interactive lectures.	Ask questions and give assign-ments.
10	3	•How to convert this type to another one.	Volterra Equations: Reduction of Volterra equations of the second kind to Volterra equations of the first kind	Attendance interactive lectures.	Ask questions and give assign-ments.
11	3	•How to treat the discontinuities.	Integral equations with discontinuous kernels: Fredholm and Volterra integral equations with singular kernel	Attendance interactive lectures.	Ask questions and give assign-ments.
12	3	•Have understanding theorems of existence of uniqueness solution of integral equations.	Integral equations with discontinuous kernels: **(cont.)** The existence of a unique solution of	Attendance interactive lectures.	Ask questions and give assign-ments.

			Fredholm integral equation with singular kernel		
13	3	• Apply some numerical methods to solve problems involve integral equations with singular kernel arising in various scientific fields.	Integral equations with discontinuous kernels: **(cont.)** Some methods to solve linear Fredholm integral equation with singular kernel, some applications, • **Midterm exam (2)**	Attendance interactive lectures.	Ask questions and give assign-ments.
14	3	• Apply some numerical methods to solve integral equations involve nonlinear terms.	Nonlinear Volterra and Fredholm integral equations: Theory of existence and uniqueness of the solution using Picard method- Banach fixed point theorem.	Attendance interactive lectures.	Ask questions and give assign-ments.
15	3	• Apply some numerical methods to solve integral equations involve nonlinear terms.	Nonlinear Volterra and Fredholm integral equations **(cont.)** Some analytics methods to solve the nonlinear integral equations. Some numerical methods to solve the nonlinear integral equations.	Attendance interactive lectures.	Ask questions and give assign-ments.

11. Course Evaluation

15% Exam1, 15% Exam2, 70% Final Exam.

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	Rahman, M. (2007). Integral Equations and th Applications. WIT Press.
Main references (sources)	Atkinson, K. (1997). The numerical solution of

	integral equations of the second kind. Cambridge: Cambridge University Press.
Recommended books and references (scientific journals, reports…)	• Linz, P. (1969). Numerical methods for Volterra integral equations of the first kind. The Computer Journal, 12(4), pp.393-397. • Abdou, M., Mohamed, K. and Ismail, A. (2003). the numerical solutions of Fredholm–Volterra integral equation. Applied Mathematics & Computation, 146(2-3), pp.713-728.
Electronic References, Websites	• https://projecteuclid.org/journals/journal-of-integral-equations-and-applications • http://www.papersciences.com/J-Int-Eqs.htm

Course Description Form

1. Course Name:
English Language I
2. Course Code:
UREQ 501
3. Semester / Year:
First/ MSc
4. Description Preparation Date:
2025-9-15
5. Available Attendance Forms:
Lectures
6. Number of Credit Hours (Total) / Number of Units (Total)
30 hours/ 1 credits
7. Course administrator's name (mention all, if more than one name)
Name: Dr. Akram Abbas Al-Sabbagh Email: akram.alsabbagh@nahrainuniv.edu.iq
8. Course Objectives

Course Objectives	• The aims of New Headway Academic Skills are to help postsecondary students become more efficient and effective in their studies • developing strategies to improve reading speed, and to improve the ability to comprehend complex academic texts. • developing strategies to produce more coherent writing, and to make clear, t1ppropriate, and relevant notes from academic texts. • encouraging them to adopt various approaches for dealing with new or unknown vocabulary by practicing effective use of dictionaries, and through making effective vocabulary records.

9. Teaching and Learning Strategies	
Strategy	The strategy is to provide the students with as much information about academic reading and writing skills as possible by attending lectures to maximize the connection between the students and the lecturer. The lectures, some homework and some other additional exercises is also shared on Google Classroom.

10. Course Structure

Week	Hours	Required	Unit or subject	Learning	Evaluation method

		Learning Outcomes	name	method	
1	2	Introduction		Attendance interactive lectures	Ask questions and give assignments
2	2	READING: Going abroad to study	International students	Attendance interactive lectures	Ask questions and give assignments
3	2	WRITING: A host family	International students	Attendance interactive lectures	Ask questions and give assignments
4	2	READING: Three countries	Where in the world...?	Attendance interactive lectures	Ask questions and give assignments
5	2	WRITING: My country	Where in the world...?	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attence mid exam
6	2	Exam 1		Attendance interactive lectures	Ask questions and give assignments
7	2	READING: An unexpected journey	Newspaper articles	Attendance interactive lectures	Ask questions and give assignments
8	2	WRITING: Mistaken identity	Newspaper articles	Attendance interactive lectures	Ask questions and give assignments
9	2	READING: Innovations	Modern technology	Attendance interactive lectures	Ask questions and give assignments
10	2	WRITING: Technology - good or bad?	Modern technology	Attendance interactive lectures	Ask questions and give assignments
11	2	Exam 2		Attendance interactive lectures	Ask questions and give assignments
12	2	READING: A conference in Istanbul	Conferences and visits	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd attence mid exam
13	2	WRITING: Invitations	Conferences and visits	Attendance interactive lectures	Ask questions and give assignments
14	2	Exam 3		Attendance interactive lectures	Ask questions and give assignments
15	2	Final exam preparing		Attendance interactive lectures	Ask questions and give assignments

