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 COURSE DESCRIPTION GUIDE

2025-2024

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

File Completion Date: 11 / 2 / 2025

Signature:

Head of Department Name:

Prof. Dr. Fadhel Subhi Fadhel

Date: 11 / 2 / 2025

Signature:

Scientific Associate Name:

Assist. Prof. Dr. Manaf Adnan Saleh

Date: 26 / 3 / 2025

جامعة النهرين / كلية العلوم
قسم الرياضيات
و
تطبيقات الحاسوب

The file is checked by: Orooba Nadhim Harbi

Department of Quality Assurance and University Performance

Director of the Quality Assurance and University Performance Department:

Lect. Dr. Orooba Nadhim Harbi

Date: 26/ 3 /2025

Signature:

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة النهرين / كلية العلوم
مكتب العميد
Dean's office
Republic of Iraq
Ministry of Higher Education and Scientific Research
Al-Nahrain University / College of Science

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	12	17	11.80%	
College Requirements	5	15	10.42%	
Department Requirements	31	112	77.78%	
Summer Training	____	____	____	
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
Stage One	MATH 141	Calculus I	4	
	MATH 142	Calculus II	4	
	MATH 112	Finite Mathematics	4	
	MATH 114	Mathematical Foundation I	4	
	MATH 115	Mathematical Foundation II	4	
	MATH 113	Analytic Geometry	4	
	UREQ 110	English Language	2	
	UREQ 151	Programming Fundamentals	2	3
	UREQ 150	Introduction to Computer Science	2	3
Stage two	MATH 210	Advanced Calculus I	4	
	MATH 211	Advanced Calculus II	4	
	COMP 251	Programming I	2	3
	COMP 253	Computer Graphics	2	3
	MATH 212	Linear Algebra I	4	
	MATH 213	Linear Algebra II	4	
	MATH 214	Optimization I	2	3
	MATH 243	Probability and Statistics	3	
	MATH 216	Solution of ODE	4	
	CHEM 271	General Chemistry	2	
	URIQ 201	Arabic Language I	2	

	URIQ 202	Arabic Language II	2	
Third Stage	MATH 316	Applied Mathematics	4	
	MATH 319	Optimization II	2	
	MATH 312	Abstract Algebra I	4	
	MATH 313	Abstract Algebra II	4	
	MATH 317	Fuzzy Set	3	
	MATH 314	Numerical Analysis I	2	3
	MATH 315	Numerical Analysis II	2	3
	MATH 310	Real Analysis I	4	
	MATH 311	Real Analysis II	4	
	UREQ 420	Human rights	1	
	MATH 318	Theory of ODE	4	
	URMETHO	Research Methodology	1	
Stage Four	MATH 411	Complex Analysis I	4	
	MATH 412	Complex Analysis II	4	
	MATH 413	Mathematical Statistics I	4	
	MATH 414	Mathematical Statistics II	4	
	MATH 415	Topology I	4	
	MATH 416	Topology II	4	
	MATH 430	Topics in Pure Mathematics	4	
	MATH 410	PDE	4	
Master	MATH514	Approximation Theory		
	MATH504	Numerical solutions of ODEs		
	MATH502	Integral Equations		
	MATH518	Calculus of Variation		
	MATH516	Mathematical Programming		
	UREQ 501	English Language I		
	UREQ 502	English Language II		
	MATH450	Control Systems Theory and Design		
	MATH512	Dynamical Systems		
	MATH501	FUNCTIONAL ANALYSIS I		
	MATH517	FUNCTIONAL ANALYSIS II		

	MATH507	**Topics in Applied Mathematics**		
	MATH520	**Numerical Solutions of Partial Differential Equations**		

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 use computer programs to find solutions to mathematical equations and enables him to read the literature of the specialized scientific subject. 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 using computer programs and experience in solving many life problems. 3- Urging the student to build a self-study plan and teaching them how to progress towards achieving this plan through self-learning. 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. 2- Enabling the student to use mathematical concepts, both applied and pure. 3- Understanding and solving life applications of various types. 4- The student's knowledge of linking mathematical concepts to each other.

