



Course Specifications (Postgraduate Degree)

Course Title:	Introduction to Measure and Integration
Course Code:	MAT 6111
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Level 2 / Year 1
4. Pre-requisites for this course (if any):	MAT 6171
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and applications in measure and integration on the real line. The course includes the essential fundamentals of σ -algebra, measurable sets and functions, Lebesgue integral, convergence theorem and the L^1 space on $\mathbb{R}$. It covers classical topics in Riemann's integral and makes comparison with the Lebesgue integral. The emphasis is on theoretical results and their applications.

2. Course Main Objective

The main purpose of this course is to provide the student with the basic concepts and theorems in measure and integration. We will introduce the Lebesgue measure and the Lebesgue integral on the real line. We will state and prove the main convergence theorems, including differentiation theorem. Other topics include the L^1 -space.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To write the central role of sigma-algebras, outer measure, and measurable sets in integration theory.	K1, K2
1.2	To recognize measurable functions and Lebesgue's integral.	K1, K2
2	Skills:	
2.1	To develop techniques of proof involved in Lebesgue integration.	S1, S2
2.2	To develop oral communication and technical writing skills through convergence theorems.	S4
2.3	To use Internet in searching for different kind of Measures.	S3
2.4	To demonstrate out deep and not short proofs in L_p spaces.	S1, S2
3	Values:	
3.1	To work independently.	V1, V2
3.2	To collaborate with work groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics: The set $\mathbb{R}$ of the real line and its topology (open and closed sets, completion), countable and uncountable sets, sigma-algebras, Borel sets.	11
2	Lebesgue Measure: Outer measure and the sigma-algebra of measurable sets, zero measure set, Cantor's set, nonmeasurable set. Borel set, G_δ and F_σ sets.	13
3	Lebesgue Measurable Functions: Review of sequences of functions: pointwise and uniform convergence of sequences, interchange of limits (limit and continuity, limit and derivative). Measurable functions: main properties, step functions, approximation Lemma, Lusin's Theorem.	13
4	Lebesgue Integration: The Riemann integral: definition, properties, Fundamental Theorems of Calculus, Interchange of limit and integral. The Lebesgue integral: Integrals of simple functions, integrals of non-negative measurable functions, integrals of measurable functions, general properties. Comparison with Riemann's integral, Lebesgue's Integrability Criterion of Riemann integral.	13
5	Convergence Theorems: Monotone Convergence Theorem, Fatou's Lemma, Beppo-Levi Theorem, and Lebesgue Dominated Theorem. Continuity and Differentiation Theorems.	11
6	The L^p spaces: The L^1 normed space. The L^p normed space for $1 \leq p < \infty$: Young, Holder and Minkovski Inequalities. The normed space L^∞ . The Banach space L^p for $1 \leq p \leq \infty$	11
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.1	To write the central role of sigma-algebras, outer measure, and measurable sets in integration theory.	• 4 lecture hours\week • 2 tutorial hour\week • Self-study	• Regular Exams • Assignments • Short Quizzes
1.2	To recognize measurable functions and Lebesgue's integral.		
2.0	Skills		
2.1	To develop techniques of proof involved in Lebesgue integration.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through convergence theorems.	Self-study	Participations
2.3	To use Internet in searching for different kind of Measures.	Deep problems	Short Quizzes
2.4	To demonstrate out deep and not short proofs in L_p spaces.	Self-study	Participations
3.0	Values		
3.1	To work independently.	Personal questions	Participation
3.2	To collaborate with work groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	H.L. Royden, P.M. Fitzpatrik, <i>Real Analysis</i> , Pearson, 4 th Edition, 2010. (Main Reference)
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Essential References Materials	• M. Capinski, P. E. Kopp, <i>Measure, Integral and Probability</i>, Springer, 2003 • R.G. Bartle, D.R. Sherbert, <i>Introduction to Real Analysis</i>, 3rd Edition, John Wiley & Sons, 2000. • C. W. Rudin, <i>Real and Complex Analysis</i>, McGraw Hill, 3rd Edition, 1987. • S. K. Berberian, <i>Measure and Integration</i>, AMS/Chelsea Publishing, 2010.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Introduction to Functional Analysis
Course Code:	MAT 6113
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Level 3 / Year 1
4. Pre-requisites for this course (if any):	MAT 6171
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and applications in Functional Analysis. The course includes the essential fundamentals of normed, Banach, and Hilbert spaces. It covers the concept of linear, adjoint, unitary and normal operators. The emphasis is on theoretical results and their applications.