11. Course Evaluation

Midterm exam: 30 marks
Final exam: 70 marks

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	Academic Skills: Reading, Writing, and Study Skills, LEVEL 2, Student's Book
Main references (sources)	Academic Skills: Reading, Writing, and Study Skills, LEVEL 2, Student's Book

Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description Form

1. Course Name:
Control Systems Theory and Design
2. Course Code:
MATH450
3. Semester / Year:
First/ Master
4. Description Preparation Date:
1/9/2025
5. Available Attendance Forms:
Physical attendance
6. Number of Credit Hours (Total) / Number of Units (Total)
45 hours/ 3 units
7. Course administrator's name (mention all, if more than one name)
Name: Fatimah Al-Taie Email: fatimah.altaie@nahrainuniv.edu.iq
8. Course Objectives

Course Objectives	• Learning the basic concepts of cont systems, such as state space and trans

	function, solution, stability, controllabil and observability of control systems. • Teaching the students how to dealing w real life applications. • Dealing with design a controller for unstal systems.

9. Teaching and Learning Strategies

Strategy	The learning and teaching strategy is presented by: Providing the students with a sufficient amount of mathematical ter and definitions by attending lectures and presenting on the whiteboard connect the students with the lecturer to solve as many real-l applications as possible. The pdf lectures, homework, quizzes, a exercises are shared on Google Classroom. The subject will be given to the students on a whiteboard through a ser of lectures with problem-solving practice carried out in interacti tutorials. These tutorials will be supported by practice and directed stu outside the classroom. Formative assessment takes place during tutori and feedback is given during these tutorials.

10.Course Structure

Week	**Hours**	**Required Learni Outcomes**	**Unit or subject name**	**Learning method**	**Evaluation method**
1-2	6	Introduction control systems	Definitions, state spa and transfer functi solution and stability control systems	lectures	
3-6	12	Controllability control systems	Controllable system, p placement, uncontrolla subsystem, transformati matrix, controlla	lectures	

			subspace a stabilizability, PBH-tes		
7-9	9	Observability control systems	Observable system, st estimation, unobserva system, transformati matrix, observa subspace, detectabili Duality (PBH-test).	lectures	
10-11	6	Observer-based control	Closed-loop systems	lectures	
12-1		Optimal control+MIMO systems	Symmetric root loc Pareto curve	lectures	
14-15		Digital control+Lyapunov inequalities	Stability of closed lo via Lyapunov inequaliti	lectures	

11.Course Evaluation

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

Pre-final exam: 30%

(Quizzes, homework: 10%, Mid-Exams 20%).

Final exam: 70%

Total: 100%

12.Learning and Teaching Resources	
Required textbooks (curricular books, any)	
Main references (sources)	[1] K. Zhou, J.C. Doyle and K. Glover,"Rob and Optimal Control", Prentic Hall, 2004. [2] G. Strang, "Linear Algebra and Applications", Third edition Harcourt Bra Jovanich College Publishers, 2000. [3] T.Kalitah, "Linear Systems", Prentic H 1996.
Recommended books and referen (scientific journals, reports...)	Applications of Control Systems
Electronic References, Websites	Google.com

Course Description Form

1. Course Name: FUNCTIONAL ANALYSIS I

2. Course Code: MATH517

3. Semester / Year: First/ 2025-2026

4. Description Preparation Date: November 2025

5. Available Attendance Forms: Attendance lectures in the classroom

6. Number of Credit Hours (30) / Number of Units (2)

7. Course administrator's name (mention all, if more than one name)

Name: AAMENA RASIM MOHAMMED
Email: Aamena.raimmohammed@nahrainuniv.edu.iq

8. Course Objectives

Course Objectives	➢ **Metric spaces.** ➢ **Vector spaces.** ➢ **Normed space (Banach space).** ➢ **Further properties of normed spaces.** ➢ **Convergent sequences and Cauchy sequences.** ➢ **Inner product spaces (pre-Hilbert spaces).** ➢ **Hilbert spaces.** ➢ **Orthogonal and orthonormal sets** ➢ **Distance in pre-Hilbert spaces.** ➢ **Isomorphic inner product spaces.**

9. Teaching and Learning Strategies

Strategy	1. Attend classroom lectures, electronic homework, and various activities and assignments. 2. Adopting the interactive aspect between the teacher and the student when explaining the subject. 3. Direct questions to students to test their understanding of the topic. 4. Adopting the principle of preparing reports by students in various subject areas.