9. Teaching and Learning Strategies

The teaching and learning strategy is a set of tools and practices used by both the teacher and the student in order to comprehend the academic material or course in the best possible way.

This depends on two basic factors: good transmission by the teacher of the subject, 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 theoretical subjects, skill goals in proofs in a mathematical manner through sequential and ordered steps, and emotional and value goals through sensory perception of the theorems' statements and results and then their proofs and how to use their syntax theoretically, as well as introducing the student and expanding their programming skills using specialized computer programs to solve mathematical problems numerically and model mathematical and real-life problems programmatically; that is done through specific teaching and learning methods in order for the student to acquire transferable general and qualifying skills.

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	
Assistant Lecturer	Computer Science	Computer Graphics			1	
Assistant Lecturer	Mathematics	Numerical Solutions of Partial Differential Equations			1	

Assistant lecturer	Mathematics	Mathematical Statistics			3	
Assistant Lecturer	Mathematics	Approximate Solutions of Integro–Differential Equations			1	
Assistant Lecturer	Mathematics	Algebra			3	
Assistant Lecturer	Mathematics	Ordinary Differential Equations			1	
Assistant lecturer	Mathematics	Numerical Solutions of Boundary Value Problems			1	
Assistant Lecturer	Mathematics	Integro–Differential Equations			1	
Assistant Lecturer	Mathematics	Biomathematics			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 supporting 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.

13. The most important sources of information about the program

-The Student's Handbook (Guide) to the central acceptance program issued by the Ministry of Higher Education and Scientific Research.

-The College of Science Handbook (Guide).

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
Stage One	MATH 141	Calculus I	Basic	X	X			X				X	X		
	MATH 142	Calculus II	Basic	X	X			X				X	X		
	MATH 112	Finite Mathematics	Basic	X	X		X	X				X	X	X	X
	MATH 114	Mathematical Foundation I	Basic	X	X	X		X				X	X	X	
	MATH 115	Mathematical Foundation II	Basic	X	X	X		X				X	X	X	
	MATH 113	Analytic Geometry	Basic	X	X			X	X	X					
	UREQ 110	English	Basic	X	X			X	X	X		X	X	X	
	UREQ 151	Programming Fundamentals	Basic	X	X			X	X	X		X			
	UREQ 150	Introduction to computer	Basic	X	X	X		X	X	X		X			
Stage two	MATH 210	Advanced Calculus I	Basic	X	X	X	X	X	X	X		X	X		
	MATH 211	Advanced Calculus II	Basic	X	X	X	X	X	X	X		X	X		

	COMP 251	Programming I	Basic	X	X			X	X			X			
	COMP 253	Computer Graphics	Basic	X	X	X	X	X	X	X	X	X	X		
	MATH 212	Linear Algebra I	Basic	X	X			X							
	MATH 216	Solutions of ODE	Basic	X	X		X	X				X	X	X	X
	MATH 213	Linear Algebra II	Basic	X	X			X							
	MATH 214	Optimization I	Basic	X	X	X	X	X	X	X	X	X			
	MATH 243	Probability and Statistics	Basic	X	X	X	X	X	X						
	UREQ 201	Arabic Languages	Basic	X	X	X	X	X	X						
	CHEM 271	General Chemistry	Basic	X	X			X				X	X	X	
Third Stage	MATH 316	Applied Mathematics	Basic	X	X	X		X							
	MATH 319	Optimization II	Basic	X	X			X				X	X		
	MATH 312	Abstract Algebra I	Basic	X	X			X				X	X		
	MATH 313	Abstract Algebra II	Basic	X	X			X	X	X		X	X	X	
	MATH 317	Fuzzy Set	Basic	X	X			X	X			X	X	X	
	MATH 314	Numerical Analysis I	Basic	X	X	X		X	X			X	X		
	MATH 315	Numerical Analysis II	Basic	X	X	X		X	X			X	X	X	