2. Course Main Objective

The main purpose of this course is to provide the student with the basic concepts and theorems in Functional Analysis and its applications.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To state the main properties of normed and Hilbert spaces.	K1, K2
1.2	To summarize relevant properties of continuous linear operators.	K1, K2
2	Skills:	

CLOs		Aligned PLOs
2.1	To develop techniques of proofs for continuous linear operators.	S1, S2
2.2	To develop oral communication and technical writing skills for Banach and Hilbert spaces.	S4
2.3	To use Internet in searching for orthonormal sets and sequences.	S3
2.4	To illustrate out deep and not short proofs for Hahn-Banach Theorem.	S1, S2
3	Values:	
3.1	To work with independence and responsibility.	V1, V2
3.2	To cooperate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Normed and Banach Spaces: Review of metric spaces, Normed spaces, Cauchy sequences and Banach spaces, Equivalence of norms in finite dimensional normed spaces, The Euclidian space R^n and the unitary space C^n , the spaces L^p .	18
2	Inner product and Hilbert spaces: Schwarz and triangle inequalities, Subspaces of Hilbert spaces, Orthogonal complements and direct sums, The null space Lemma, Orthonormal sets and sequences, Bessel inequality, Total sets and total orthonormal sets, Separable Hilbert spaces, Isomorphic property of the dimension.	19
3	Continuous linear operators between normed spaces: The normed space of linear operators, Hilbert's adjoint operator and its properties, Self-adjoint, unitary, and normal operators, The uniform boundedness theorem, The open mapping and the closed graph theorem.	19
4	Duality of normed linear spaces: Hahn-Banach Theorem, weak derivatives, weak convergence, weak sequential convergence.	16
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To state the main properties of normed and Hilbert spaces.	• 4 lecture hours\week	• Regular Exams
1.2	To summarize relevant properties of continuous linear operators.	• 2 tutorial hour\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proofs for continuous linear operators.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for Banach and Hilbert spaces.	Self-study	Participations
2.3	To use Internet in searching for orthonormal sets and sequences.	Deep problems	Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.4	To illustrate out deep and not short proofs for Hahn-Banach Theorem.	Self-study	Participations
3.0	Values		
3.1	To work with independence and responsibility.	Personal questions	Participation
3.2	To cooperate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	E. Kreyszig, Introductory Functional Analysis; Wiley, 1st Ed. 1989. (Main Reference)
Essential References Materials	• H.L. Royden, P.M. Fitzpatrik, Real Analysis, Pearson, 4th Edition, 2010. • J. P. Aubin, Applied Functional Analysis; Wiley-Interscience, 2000. • J. Oden, L. Demkowicz, Applied Functional Analysis; Chapman & Hall, 2nd Ed., 2009. • Y. Eidelman, V. Milman, and A. Tzolomitis, Functional Analysis: An Introduction; American Mathematical Society; 1st Ed. 2004.
Electronic Materials	None