3. Course Structure

Wee	Ho	Required Learning	Unit or subject name	Learning	Evaluation method

k	urs	Outcomes		method	
1	2	Giving the basics definitions of metric spaces (Complete metri spaces)	Metric soaces	Attendance Interactive lectures	Ask questions and Give assignments
2	2	Study the basic algebrai properties with exampl	Open and closed sets And limit points	Attendance Interactive lectures	Ask questions and Give assignments
3	2	Definition and examples	Vector Spaces	Attendance interactive lectures	Ask questions and Give assignments
4	2	Definition of normed Spaces and examples	Normed spaces	Attendance interactive lectures	Ask questions and give assignments
5	2	Normed spaces and Metric spaces (Banach spaces)	Normed spaces	Attendance interactive lectures	Ask questions and give assignments
6	2	-	-	-	1st attended mid exam
7	2	Definition of Pre-Hilber spaces And examples	Pre-Hilbert spaces	Attendance interactive lectures	Ask questions and give assignments
8	2	Relation between inner Product spaces and Normed spaces	Pre-Hilbert spaces (Inner product spaces)	Attendance interactive lectures	Ask questions and give assignments
9	2	Definition of Hilbert spaces with examples	Hilbert spaces	Attendance interactive lectures	Ask questions and give assignments
10	2	Study the compactness finite dimensional	Compactness terminology on finite dimensional normed space	Attendance interactive lectures	Ask questions and give assignments
11	2	Orthogonal vectors And orthogonal Complement sets	Orthogonal and Orthonormal sets	Attendance interactive lectures	Ask questions and give assignments
12	2	Bessel Inequality And Gram Schmidt	Orthogonal and Orthonormal sets	Attendance interactive lectures	Ask questions and give assignments
13	2	-	-	-	2nd attended mid exam
14	2	Distance in inner Product spaces (convex sets)	Distance in inner Product spaces	Attendance interactive lectures	Ask questions and give assignments
15	2	Definition and examples	Isomorphic inner Product spaces	Attendance interactive lectures	Ask questions and give assignments
4. Course Evaluation					
30% (mid exams) and 70% (final exam)					
5. Learning and Teaching Resources					

Required textbooks (curricular books any)	Introduction to Hilbert Space by Sterling K. Berberian
Main references (sources)	Introductory Functional analysis with Applications by Erw Kreyszig.
Recommended books and references (scientific journals, reports...)	
Electronic References, Websites	➢ https://www.youtube.com/playlist?list=PLUl4u3cNGP6icsJp_--fRAjZXPrQzW. ➢ https://www.math.uci.edu/~rvershyn/teaching/2010-11/602/functional-analysis.pdf ➢ https://ocw.mit.edu/courses/18-102-introduction-to-functional-analysis-spring-2009/pages/lecture-notes.

Master\ Second Term

Course Description Form

1. Course Name: Topics in Applied Mathematics
2. Course Code:
MATH507
3. Semester / Year: Second / 2025-2026
4. Description Preparation Date:
2025-9-25
5. Available Attendance Forms: Class Attendance
6. Number of Credit Hours (Total) / Number of Units (Total): 45
7. Course administrator's name (mention all, if more than one name)
Name: Prof.Dr. Ali Hassan Nasser Al-Fayadh Email: ali.hassan@nahrainuniv.edu.iq
8. Course Objectives

Course Objectives	• To develop the knowledge of different transforms and its applications • To provide an introduction to the integral transforms and their applications in mathematics and signal processing. • To make the students acquire sound knowledge of techniques in solving differential and integral equations. • To equip the students with various possible applications of integral transforms.

9. Teaching and Learning Strategies

Strategy	• Lectures. • Tutorials. • Discussion. • Problem solving. • Home work. • Exam.

10. Course Structure

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

		Outcomes			
1	3	•Have understanding regarding different mathematical concepts. • Derive Fourier series representation of periodic functions	•Introduction: Basic definitions. Vector space, Inner products and orthonormal sets, piecewise Continuous functions, Periodic function, Fourier series formula for periodic functions.	Attendance interactive lectures	• Ask questions and give assign-ments.
2	3	• Derive Fourier series representation of odd and even functions. • Derive Fourier series representation on other intervals, and for discontinuous functions.	• Fourier Series (part I). Fourier series for odd and even functions, adaptation to other intervals, Fourier series for discontinuous functions, half range Fourier series , half range Cosine series, half range Sine series	Attendance interactive lectu	• Ask questions and give assign-ments.
3	3	• Prove some theorems regarding Fourier coefficients. • Prove some theorems regarding Differentiation and integration of Fourier series.	• Fourier Series (part II). One-Sided derivatives, A property of Fourier coefficients, Absolute and uniform convergence of Fourier series, Differentiation of Fourier series, Integration of Fourier series.	Attendance interactive lectu	• Ask questions and give assign-ments.
4	3	• Apply Fourier series of a function to obtain best approximation. • Prove and apply Bessel's inequality and Parseval's equation.	• Fourier Series (part III). Best approximation in the mean, Bessel's inequality and Parseval's equation, Applications to Fourier series.	Attendance interactive lectu	• Ask questions and give assign-ments.
5	3	• Studying various types of Fourier	• Fourier Integral. Fourier integral of a	Attendance interactive lectu	• Ask questions and give assign-

		Integrals.	function, Fourier Cosine integral, Fourier Sine integral, Complex Fourier integral, Properties of Fourier integral, Computation of integration using Fourier integral.		ments.
6	3	• Studying various types of Fourier Integrals.	• Fourier Transform (part I). Fourier sine and cosine transformation Properties of Fourier Sine and Cosine transform, Applications of Fourier Sine and Cosine transform on Partial differential Equations.	Attendance interactive lectur	• Ask questions and give assign-ments.
7	3	• Apply Fourier transform for solving PDEQs.	• Fourier Transform (part II). Convolution theorem, Parseval's identity for Fourier transforms, Fourier transform of the derivative of a function, Applications to solve integral equations, Finite Fourier transforms.	Attendance interactive lectur	• Ask questions and give assign-ments.
8	3	• Apply Fourier transform for solving IEQs. •Applications of Fourier transforms i initial and boundary value problems: applications of infinite Fourier transforms.	• Fourier Transform (part III). Finite Fourier Sine transforms, Inversion formula. Finite Fourier Cosine transforms, Inversion formula, Applications of Fourier transforms in initial and boundary value problems:	• Attendance interactive lectur	• Ask questions and give assign-ments.