	MATH 310	Real Analysis I	Basic	X	X	X	X	X	X			X			
	MATH 311	Real Analysis II	Basic	X	X	X		X	X						
	UREQ 420	Human rights	Basic	X	X		X	X				X			
	MATH 318	Theory of ODE	Basic	X	X	X		X	X						
	URME THO	Research Methodology	Basic												
Stage Four	MATH 411	Complex Analysis I	Basic	X	X	X		X	X			X	X		
	MATH 412	Complex Analysis II	Basic	X	X	X		X	X			X	X		
	MATH 413	Mathematical Statistics I	Basic	X	X	X		X				X	X		
	MATH 414	Mathematical Statistics II	Basic	X	X	X		X	X	X		X	X		
	MATH 415	Topology I	Basic	X	X			X	X			X	X		
	MATH 416	Topology II	Basic	X	X			X				X	X		
	MATH 430	Topics in Pure Mathematics	Basic	X	X	X		X	X			X	X	X	
	MATH 410	PDE	Basic	X	X	X		X	X			X	X	X	

Master	MATH 514	Approximation Theory													
	MATH 504	Numerical solutions of ODEs													
	MATH 502	Integral Equations													
	MATH 518	Calculus of Variation													
	MATH 516	Mathematical Programming													
	UREQ 501	English Language I													
	UREQ 502	English Language II													
	MATH450	Control Systems Theory and Design													
	MATH 512	Dynamical Systems													
	MATH 501	FUNCTIONAL ANALYSIS I													
	MATH 517	FUNCTIONAL ANALYSIS II													
	MATH 507	Topics in Applied Mathematics													
	MATH 520	Numerical Solutions													

		of Partial Differential Equations													

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

Course Description Form

1. Course Name:
Approximation Theory
2. Course Code:
MATH508
3. Semester / Year:
First 2024-2025
4. Description Preparation Date:
24/9/2024
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 difference	Attendance interac lectures	Ask questions and give assignments
2	4	Polynomial interpolat	Basic facts about polynomial interpolati and divided difference	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 normed linear spaces	Definitions and theorer that talking about the conditions of best approximations	Attendance interac lectures	Ask questions, give assignments, and make a 2^{nd} attendance mid exam
13	4	Approximations normed linear spaces	Definitions and theore that talking about conditions of 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 / 2024-2025	
4. Description Preparation Date:	
23-9-2024	
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	Linear multistep methods	Attendance interactive lectures	Ask questions and give assignments

		stability of the numerical method			
10	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
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 / 2024-2025

4. Description Preparation Date:2024-9-10

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:
2024-9-15
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 Learning Outcomes	Unit or subject name	Learning method	Evaluation 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

13. Course Name:	
Dynamical Systems	
14. Course Code:	
MATH512	
15. Semester / Year:	
First/ 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:
Control Systems Theory and Design
2. Course Code:
MATH450
3. Semester / Year:
First/ Master
4. Description Preparation Date:
1/9/2024
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 unstable systems.

9. Teaching and Learning Strategies

Strategy	The learning and teaching strategy is presented by: Providing the students with a sufficient amount of mathematical terms a 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 interact 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 nar**	**Learning method**	**Evaluation method**
1-2	6	Introduction to cont systems	Definitions, st space and trans function, solution a stability of cont systems	lectures	
3-6	12	Controllability control systems	Controllable syste pole placeme uncontrollable	lectures	

			subsystem, transformation matr controllable subspa and stabilizabili PBH-test		
7-9	9	Observability control systems	Observable syste state estimati unobservable syste transformation matr observable subspa detectability, Dual (PBH-test).	lectures	
10-11	6	Observer-based control	Closed-loop system	lectures	
12-1		Optimal control+MIMO systems	Symmetric root loc Pareto curve	lectures	
14-15		Digital control+Lyapunov inequalities	Stability of clos loop via Lyapur inequalities	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, if an	
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 referenc (scientific journals, reports...)	Applications of Control Systems
Electronic References, Websites	Google.com

Course Description Form

FUNCTIONAL ANALYSIS I / MATH501

COURSE SPECIFICATION

This Course Specification provides a concise summary of the main features of the course and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. It should be cross-referenced with the program specification.