Other Learning Materials	None
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2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Advanced Linear Algebra
Course Code:	MAT 6121
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Level 1 / Year 1
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description This course describes the most important ideas and theoretical results regarding the fundamentals of linear algebra. A particular attention will be given to applications in Matrix Theory and canonical transformations. The course includes the essential fundamentals of inner product spaces and their matrices with spectral properties. Quadratic forms are investigated too.
2. Course Main Objective The main purpose of this course is to give basic methods of the theory of linear transformations of vector spaces over complex numbers and their matrices, in order to learn algorithms of finding canonical bases consisting of their eigenvectors and applications in various branches of mathematics.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To describe the 1-1-correspondence between linear transformations and matrices.	K1, K2
1.2	To list various kinds of operators over complex numbers and recognize them via their matrices.	K1, K2
1.3	To reproduce methods of diagonalization and Jordanization of matrices; case of quadratic forms.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the diagonalization of matrices.	S1, S2
2.2	To develop oral communication and technical writing skills through homogeneous and non-homogeneous linear systems.	S4
2.3	To use Internet in searching for Cayley-Hamilton theorem.	S3
2.4	To analyze out deep and not short proofs for quadratics forms.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Vector Spaces: review of Bases and Dimensions, Linear transformations and their matrices, Nullity and image, The solution space of a homogeneous linear system, The general solution of a non-homogeneous linear system, direct sum and quotient spaces, The rank nullity theorem and complements, Dual and double dual spaces.	18
2	Eigenvalues and Linear operators: Eigenvalues and eigenvectors, Characteristic polynomial and Cayley-Hamilton Theorem, Similarity and diagonalizations of Matrices, Invariant subspaces, Primary decompositions, Rational and Jordan canonical forms.	19
3	Inner Product Spaces: Inner products and norms, Orthonormality and Gram-Schmidt processes, The adjoint of a linear operator, Normal and self-adjoint Operators, Unitary and orthogonal operators and their matrices, Orthogonal Projections and the Spectral Theorem.	19
4	Quadratic Forms: Bilinear and Quadratic Forms, Rank of a Quadratic Form, Equivalent Quadratic Forms, Diagonal Form of a Quadratic Form and Law of Inertia.	16
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To describe the 1-1-correspondence between linear transformations and matrices.	4 lecture hours\week	Regular Exams
1.2	To list various kinds of operators over complex numbers and recognize them via their matrices.	2 tutorial hour\week	Assignments
1.3	To reproduce methods of diagonalization and Jordanization of matrices; case of quadratic forms.	Self-study	Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the diagonalization of matrices.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through homogeneous and non-homogeneous linear systems.	Self-study	Participations
2.3	To use Internet in searching for Cayley-Hamilton theorem.	Self-study	Short Quizzes
2.4	To analyze out deep and not short proofs for quadratics forms.	Deep problems	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

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#	Assessment task*	Week Due	Percentage of Total Assessment Score
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- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.

- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	S. Friedberg, A. Insel, and L. Spence, Linear algebra; Pearson, 4th Ed. 2002.
Essential References Materials	• K. Hoffman, R. Kunze, Linear Algebra, 2nd Ed., Pearson Education, 1971 • J. Kwak, S. Hong, Linear Algebra, Birkhäuser Boston, 2nd Ed., 2004.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
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Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Algebra (1)
Course Code:	MAT 6123
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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1.Learning Resources	5
2. Facilities Required.....	6
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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Level 3 / Year 1
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description The main goals of this course: - To introduce the fundamentals of modern abstract algebra. - To raise student's proficiency in writing proofs. - To acquire more familiarity with abstract mathematical reasoning and proofs in general, as a transition to more advanced mathematical courses.
2. Course Main Objective The main purpose of this core course is to study basic concepts of groups, rings, fields and modules. Symmetry groups, linear groups, Sylow theorems; quotient rings, polynomial rings, ideals, unique factorization, Nullstellensatz; field extensions, finite fields, Jordan–Holder theorem and composition series.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and understanding	
1.1	To recall the important properties for group, rings, and fields.	K1, K2
1.2	To write the fundamental theorem of finite groups and finite fields.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the direct product and direct sum.	S1, S2
2.2	To develop oral communication and technical writing skills through Sylow theorem and Cauchy theorem.	S4
2.3	To use Internet in searching for polynomial rings.	S3
2.4	To show out deep and not short proofs for field extension.	S1, S2
3	Values:	
3.1	To do homework and assignments with independence and responsibility.	V1, V2
3.2	To collaborate and cooperate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Groups: Review of basics; Direct Products (External and Internal); The Fundamental Theorem of finitely generated abelian groups with applications, Group Action; The Class Equation; Sylow theorems with applications; Cauchy Theorem.	38
2	Rings and Fields: Review of basics; Direct product and direct sum of rings; Polynomial Rings and their factorizations; UFD's, PID's and Euclidean domains; Gaussian rings, Field extensions; Finite algebraic extensions; Finite Fields.	34
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To recall the important properties for group, rings, and fields.	• 4 lecture hours\week	• Regular Exams
1.2	To write the fundamental theorem of finite groups and finite fields.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the direct product and direct sum.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through Slow theorem and Cauchy theorem.	Self-study	Participations
2.3	To use Internet in searching for polynomial rings.	Deep problems	Short Quizzes
2.4	To show out deep and not short proofs for field extension.	Self-study	Participations
3.0	Values		
3.1	To do homework and assignments with independence and responsibility.	Personal questions	Participation
3.2	To collaborate and cooperate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homework, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	D. Dummit, R. Foote, <i>Abstract Algebra</i>; John Wiley, 3rd ed. 2003. (Main Reference)
Essential References Materials	• D. Robinson, <i>An Introduction to Abstract Algebra</i>; De Gruyter, 2003. • T. W. Hungerford: <i>Algebra</i>, Springer, 1st Edition, 1980.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g., if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Numerical Analysis
Course Code:	MAT 6141
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours: 5 (4 Lectures, 0 Lab, 2 Tutorial)			
2. Course type			
a.	University ☐	College ☐	Department ☒ Others ☐
b.	Required ☒	Elective ☐	
3. Level/year at which this course is offered: Level 2 / Year 1			
4. Pre-requisites for this course (if any): None			
5. Co-requisites for this course (if any): None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas in numerical analysis: error, convergence and stability analysis for the algorithms and implement these using a Computer Algebra System (CAS) such as MATLAB. Moreover, basic numerical methods are introduced to find numerical solution of certain test problems.