			applications of infinite Fourier transforms, Applications of finite Fourier transforms, finite Fourier transforms of partial derivation. **Midterm exam (1)**		
9	3	•Applications of DFT, DCT, and DST in signal processing.	• Discrete Fourier Transform (DFT): General formula, Discrete Cosine Transform (DCT), Discrete Sine Transform (DST), Applications to signal processing.	Attendance interactive lectur	• Ask questions and give assign-ments.
10	3	• Applications of Laplace transforms for solving PDEQs and IEQs.	• Laplace Transform. Definition, Standard forms, Shifting theorems, Properties, Inverse transform of derivatives, Heaviside expansion theorem, Inverse Laplace transform, Convolution theorem, Differentiation and integration properties of Laplace transform, Applications of Laplace transforms to solutions of partial differential equations and integral equations.	Attendance interactive lectur	• Ask questions and give assign-ments.
11	3	• Understanding and Applications of Hankel and Mellin transforms in various scientific fields.	• Hankel Transform: Introduction, properties and applications to PDEQs, • Mellin transforms: Introduction,	Attendance interactive lectur	• Ask questions and give assign-ments.

			properties, applications; Generalized Mellin transforms.		
12	3	• Understanding and Applications of Z Transform in Engineering and Physics problems.	• Z Transform: Introduction, Definition, Properties; Dynamic linear system and impulse response, Inverse Z transforms, Summation of infinite series, Applications to finite differential equations. • **Midterm exam (2)**	Attendance interactive lectu	• Ask questions and give assign-ments.
13	3	• Applications of fractional Laplace transforms for solving fractional DEQs.	• Fractional Calculus and its applications. Introduction, fractional derivatives, integrals, Laplace transform of fractional integrals and derivatives.	Attendance interactive lectu	• Ask questions and give assign-ments.
14	3	• Understanding the derivation of wavelets transform.	• Wavelet Transform. (part I) Definition, Discussion on continuous and discrete, Properties, Multi-resolution property, Haar, Shannon and Daubechie Wavelets.	Attendance interactive lectu	• Ask questions and give assign-ments.
15	3	• How to apply wavelets transform in various scientific fields.	• Wavelet Transform. (part II) Applications: Solving PDEQs, Signal processing.	Attendance interactive lectures.	• Ask questions and give assign-ments.

11. Course Evaluation	
15% Exam1, 15% Exam2, 70% Final Exam.	
12. Learning and Teaching Resources	
Required textbooks (curricular books, if any)	• R.V. Churchill and J. Brown.: "Fourier Series and Boundary Value Problems" (7th edition)(Publisher: McGraw-Hill Book Company). • Advanced Topics in Applied Mathematics for Engg physical Science: Sudhakar Nair.
Main references (sources)	• Introduction to Applied Mathematics, Gilbert Strang. • Fractional Calculus Theory and Applications of Differentiation and Integration to Arbitrary Order: J. Spanier and K. B. Oldham. • Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010.
Recommended books and references (scientific journals, reports…)	• Handbook of Mathematical Functions: M. Abramowitz & I. Stegun. • W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", John Wiley and Sons.(7th Edition) • L Debnath , D Bhatta, Integral Transforms & their Applications – Chapman & Hall/CRC. • Ravish R. Singh and Mukul Bhatt, Advanced Engineering Mathematics(4th Edition),McGrawHill publication,2018. • Ingrid Daubechies. 1992. Ten lectures on wavelets. SIAM. • G. Kaiser, A Friendly Guide to Wavelets, Birkhauser, Boston, 1994, pp. 44-45.
Electronic References, Websites	•http://www.efunda.com/math/math_home/math.cfm •http://www.sosmath.com •http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks

Course Description Form

1. Course Name:
Numerical Solutions of Partial Differential Equations
2. Course Code:
MATH520
3. Semester / Year:
Second 2025
4. Description Preparation Date:
23/3/2025
5. Available Attendance Forms:
Attendance lectures in the classroom
6. Number of Credit Hours (Total) / Number of Units (Total)
60/4
7. Course administrator's name (mention all, if more than one name)
Name: Dr. Osama Hameed Mohammad Email: Osama.hameed@nahrainuniv.iq

8. Course Objectives

Course Objectives	• Students should learn the principles for designing numerical schemes for PDEs, in particular, finite difference schemes. • Students should learn to make a connection between the mathematical equations or properties and the corresponding physical meanings. • Students should be able to analyze the consistency, stability and convergence of a numerical scheme (finite difference schemes) . • Students should know, for each type of PI (hyperbolic, parabolic and elliptic), what kind numerical methods are best suited for and the reas behind these choices.

9. Teaching and Learning Strategies

Strategy	7- Lecture strategy. 8- Discussion strategy. 9- Brainstorming. 10- Shared homework. 11- Provide illustrative examples. 12- Conclusion.