1. Teaching Institution	**College of Science/ Al-Nahrain University**
2. University Department/Centre	**Department of Mathematics and Computer Applications**
3. Course title/Code	**Functional Analysis I / MATH501**
4. Modes of Attendance offered	**Attendance lectures in the classroom**
5. Semester/Year	**First/ M.Sc.**
6. Number of hours tuition (total)	**45 hours**
7. Date of production/revision of this specification	**July 2023**

8. Aims of the Course

At the end of the course, the student will be familiar with the following basic concepts:

- Inner Product Spaces (Hilbert Spaces).
- Further Properties of Inner Product Spaces.
- Orthogonal Complements and Direct Sums.
- Orthonormal Sets and Sequences.
- Representation of Functional on Hilbert Spaces.
- Self-Adjoint, Unitary and Normal Operators.
- More advanced theory of normed and Banach spaces without which the usefulness of these spaces and their applications.

9. Learning Outcomes, Teaching, Learning and Assessment Method

A- Cognitive goals.

1. Enable students to obtain knowledge and understanding of the basic principles of Inner Product Spaces (Hilbert Spaces).
2. Empowering and raising the student's skills to obtain knowledge and understanding of the laws and properties of Orthogonal Complements and Direct Sums.
3. Expand the student's awareness to gain knowledge and understanding of how laws are linked
4. It will help the students to gain insight into knowledge properties of Representation of Functional on Hilbert Spaces.
5. Give students acquisition of experience to identify the most important applications of Self-Adjoint, Unitary and Normal Operators.
6. Enable students to study the basics of the more advanced theory of normed and Banach spaces without which the usefulness of these spaces and their applications would be somewhat limited.

B. The skills goals special to the course.

1. Increase students' skills for solving mathematical problems relevant to functional analysis.
2. Interpreting the theoretical results and linking them to various subjects such as optimization, dynamic systems, etc.

Teaching and Learning Methods

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.

Assessment methods

1. Monthly and daily exams.
2. Programmed mid-term exams.
3. Homework’s.
4. direct oral questions.

C. Affective and value goals

1. Enabling students to solve problems related to functional analysis problems.
2. Expand students’ awareness
3. Student participation during the lecture and commitment to the lecture times.

D. General and rehabilitative transferred skills (other skills relevant to employability and personal development)

1. The ability to self-research to solve mathematical problems.
2. Recognize dual spaces and its benefits and use in variety mathematical problems.
3. Emphasize on mathematics role in solving problems in various fields of science, engineering, medicine...etc.

10. Course Structure

Week	Hours	ILOs	Unit/Module or Topic Title	Teaching Method	Assessment Method
1	3	Giving the basics definitions of Inner Product Space (Hilbert Space).	Inner Product Space (Hilbert Space)	Attendance interactive lectures	Ask questions and give assignments
2	3	Study the basic algebraic operations with examples	Further Properties of Inner Product Spaces	Attendance interactive lectures	Ask questions and give assignments
3	3	study the subspace of vectors where all of the vectors in it are orthogonal to all of the vectors in a particular subspace.	Orthogonal Complements and Direct Sums	Attendance interactive lectures	Ask questions and give assignments
4	3	Recognizing the application of such sets and sequences makes up quite a substantial part of the whole theory of inner product and Hilbert spaces.	Orthonormal Sets and Sequences	Attendance interactive lectures	Ask questions and give assignments
5	3	Study the connection with the Bessel inequality.	Series Related to Orthonormal Sequences and Sets	Attendance interactive lectures	Ask questions, give assignments
6	3	To understand every element in space can be represented or sufficiently accurately approximated by using those orthonormal sets.	Total Orthonormal Sets and Sequences	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attended mid exam
7	3	To discuss some total	Legendre, Hermite	Attendance	Ask questions and