2. Course Main Objective

Finding analytical solution of mathematical problems arising in science and technology is, in general, next to impossible. Nowadays it has become very common to approximate solution of these mathematical problems using numerical methods. Therefore, this course is devoted to introducing basic numerical methods and corresponding numerical algorithms.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and understanding	
1.1	To outline numerical methods for solving nonlinear equations.	K1, K2
1.2	To describe different numerical methods for solving systems of linear equations.	K1, K2
1.3	To state the convergence of the numerical schemes.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for solving equations and systems.	S1, S2
2.2	To develop oral communication and technical writing skills through error and convergence analysis.	S4
2.3	To use Internet in searching for Newton, Brent, Aitkin, and Muller methods.	S3
2.4	To carry out deep and not short proofs for eigenvalue problem.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Preliminaries: Errors and numbers representation; Floating-point representation; Significant digits; Rounding and chopping; Accuracy and precision, absolute error and relative error, Truncation error.	16
2	Solving Equations: Bisection, fixed-point iterations, Newton's method, Brent method, Aitkin's Δ^2 method & Muller method; Error and convergence analysis.	17
3	Solving Linear Systems: Direct methods: Pivoting, LU factorization; Norms of vectors and matrices; Well-posed and ill-posed problems; Conditioning and Error analysis; Iterative methods: Jacobi, Gauss-Seidel & SOR methods; Krylova subspaces methods (Conjugate gradient method, GMRES,...); Error and convergence analysis; Preconditioning.	23
4	Eigenvalue Problem: Power and Inverse Power method, Jacobi method, Householder method, QR method, Singular value decomposition.	16
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To outline numerical methods for solving nonlinear equations.	4 lecture hours\week	Regular Exams
1.2	To describe different numerical methods for solving systems of linear equations.	2 tutorial hours\week	Assignments
1.3	To state the convergence of the numerical schemes.	Self-study	Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for solving equations and systems.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through error and convergence analysis.	Self-study	Participations
2.3	To use Internet in searching for Newton, Brent, Aitkin, and Muller methods.	Deep problems	Short Quizzes
2.4	To carry out deep and not short proofs for eigenvalue problem.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	<i>R.L. Burden, J.D. Faires, Numerical Analysis, 8th Edition. (Main Reference)</i>
Essential References Materials	• <i>J. Stoer, R. Burlish, Introduction to numerical Analysis; Springer-Verlag, 3rded. 2010</i> • <i>T. Sauer, Numerical Analysis, Pearson, 2012.</i> • <i>Y. Saad, Numerical Methods for Large Eigenvalue Problems; SIAM, Revised Edition, 2011.</i>
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Topology
Course Code:	MAT 6171
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Level 1 / Year 1
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and applications in general topology. The course starts from the basic notions of topological and metric spaces. It includes the essential fundamentals of compactness and connectedness with applications to $\mathbb{R}^n$. It also covers classical topics in countability and separation theory.