10. Course Structure

Week	Hours	Required Learning	Unit or subject	Learning	Evaluation

		Outcomes	name	method	method
1	4	Introduction: Some physics behind the PDEs	Transformation to non–dimensional form	Attendance interactive lectures	Ask questions and give assignments
2	4	Parabolic equations	Finite difference method for parabolic equations	Attendance interactive lectures	Ask questions and give assignments
3	4	Explicit and implicit finite difference schemes	A worked example including a comparison table	Attendance interactive lectures	Ask questions and give assignments
4	4	Explicit and implicit finite difference schemes	Crank–Nicolson method	Attendance interactive lectures	Ask questions and give assignments
5	4	Solutions of the implicit equations	Gauss's elimination method	Attendance interactive lectures	Ask questions, give assignments,
6	4	Derivative boundary condition	Explicit formula and central–differenced boundary condition	Attendance interactive lectures	Ask questions and give assignments and make a 1st attence mid exam
7	4	Derivative boundary condition	Explicit formula and forward–differenced boundary condition	Attendance interactive lectures	Ask questions and give assignments
8	4	Derivative boundary condition	Implicit formula and central–differenced boundary condition	Attendance interactive lectures	Ask questions and give

					assignments
9	4	Convergence, stability and consistency	Convergence descriptive treatment	Attendance interactive lectures	Ask questions and give assignments
10	4	Convergence, stability and consistency	Definitions of local truncation error and consistency, stability descriptive treatment	Attendance interactive lectures	Ask questions and give assignments
11	4	Convergence, stability and consistency	Convergence analysis of an explicit difference approximation	Attendance interactive lectures	Ask questions and give assignments
12	4	Convergence, stability and consistency	Stability analysis by matrix method and von Neumann's method	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd attence mid exam
13	4	Hyperbolic Equations	Finite-difference methods on a rectangular mesh for first order equations	Attendance interactive lectures	Ask questions and give assignments
14	4	Hyperbolic Equations	Finite-difference methods on a rectangular mesh for second-order equations	Attendance interactive lectures	Ask questions and give assignments
15	4	Elliptic Equations	Finite-differences in polar coordinates	Attendance interactive lectures	Ask questions and give assignments

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)	3. Numerical solution of partial differential equations : Finite difference Methods . By G.D.Smith 4. Numerical Solution of Partial Differential Equations. By K. W. Morton and D. F. Mayers, Cambridge, 2nd Edition
Main references (sources)	
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description Form

1. Course Name:
English Language II
2. Course Code:
UREQ502
3. Semester / Year:
Second/ MSc
4. Description Preparation Date:
2025-2-1
5. Available Attendance Forms:
Lectures
6. Number of Credit Hours (Total) / Number of Units (Total)
30 hours/ 1 credit
7. Course administrator's name (mention all, if more than one name)
Name: Dr. Akram Abbas Al-Sabbagh Email: akram.alsabbagh@nahrainuniv.edu.iq
8. Course Objectives

Course Objectives	• The aims of New Headway Academic Skills are to help postsecondary students become more efficient and effective in their studies • developing strategies to improve reading speed, and to improve the ability to comprehend complex academic texts. • developing strategies to produce more coherent writing, and to make clear, t1ppropriate, and relevant notes from academic texts. • encouraging them to adopt various approaches for dealing with new or unknown vocabulary by practicing effective use of dictionaries, and through making effective vocabulary records.

9. Teaching and Learning Strategies

Strategy	The strategy is to provide the students with as much information about academic reading and writing skills as possible by attending lectures to maximize the connection between the students and the lecturer. The lectures, some homework and some other additional exercises is also shared on Google Classroom.

10. Course Structure

Week	Hours	Required	Unit or subject	Learning	Evaluation method

		Learning Outcomes	name	method	
1	2	Introduction		Attendance interactive lectures	Ask questions and give assignments
2	2	READING Air pollution	Science and our world	Attendance interactive lectures	Ask questions and give assignments
3	2	WRITING Trends	Science and our world	Attendance interactive lectures	Ask questions and give assignments
4	2	READING Three famous writers	People: past and present	Attendance interactive lectures	Ask questions and give assignments
5	2	RESEARCH Information on the Net	People: past and present	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attence mid exam
6	2	Exam 1		Attendance interactive lectures	Ask questions and give assignments
7	2	READING Computers	The world of IT	Attendance interactive lectures	Ask questions and give assignments
8	2	WRITING IT - benefits and drawbacks	The world of IT	Attendance interactive lectures	Ask questions and give assignments
9	2	READING How things work	Inventions, discoveries, and processes	Attendance interactive lectures	Ask questions and give assignments
10	2	WRITING How things are made	Inventions, discoveries, and processes READING How things work	Attendance interactive lectures	Ask questions and give assignments
11	2	Exam 2		Attendance interactive lectures	Ask questions and give assignments
12	2	READING How things work	Travel and tourism	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd attence mid exam
13	2	VOCABULARY DEVELOPMENT Varying vocabulary (2)	Travel and tourism	Attendance interactive lectures	Ask questions and give assignments
14	2	Exam 3		Attendance interactive lectures	Ask questions and give assignments
15	2	Final exam preparing		Attendance interactive lectures	Ask questions and give assignments