		orthogonal and orthonormal sequences which are used quite frequently in connection Hilbert Spaces with practical problems.	and Laguerre Polynomials	interactive lectures	give assignments
8	3	To know the general form of bounded linear functionals on various spaces.	Representation of Functional on Hilbert Spaces	Attendance interactive lectures	Ask questions and give assignments
9	3	This operator was suggested by problems in matrices and linear differential and integral equations.	Hilbert-Adjoint Operator	Attendance interactive lectures	Ask questions and give assignments
10	3	It also helps to define three important classes of operators	Further properties of Hilbert-Adjoint Operator	Attendance interactive lectures	Ask questions and give assignments
11	3	Study the properties of these class of operators	Self-Adjoint, Unitary Operators	Attendance interactive lectures	Ask questions and make a 2nd attended mid exam
12	3	Playing a key role in various applications.	Normal Operators	Attendance interactive lectures	Ask questions and give assignments
13	3	Study their crucial characteristics	Further properties of Self-Adjoint, Unitary and Normal Operators	Attendance interactive lectures	Ask questions and give assignments
14	3	Study the basics of the more advanced theory of normed and Banach spaces without which the usefulness of these spaces and their applications would be somewhat limited.	Fundamental Theorems for Normed and Banach Spaces	Attendance interactive lectures	Ask questions and give assignments
15	3		Fundamental Theorems for Normed and Banach Spaces		

11. Infrastructure

1. Books Required reading:	➢ Functional Analysis by **Michel Willem**. ➢ Lectures in Functional Analysis and Operator Theory by **S. K. Berberian** and **P. R. Halmos**. ➢ History of Functional Analysis by **J. Dieudonne**.
2. Main references (sources)	➢ Introductory Functional analysis with Applications by **Erwin Kreyszig**.
A- 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.
B-Electronic references, Internet sites…	➢ https://www.youtube.com/playlist?list=PLUl4u3cNGP63micsJp_--fRAjZXPrQzW_
12. The development of the curriculum plan ➢ Follow up the latest publications and periodicals on websites and short videos on YouTube. ➢ Give reports to students that deal with various topics of the course. ➢ Encouraging students to solve different kinds of functional analysis problems.	

Course Description Form

1. Course Name: Topics in Applied Mathematics
2. Course Code:
MATH507
3. Semester / Year: Second / 2024-2025
4. Description Preparation Date:
2024-9-25
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 Outcomes	Unit or subject name	Learning method	Evaluation method
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 lectur	• 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 lectur	• 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 lectur	• Ask questions and give assign-ments.

5	3	• Studying various types of Fourier Integrals.	• Fourier Integral. Fourier integral of a function, Fourier Cosine integral, Fourier Sine integral, Complex Fourier integral, Properties of Fourier integral, Computation of integration using Fourier integral.	Attendance interactive lectur	• Ask questions and give assign-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	• Fourier Transform (part III). Finite Fourier Sine transforms, Inversion formula. Finite Fourier Cosine transforms, Inversion formula,	• Attendance interactive lectur	• Ask questions and give assign-ments.

		infinite Fourier transforms.	Applications of Fourier transforms in initial and boundary value problems: 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 lecture	• 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 lecture	• Ask questions and give assign-ments.
11	3	• Understanding and Applications of Hankel and Mellin transforms	• Hankel Transform: Introduction, properties and	Attendance interactive lecture	• Ask questions and give assign-ments.

		in various scientific fields.	applications to PDEQs, • Mellin transforms: Introduction, 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.	Attendance interactive lecture	• Ask questions and give assign-ments.
			• Midterm exam (2)		
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 lecture	• 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 lecture	• Ask questions and give assign-ments.
15	3		• Wavelet Transform. (part II)	Attendance interactive	• Ask questions and give assign-ments.