2. Course Main Objective

The main objective of this course is to provide the student with the basic concepts and main theorems in topology in order to enable the student to have strong knowledge in general topology and to continue more advanced study in this area.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To state the main properties of the topological spaces and metric spaces.	K1, K2
1.2	To define concepts of connectedness and compactness in topological spaces.	K1, K2

CLOs		Aligned PLOs
2	Skills:	
2.1	To develop techniques of proof for complete metric spaces.	S1, S2
2.2	To develop oral communication and technical writing skills through Hausdorff spaces.	S4
2.3	To use Internet in searching for Tychonoff and Stone-Cech theorems.	S3
2.4	To demonstrate out deep and not short proofs for normal spaces.	S1, S2
3	Values:	
3.1	To work with independence and responsibility.	V1, V2
3.2	To collaborate and cooperate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics: Basic set theory; Topological spaces and equivalent topologies; Order topology, Closure of a set and dense sets; Basis and sub-basis, Subspaces, Hausdorff spaces, Continuous functions, Open and closed mappings, Quotient topology, Homeomorphisms and topological properties, Product and box topologies.	18
2	Metric Spaces: Definition and important examples, Metrics on $\mathbb{R}^\omega$, The Induced metric topology, Metrizable topological spaces; Sequences and the sequence lemma, Cauchy sequences and complete metric Spaces, Uniform convergence.	18
3	Connectedness & Compactness: Connected topological spaces, Basic properties, Products of connected spaces, Path connectedness, Connectedness in $\mathbb{R}$. Compact spaces and basic properties, Hausdorff compact spaces, Compactness in $\mathbb{R}$, Lebesgue number lemma and the uniform convergence theorem, Compactness in $\mathbb{R}^n$, Limit and sequentially compactness, Local compactness and the one-point compactification, Tychonoff Theorem, Stone-Cech compactification Theorem.	20
4	Countability and Separation Axioms: Countability axioms, Separation axioms, Normal spaces, Urysohn Lemma and Urysohn Metrization Theorem.	16
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To state the main properties of the topological spaces and metric spaces.	• 4 lecture hours/week	• Regular Exams
1.2	To define concepts of connectedness and compactness in topological spaces.	• 2 tutorial hour/week • Self-study	• Assignments • Short Quizzes
2.0	Skills		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.1	To develop techniques of proof for complete metric spaces.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through Hausdorff spaces.	Self-study	Participations
2.3	To use Internet in searching for Tychonoff and Stone-Cech theorems.	Deep problems	Short Quizzes
2.4	To demonstrate out deep and not short proofs for normal spaces.	Self-study	Participations
3.0	Values		
3.1	To work with independence and responsibility.	Personal questions	Participation
3.2	To collaborate and cooperate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• J. R. Munkres, Topology; Pearson, 2nd Ed. 2000. (Main Reference) • B. Mendelson, Introduction to Topology; Dover Publications; 3rd Ed. 1990.
Essential References Materials	• S. Willard, General Topology; Dover Publications 2004.

	Fred H. Croom, Basic Concepts of Algebraic Topology; Undergraduate Texts in Mathematics, Springer Verlag, 1978.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Each class room should be equipped with a whiteboard and a projector. Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Partial Differential Equations
Course Code:	MAT 6231
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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F. Learning Resources and Facilities.....	5
1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
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A. Course Identification

1. Credit hours:	5 (4 Lectures, 0 Lab, 2 Tutorial)		
2. Course type			
a.	University ☐	College ☐	Department ☒
b.	Required ☒	Elective ☐	Others ☐
3. Level/year at which this course is offered:	Level 4 / Year 2		
4. Pre-requisites for this course (if any):	None		
5. Co-requisites for this course (if any):	None		

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		72

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas and theoretical results in Partial Differential Equations. The course introduces the concept of distributions and study some existence and uniqueness results for the main three types of PDEs: hyperbolic, parabolic, and elliptic PDEs.