11. Course Evaluation

Midterm exam: 30 marks
Final exam: 70 marks

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	Academic Skills: Reading, Writing, and Study Skills, LEVEL 2, Student's Book
Main references (sources)	Academic Skills: Reading, Writing, and Study Skills, LEVEL 2, Student's Book
Recommended books and references (scientific journals, reports…)	
Electronic References, Websites	

Course Description Form

1. Course Name:

Mathematical Programming

2. Course Code:

MATH516

3. Semester / Year:

Second/ Master

4. Description Preparation Date:

1/2/2025

5. Available Attendance Forms:

Mathematics attendance

6. Number of Credit Hours (Total) / Number of Units (Total)

45 hours/ 3 units

7. Course administrator's name (mention all, if more than one name)

Name: Rewayda Razaq Mohsin Abo alsabeh
Email: rewayda.r.mohsin@nahrainuniv.edu.iq

8. Course Objectives

Course Objectives	Learning the basic concepts of Integer Programming. Definition of the problem. Construction of the model. Solution of the model. Validation of the model. Teaching the students how to dealing with real life applications.

9. Teaching and Learning Strategies

Strategy	The learning and teaching strategy is presented by: Providing the students with a sufficient amount of mathematical terms and definitions by attending lectures and presenting on the whiteboard to connect the students with the lecturer to solve as many real-life applications as possible. The pdf lectures, homework, quizzes, and exercises are shared on Google Classroom. The subject will be given to the students on a whiteboard through a series of lectures with problem-solving practice carried out in interactive tutorials. These tutorials will be supported by practice and directed study outside the classroom. Formative assessment takes place during tutorials and feedback is given during these tutorials.

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1-4	12	General IP/MIP problems	Facility Location Problems Uncapacitated Model Capacitited Model, Knapsack and Assignment Problems, Set covering, packing, Partitioning	lectures	

			problems, the Travelling salesman problem. Binary Variables and Conjunctive normal form		
5-7	9	Modelling logical constraints and piecewise linear functions	Modelling logical constraints with binary variables, Modelling piecewise linear functions with binary variables. Solution methods to MIP. Linear programming relaxations, bounding solution, sharp LP relaxation and convex Hull, Pre-processing and model improvement, bound tightening	lectures	
8-11	12	Polyhedral theory	Special purpose algorithm for knapsack model, greedy algorithm, disaggregating constraints. Convex hull and linear combinations, polyhedral and dimensions, extreme points and extreme rays, Minkowski's theorem	lectures	
12-15	12	Exact and evolutionary algorithms	Cutting plane algorithm, Branch and Bound method, Evolutionary algorithms, Genetic algorithm, representation, genetic operators, stopping criteria	lectures	

11. Course Evaluation

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

Pre-final exam: 30%
(Quizzes, homework: 10%, Mid-Exams 20%).

Final exam: 70%

Total: 100%

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	
Main references (sources)	• H. P. Williams, Model Building in Mathematical Programming (second edition). Wiley Interscience (1985). • G.L. Nemhauser & L.A. Wolsey, Integer and Combinatorial Optimization. Wiley Interscience (1988). • Wayne L. Winston, Operations Research: Applications and Algorithms (2004).

	•Reeves, Colin, and Jonathan E. Rowe. *Genetic algorithms: principles and perspectives: a guide to GA theory*. Vol. 20. Springer Science & Business Media, 2002. • Lindfield, George, and John Penny. *Introduction to nature-inspired optimization*. Academic Press, 2017. • Taha, Hamdy A. Operations research: an introduction. Pearson Education India, 2013.
Recommended books and references (scientific journals, reports…)	Arora, Rajesh Kumar. Optimization: algorithms and applications. CRC press, 2015.
Electronic References, Websites	Google.com

Course Description Form

1. Course Name: FUNCTIONAL ANALYSIS II

2. Course Code: MATH517

3. Semester / Year:second/ 2025-2026

4. Description Preparation Date: January 2026

5. Available Attendance Forms: Attendance lectures in the classroom

6. Number of Credit Hours (30) / Number of Units (2)

7. Course administrator's name (mention all, if more than one name)

Name: AAMENA RASIM MOHAMMED
Email: Aamena.raimmohammed@nahrainuniv.edu.iq

8. Course Objectives

Course Objectives	1. Continuous Linear Mappings 2. Continuous Linear Forms in Hilbert Spaces 3. Operators In Hilbert Space 4. Proper Values 5. Completely Continuous Operators

9. Teaching and Learning Strategies

Strategy	1. Attend classroom lectures, electronic homework, and various activities and assignments. 2. Adopting the interactive aspect between the teacher and the student when explaining the subject. 3. Direct questions to students to test their understanding of the topic. 4. Adopting the principle of preparing reports by students in various subject areas.