		• How to apply wavelets transform in various scientific fields.	Applications: Solving PDEQs, Signal processing.	lectures.	

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: FUNCTIONAL ANALYSIS II	
2. Course Code: MATH517	
3. Semester / Year: SECOND/M.SC.	
4. Description Preparation Date: MARCH 2025	
5. Available Attendance Forms: Attendance lectures in the classroom	
6. Number of Credit Hours (30) / Number of Units (30)	
7. Course administrator's name (mention all, if more than one name)	
Name: MANAF ADNAN SALEH SALEH Email: manaf.adnan@nahrainuniv.edu.iq	
8. Course Objectives	
Course Objectives	➢ **Normed space (Banach space).** ➢ **Further properties of normed spaces.** ➢ **Convergent and absolutely convergent series.** ➢ **Schauder basis and separable space.** ➢ **Finite dimensional and its applications.** ➢ **Linear operators with basic examples.** ➢ **Functional and dual spaces.** ➢ **Reflexive spaces.** ➢ **More advanced theory of normed and Banach spaces with out which the usefulness of these spaces and their applications.**
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 norm spaces (Banach Spaces)	Normed Space (Banach Space)	Attendance Interactive lectures	Ask questions and Give assignments
2	2	Study the basic algebraic operations with examples	Further Properties of Normed spaces	Attendance Interactive lectures	Ask questions and Give assignments
3	2	study the subspace of normed space	Subspace of normed space and closedness	Attendance interactive lectures	Ask questions and Give assignments
4	2	Explain the convergent and absolutely convergent series of Normed spaces.	Convergent and Absolutely convergent series terminologies	Attendance interactive lectures	Ask questions and give assignments
5	2	Study Schauder basis and separable	Schauder basis of normed spaces and separable spaces	Attendance interactive lectures	Ask questions and give assignments
6	2	-	-	-	1st attended mid exam
7	2	To know the general form of bounded linear functionals on various spaces	Linear functional with its examples	Attendance interactive lectures	Ask questions and give assignments
8	2	It also helps to define a dual space	Dual space and its applications	Attendance interactive lectures	Ask questions and give assignments
9	2	Study their crucial characteristics	Further applications of dual space and reflexive space	Attendance interactive lectures	Ask questions and give assignments
10	2	Study the compactness on fin dimensional	Compactness terminology on finite dimensional normed space	Attendance interactive lectures	Ask questions and give assignments
11	2	Study bidual space	Bidual space and embedding concept	Attendance interactive lectures	Ask questions and give assignments
12	2	-	-	-	2nd attended mid exam
13	2	Study the basics of more advanced theory of normed and Banach spaces without	Fundamental Theorems for Normed and Banach Spaces	Attendance interactive lectures	Ask questions and give assignments

		which the usefulness of these spaces and their applications would be somewhat limited.			
14	2	Study the basics of the more advanced theory of normed and Banach spaces without which the usefulness of these spaces and their applications would be somewhat limited.	Fundamental Theorems for Normed and Banach Spaces Fundamental Theorems for Normed and Banach Spaces	Attendance interactive lectures	Ask questions and give assignments
15	2	Study the basics of more advanced theory of normed and Banach spaces without which the usefulness of these spaces and their applications would be somewhat limited.	Fundamental Theorems for Normed and Banach Spaces Fundamental Theorems for Normed and Banach 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)	
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.