2. Course Main Objective

This course introduces students to partial differential equations, so that students will be able to analyze, and solve various mathematical models (that involve PDEs). This course has three main aims:

- To provide an understanding of the basic of PDEs.
- To give the fundamental analytical methods for solving PDEs.
- To prove some existence and uniqueness results for PDEs.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and understanding	
1.1	To define the notion of distributions and weak derivatives.	K1, K2
1.2	To outline main techniques for solving PDEs.	K1, K2
1.3	To explain some existence and uniqueness results of solutions for PDEs.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for Cauchy problem for PDE.	S1, S2
2.2	To develop oral communication and technical writing skills through hyperbolic, parabolic, and elliptic PDE.	S4
2.3	To use Internet in searching for Green's functions.	S3
2.4	To write out deep and not short proofs for maximum principle.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Introduction and Preliminaries: Transport Equation, Solution of linear first order PDE, characteristic method, the Cauchy problem for first order PDE, First order non-linear equations, Charpit's method, classification of second-order equations, canonical forms for hyperbolic, parabolic, and Laplace equation.	12
2	Introduction to Distributions: Test functions, support of smooth functions, properties of distributions, weak derivatives, space of distributions, convergence of distributions.	18
3	Hyperbolic Partial Differential Equations: One-dimensional wave equation and d'Alembert's formula, wave with source, method of characteristic coordinates, method using Green's theorem, energy methods and the uniqueness, separation of variable method.	14
4	Parabolic Partial Differential Equations: Fundamental solution of heat equation and heat kernel, maximum principle and the uniqueness, nonnegative solutions, Diffusion on the whole line, diffusion with a source.	14
5	Elliptic Partial Differential Equations: Green's identities, Green's function, fundamental solution of Laplace's equation, mean value property, maximum principle, weak solution and weak formulation, Laplace's equation in different coordinate systems.	14
Total		72

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To define the notion of distributions and weak derivatives.	4 lecture hours\week	Regular Exams
1.2	To outline main techniques for solving PDEs.	2 tutorial hours\week	Assignments
	To explain some existence and uniqueness results of solutions for PDEs.	Self-study	Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for Cauchy problem for PDE.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through hyperbolic, parabolic, and elliptic PDE.	Self-study	Participations
2.3	To use Internet in searching for Green's functions.	Deep problems	Short Quizzes
2.4	To write out deep and not short proofs for maximum principle.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	R. Haberman , <i>Applied Partial Differential Equations with Fourier Series and Boundary Value Problems</i> ; Pearson 2012. Main reference)
Essential References Materials	• L.C. Evans, <i>Partial Differential Equations</i>; American Mathematical Society, 2ndEd. 2010. • F. John, <i>Partial Differential Equations (Applied Mathematical Sciences) (v. 1)</i>, Springer, 4th Edition, 1991. • R. McOwen, <i>Partial Differential Equations: Methods and Applications</i>; 2nd Edition, Pearson, 2002. • K. Sankara Rao, <i>Introduction to Partial Differential Equations</i>; Third Edition, Prentice-Hall of India Pvt. Ltd, 2010.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	▪ The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Research Project
Course Code:	MAT 6299
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☒ Elective ☐
3. Level/year at which this course is offered:	Levels 6 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description This course introduces the student to the research in the field of mathematics. The student has to read some papers and/or chapters of books recommended by the supervisor, then write a report, and present a talk about theses readings.
2. Course Main Objective • This course enables students to carry out a sustained, guided, independent study of a topic in mathematics. • This course is a faculty directed project that could be considered original in nature. • Training student through research in a current field of mathematics and problem-solving skills, literature searching and presentation skills. • To develop an appropriate level of mathematical literacy as well as competency in documentation, analyses and presentation of results. • The topics and contents vary depending on the ability of the student and the courses that he has completed.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To state knowledge and skills to a research problem.	K1, K2
1.2	To develop a skill set relevant to a specific research project.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the corresponding subject.	S1, S2
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	S4
2.3	To use Internet in searching for scientific information	S3
2.4	To demonstrate out deep and not short proofs.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Research subject dependent.	60
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To state knowledge and skills to a research problem.	• 3 lecture hours/week	• Presentations
1.2	To develop a skill set relevant to a specific research project.	• 2 tutorial hours/week • Self-study	• Assignments • Discussions
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Assignments
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Presentations
2.3	To use Internet in searching for scientific information	Deep problems	Assignments
2.4	To demonstrate out deep and not short proofs.	Self-study	Discussions
3.0	Values		
3.1	To work individually.	Personal questions	• Written report • Presentation in face of an experts committee
3.2	To work in groups.	Team work	• Presentations • Assignments • Discussions