3. Course Structure

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

1	2	Giving the basics definitions of Linear Mappings and Isomorphic Vector Spaces	Continuous Linear Mappings	Attendance Interactive lectures	Ask questions and Give assignments
2	2	Study the basic algebraic properties of the vector Spaces *f(V,W)* and the Algebra *f(V)* with examples	Continuous Linear Mappings	Attendance Interactive lectures	Ask questions and Give assignments
3	2	Study the basic algebraic properties of the Normed Spaces $f_c(N_1,N_2)$ and the Normed Algebra $f_c(N_1)$	Continuous Linear Mappings	Attendance interactive lectures	Ask questions and Give assignments
4	2	Giving the basics definitions of Banach Algebra and the Dual Space N`.	Continuous Linear Mappings	Attendance interactive lectures	Ask questions and give assignments
5	2	Giving Riesz-Frechet Theorem and Completion	Continuous Linear Forms in Hilbert Spaces	Attendance interactive lectures	Ask questions and give assignments
6	2	-	-	-	1st attended mid exam
7	2	Giving the basics definitions of Bilinear Mapping and Bounded Bilinear Mappings with examples	Continuous Linear Forms in Hilbert Spac	Attendance interactive lectures	Ask questions and give assignments
8	2	Giving the basics definitions of Sesquilinear Mappings, Bounded Sesquilinear Mappings Forms in Hilbert Spaces and adjoint.	Continuous Linear Forms in Hilbert Spaces	Attendance interactive lectures	Ask questions and give assignments
9	2	Giving the basics definitions of Isometric Operators and Unitary Operators with examples and some properties	Operators In Hilbert Space	Attendance interactive lectures	Ask questions and give assignments
10	2	Giving the basics definitions of self-adjoint Operators and projection operator with examples and some properties	Operators In Hilbert Space	Attendance interactive lectures	Ask questions and give assignments
11	2	Giving the basics definitions of normal Operators with	Operators In Hilbert Space	Attendance interactive	Ask questions and give assignments

		examples and some properties		lectures	
12	2	Giving the basics definitions of proper vector and proper values with examples and som properties	Proper Values	Attendance interactive lectures	Ask questions and give assignments
13	2	-	-	-	2nd attended mid exam
14	2	Giving the basics definitions of proper subspaces and approximate proper values with examples and some properties.	Proper Values	Attendance interactive lectures	Ask questions and give assignments
15	2	Giving the basics definitions of completely continuous operators with examples and some properties.	Completely continuous operators	Attendance interactive lectures	Ask questions and give assignments

4. Course Evaluation	
30% (mid exams) and 70% (final exam)	
5. Learning and Teaching Resources	
Required textbooks (curricular books any)	Introduction to Hilbert Space by Sterling K. Berberian
Main references (sources)	Introductory Functional analysis with Applications by Erw Kreyszig.
Recommended books and references (scientific journals, reports...)	https://www.math.uci.edu/~rvershyn/teaching/2010-11/602/functional-analysis.pdf https://ocw.mit.edu/courses/18-102-introduction-to-functional-analysis-spring-2009/pages/lecture-notes
Electronic References, Websites	➢ https://www.youtube.com/playlist?list=PLUl4u3cNGP6icsJp_--fRAjZXPrQzW.

Course Description Form

13. Course Name:
Dynamical Systems
14. Course Code:
15. Semester / Year:
second/ Master
16. Description Preparation Date:
1/9/2024
17.Available Attendance Forms:
Physical attendance
18.Number of Credit Hours (Total) / Number of Units (Total)
45 hours/ 3 units
19. Course administrator's name (mention all, if more than one name)
Name: Ibtisam Kamil Hanan Email: ibtisam.kamil@nahrainuniv.edu.iq

20. Course Objectives

Course Objectives	• Learning the basic concepts of dynamical systems, to provide an introduction to the analysis of dynamic systems, the theory of dynamical systems in one and two dimensions， fixed points and periodic points and determine their stability, bifurcation theory, chaos attractors, limit cycles, non-linear dynamics. • Teaching the students how to dealing with real life applications.

21. Teaching and Learning Strategies

Strategy	The learning and teaching strategy is presented by: Providing the students with a sufficient amount of mathematical terms and definitions by attending lectures and presenting on the whiteboard to connect the students with the lecturer to solve as many real-life applications as possible. The pdf lectures, homework, quizzes, and exercises are shared on Google Classroom. The subject will be given to the students on a whiteboard through a series of lectures with problem-solving practice carried out in interactive tutorials. These tutorials will be supported by practice and directed study outside the classroom. Formative assessment takes place during tutorials and feedback is given during these tutorials.

22. Course Structure

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

1-4	12	Systems in one-Dimensional	Types of dynamical systems Classification of differential equation with respect to time Maps vs. Difference Equations Maps vs. Differential Equations Linear Maps/ Difference Equations Fixed (Equilibrium) Points Criteria for Stability Hyperbolic Fixed Points Non hyperbolic Fixed Points Periodic Points and Their Stability	lectures	
5-7	9	Attraction and Bifurcation	Basin of Attraction of Fixed Points Basin of Attraction of Periodic Orbits Singer's Theorem Bifurcation Sharkovsky's Theorem Li-Yorke Theorem	lectures	
8-11	12	Chaos in One Dimension	Density of the Set of Periodic Points Transitivity Sensitive Dependence Definition of Chaos Cantor Sets Symbolic Dynamics Conjugacy	lectures	
12-15	12	Systems in Two-Dimensional	Linear Maps vs. Linear Systems Computing A^n Fundamental Set of Solutions Second-Order Difference Equations Stability of Linear Systems Lyapunov Functions for Nonlinear Maps Stability via Linearization	lectures	

23. Course Evaluation

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

Pre-final exam: 30%
(Quizzes, homework: 10%, Mid-Exams 20%).