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 P (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 Outcomes	Unit or subject name	Learning method	Evaluation 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 Learning Outcomes	Unit or subject name	Learning method	Evaluation 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:	
Calculus of Variation	
2. Course Code:	
MATH518	
3. Semester / Year:	
Second / 2024-2025	
4. Description Preparation Date:	
27-3-2025	
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: Prof. Dr. Fadhel Subhi Fadhel Email: fadhel.subhi@nahrainuniv.edu.iq	
8. Course Objectives	
Course Objectives	• Formulation and proof of the fundamental theorem of calculus of variation and its generalization. • Study the classical topic of calculus of variation and deriving the necessary condition on functions that give the extremum (minimum or maximum) values of the function in its simplest form. • Relate variational problems (as an optimization problem) to different problems in mathematics (ordinary or partial differential equations or integral equations). • Finding the necessary condition for a function that represents various generalizations of the variational formulation. • Study of the divergence theorem and its uses in finding the necessary condition for a functional that depends on functions that of more than one independent variable (when there are partial derivatives). • Study of the parametric form of calculus of variation. • Studying solutions to some real-life and practical problems in physics and engineering after formulating the corresponding variational problem and demonstrating the suitability of this topic for solving these problems. • The inverse problem of calculus of variation and using the direct methods to solve such problems.
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 calculus of variation, 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, 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	Introduction to the subject of calculus of variation and the issues it deals with	Basic definitions and illustrative examples	Attendance interactive lectures	Ask questions and give assignments
2	3	Formulation and the proof of the fundamental theorem of calculus of variation and its various generalizations	The fundamental theorem of variation	Attendance interactive lectures	Ask questions and give assignments
3	3	Finding the necessary condition (Euler-Lagrange equation) using Gatux derivative	The simplified variational problem	Attendance interactive lectures	Ask questions and give assignments
4	3	Finding the necessary condition (Euler- Lagrange equation) for special cases of the simplified variational problem	Special cases of the simplified variational problem	Attendance interactive lectures	Ask questions and give assignments
5	3	Finding the necessary condition (Euler-Lagrange equation) to generalize the variational problem to higher-order derivatives	Generalization of the of the variational problem	Attendance interactive lectures	Ask questions and give some homework

6	3	Finding the necessary condition (Euler-Lagrange equation) to generalize the variational problem to more than one dependent function	Generalization of the of the variational problem	Attendance interactive lectures	Ask questions and give assignments
7	3	Finding the necessary condition for a function based on functions of more than one independent variable with partial derivatives	Generalization of the of the variational problem	Attendance interactive lectures	Ask questions and give assignments
8	3	Derivation of the necessary condition (Euler-Lagrange equation) using the first variation (Taylor series expansion)	Variational problem and first variation	Attendance interactive lectures	Ask questions and give assignments
9	3	Study of real-life applications in physics and engineering	Applications of calculus of variation	Attendance interactive lectures	Ask questions and give assignments
10	3	Study of real-life applications in physics and engineering	Applications of calculus of variation	Attendance interactive lectures	Ask questions, give assignments, and make a 1st attendance mid exam
11	3	Study of real-life applications in physics and engineering	Applications of calculus of variation	Attendance interactive lectures	Ask questions and give assignments
12	3	Study of the bilinear form, symmetric and non-degenerate bilinear forms and linear operators	Inverse problem of calculus of variation	Attendance interactive lectures	Ask questions and give assignments
13	3	Study and deriving the mathematical formula corresponding to the problem of calculating of variation	Magrei's approach	Attendance interactive lectures	Ask questions and give assignments
14	3	Solving the variational problem using direct	Direct methods	Attendance interactive lectures	Ask questions, give assignments, and make a 2nd

		methods (finite difference method)			attendance mid exam
15	3	Solving the variational problem using direct methods (series method and complete functions)	Direct methods	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, which are:

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- Differential equations and the calculus of variations, By: Elsgolts L., 1977. 2- Introduction to the Calculus of Variations. Courier Corporation, By: Sagan, H., 2012.
Main references (sources)	Introduction to the Calculus of Variations, By: Bernard Dacorogna, 2004
Recommended books and references (scientific journals, reports...)	Ph
Electronic References, Websites	2- 3-

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