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Written report in English (40-50 pages)	At the end of the trimester	70%
2	Oral exam: (presentation 20 minutes in English language)	At the end of the trimester	30 %

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	Research subject dependent.
Essential References Materials	Research subject dependent.
Electronic Materials	Research subject dependent.
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources	None.

Item	Resources
(Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Applied Functional Analysis
Course Code:	MAT 6215
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 5 / Year 2
4. Pre-requisites for this course (if any):	MAT 6231
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results of Functional Analysis in order to introduce the Sobolev space $H^1(\Omega)$ with application to some linear PDEs. The main topics of this course are the measure, integration, the Hilbert space $L^2(\Omega)$, and the distribution theory. Of particular importance is also the notion of weak derivative so as to define the Hilbert space $H^1(\Omega)$ and employ it as adequate setting to formulate some Dirichlet and Neumann BVPs for simple linear PDEs.

2. Course Main Objective

The aim of this course is the introduction of the Sobolev space $H^1(\Omega)$ where Ω is an open subset of the real line and then usage of this setting in order to solve some BVPs for linear elliptic PDEs.

The first step is to introduce the Hilbert space $L^2(\Omega)$ together with its main properties. The notion of weak convergence is also given.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To define the concept of a distribution and its main properties.	K1, K2
1.2	To describe how to use the setting of the Sobolev space $H^1(\Omega)$ to formulate some classical elliptic PDEs.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the Sobolev spaces.	S1, S2
2.2	To develop oral communication and technical writing skills for calculus on distributions.	S4
2.3	To use Internet in searching for the Hilbert space L^2 .	S3
2.4	To evaluate out deep and not short proofs boundary value problems.	S1, S2
3	Values:	
3.1	To present attitude of independence and responsibility.	V1, V2
3.2	To lead team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	The Hilbert space $L^2(I)$, $I \subseteq \mathbb{R}$: Basic properties, Cauchy-Schwarz inequality, convergence in norm. Riesz-Fisher Theorem and the complete space L^2 . Riesz-Frechet Representation Theorem and reflexivity, Convolution and regularization. Separability.	14
2	Review of Distribution Theory: The space $D(\Omega)$ of test functions, $\Omega \subseteq \mathbb{R}$, Support of a distribution, Regularization and approximation, Derivative of a distribution. The space $D'(\Omega)$: Calculus on distributions, Antiderivative of a distribution, Convergence of distributions. Applications: fundamental solutions of some ODEs.	14
3	The Sobolev space $H^1(\Omega)$, $\Omega \subseteq \mathbb{R}$: Definitions and properties. Mollifiers and density theorems. Sobolev imbedding theorems. Product, composition, and differentiation in $H^1(\Omega)$. Trace operator and $H_0^1(\Omega)$. The dual space $H^{-1}(\Omega)$: Definitions, properties, Poincare-Wirtinger inequality.	18
4	Variational Formulation of linear BVPs: Linear PDEs for Laplacian operator. Lax-Milgram Theorem, Weak solution, Classical solution, Maximum principle.	14
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To define the concept of a distribution and its main properties.	• 3 lecture hours/week	• Regular Exams
1.2	To describe how to use the setting of the Sobolev space $H^1(\Omega)$ to	• 2 tutorial hours/week • Self-study	• Assignments • Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	formulate some classical elliptic PDEs.		
2.0	Skills		
2.1	To develop techniques of proof in the Sobolev spaces.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for calculus on distributions.	Self-study	Participations
2.3	To use Internet in searching for the Hilbert space L^2 .	Deep problems	Short Quizzes
2.4	To evaluate out deep and not short proofs boundary value problems.	Self-study	Participations
3.0	Values		
3.1	To present attitude of independence and responsibility.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• H. Brezis, Functional Analysis, Sobolev Spaces, and Partial Differential Equations, Springer, 2010 (Main reference). • L.C. Evans, Partial Differential Equations; 2nd Edition, American Mathematical Society, 2010.
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	• J.J. Duistermaat, J.A.C. Kolk , Distributions: Theory and Applications, Springer, 2006.