Final exam: 70%

Total: 100%

24. Learning and Teaching Resources

Required textbooks (curricular books, if any)	

Main references (sources)	[1] An introduction to dynamical systems and chaos, LAYEK, G. C., et al., New Delhi: Springer, 2015. [2] A First Course in Chaotic Dynamical Systems: Theory and Experiment, Devaney, Robert L.CRC Press, 2018.
Recommended books and references (scientific journals, reports…)	Discrete Chaos with Applications in Science and Engineering, Saber N. Elaydi, Chapman & Hall/CRC, 2007.
Electronic References, Websites	Google.com

Course Description Form

1. Course Name:	
Fuzzy Theory	
2. Course Code:	
MATH513	
3. Semester / Year:	
Second / 2025-2026	
4. Description Preparation Date:	
16-2-2026	
5. Available Attendance Forms:	
Attendance lectures in the classroom	
6. Number of Credit Hours (Total) / Number of Units (Total)	
45 hours / 3 units	
7. Course administrator's name (mention all, if more than one name)	
Name: Prof. Dr. Fadhel Subhi Fadhel Email: fadhel.subhi@nahrainuniv.edu.iq	
8. Course Objectives	
Course Objectives	• Studying fuzzy logic and its connection with classical mathematical logic in set theory. • Reviewing and studying the basic algebraic and mathematical properties, as well as, fundamental operations on fuzzy sets. • Formulating some real-life problems using fuzzy logic and indicating the appropriateness of fuzzy logic in these studies. • Introducing the subject of α-level sets, as well as its basic properties and some fundamental related concepts. • Studying different types of fuzzy numbers using interval arithmetic. • Studying some mathematical topics using fuzzy logic, such as evaluating fuzzy derivatives and integrals, solution of fuzzy differential equations.
9. Teaching and Learning Strategies	
Strategy	The teaching and learning strategy is considered a set of tools and practices carried out by both the teacher and the student in order to comprehend the academic material or course, which is the theory of fuzzy sets, in the best possible way. This depends on two basic factors: good transmission by the subject teacher, which is supported by teaching strategies, and good reception by the student, which is

	supported by learning strategies. Educational strategies include a set of organized plans and methods followed by the subject teacher in order to guide students towards achieving learning goals, including the cognitive goals of fuzzy logic, the skill goals in formulating life problems in a mathematical manner by representing them with a mathematical model, and the emotional and value goals through the sensory perception of the nature of the problem and how to deal with it. With it, this is done through specific teaching and learning methods in order for the student to acquire transferable general and qualifying skills.

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	3	Introducing fuzzy logic and its history	Basic definitions and illustrative examples	Attendance interactive lectures	Ask questions and give assignments
2	3	Studying the basic set theoretic operations in fuzzy logic	Fuzzy set theoretical operations	Attendance interactive lectures	Ask questions and give assignments
3	3	Study the basic algebraic operations with examples	Basic algebraic operations	Attendance interactive lectures	Ask questions and give assignments
4	3	Generalization of non-fuzzy concepts to fuzzy logic	Expansion principle	Attendance interactive lectures	Ask questions and give assignments
5	3	Introducing the α-level sets and its connection with crisp sets	α-Level sets	Attendance interactive lectures	Ask questions and give some homeworks
6	3	Studying the membership functions and how to find some of them analytically	The membership functions	Attendance interactive lectures	Ask questions and give assignments
7	3	Introduce some types of fuzzy numbers and their relationship to fuzzy sets	Fuzzy numbers	Attendance interactive lectures	Ask questions and give assignments
8	3	Formulating fuzzy numbers as closed intervals using α-level sets and studying interval	Interval fuzzy numbers	Attendance interactive lectures	Ask questions and give assignments

		arithmetic			
9	3	Studying different types of fuzzy functions	Fuzzy function	Attendance interactive lectures	Ask questions and give assignments
10	3	How to use the extension principle to find fuzzy derivatives and integrals	Fuzzy derivatives and integrals	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attendance mid exam
11	3	Introducing the fuzzifying function and find its derivatives (left-right)	Fuzzyfying function	Attendance interactive lectures	Ask questions and give assignments
12	3	Introducing fuzzy differential equations	Fuzzy differential equations	Attendance interactive lectures	Ask questions and give assignments
13	3	Solving fuzzy differential equations analytically using complex numbers representation	Analytic solution of linear system of fuzzy ODEs	Attendance interactive lectures	Ask questions and give assignments
14	3	Solution of fuzzy ODEs using interval arithmetic	Analytical Solution of Linear Interval Fuzzy ODEs	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd attendance mid exam
15	3	Study the numerical solutions of fuzzy differential equations	Fuzzy differential equations	Attendance interactive lectures	Ask questions and give assignments

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.

20% monthly written exams

10% daily and oral exams, homework's, and class activities

70% written final exam

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	1- Fuzzy Set Theory and Its Applications, Third Edition, By: H.-J. Zimmermann, 1996.Fuzzy Mathematical Techniques with Applications, By: Kamdel A., 1985.
Main references (sources)	Fuzzy Set Theory, Foundations and Applications, by Klir G. J.

Recommended books and references (scientific journals, reports...)	2-
Electronic References, Websites	3-