Essential References Materials	F. Hirsch, G. Lacombes , Elements of Functional Analysis, Springer, 1999.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	
	Course Responsible	Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Numerical Methods for Differential Equations
Course Code:	MAT 6242
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours: 4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type			
a.	University ☐	College ☐	Department ☒ Others ☐
b.	Required ☐	Elective ☒	
3. Level/year at which this course is offered: Levels 4-5 / Year 2			
4. Pre-requisites for this course (if any): MAT 6141			
5. Co-requisites for this course (if any): None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description This course is the follow up of MAT 6141 course taught in Master 1. It is the second part of numerical methods devoted to ODEs. In this course, all fundamentals' methods will be exhibited and detailed, for ODEs and for systems of ODEs. Boundary value problems, finite difference will also be considered in this course. Error & convergence analysis will be analyzed. Moreover, MATLAB software will be used as support for implementation of numerical methods.
2. Course Main Objective The course purpose is - To give an overview of different numerical methods for solving Ordinary differential equations; - To compare the various methods by studying their convergence, consistency and stability; - To deal numerically with different type of Differential equations (IVPs, BVPs, systems of ODEs); - To develop student's skills in the implementation of numerical methods.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and understanding	
1.1	To list different numerical schemes for solving ordinary differential equations.	K1, K2
1.2	To state the analysis of convergence, stability and consistence.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for ordinary differential equations.	S1, S2
2.2	To develop oral communication and technical writing skills for Euler schemes and implicit methods.	S4
2.3	To use Internet in searching for Taylor and Runge-Kutta methods.	S3
2.4	To evaluate out deep and not short proofs for convergence analysis and stability.	S1, S2
3	Values:	
3.1	To work independently.	V1, V2
3.2	To work collectively.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Introduction: Preliminaries. Existence; Uniqueness, and wellposedness; Stability and Asymptotic Stability.	16
2	Ordinary Differential Equations (single step method): Implicit and Explicit Euler schemes, Local and global error, Taylor and Runge-Kutta methods, Error and convergence analysis, stability.	22
3	Ordinary Differential Equations (multistep method): Predictor corrector methods; Implicit Methods and Stiff Equations; Convergence, Stability and Consistency of these methods.	22
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To list different numerical schemes for solving ordinary differential equations.	• 3 lecture hours\week	• Regular Exams
1.2	To state the analysis of convergence, stability and consistence.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for ordinary differential equations.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for Euler schemes and implicit methods.	Self-study	Participations
2.3	To use Internet in searching for Taylor and Runge-Kutta methods.	Deep problems	Short Quizzes
2.4	To evaluate out deep and not short proofs for convergence analysis and stability.	Self-study	Participations
3.0	Values		
3.1	To work independently.	Personal questions	Participation
3.2	To work collectively.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	J.D. Lambert, <i>Numerical Methods for Ordinary Differential Systems, The Initial Value Problem</i>, John Wiley and Sons, 1997 J.C. Butcher, <i>Numerical Methods for Ordinary Differential Equations</i>, John Wiley and Sons, 2008
Essential References Materials	A. Stanoyevitch, <i>Introduction to Numerical Ordinary and Partial Differential Equations Using MATLAB</i>, Wiley 2005. L. F. Shampine, I. Gladwell, and S. Thompson, <i>Solving ODEs with Matlab</i>; Cambridge University Press. A. Gilat, V. Subramaniam; "Numerical Methods for Engineers and Scientists, An Introduction with Applications using MATLAB". D.F. Griffiths, Desmond J. Higham, <i>Numerical Methods for Ordinary Differential Equations, Initial Value Problems</i>, Springer, 2010. S. Ahmad , A. Ambrosetti, <i>A Textbook on Ordinary Differential Equations</i>, Springer 2014.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : Eternal assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Numerical Optimization
Course Code:	MAT 6245
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours: 4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type			
a.	University ☐	College ☐	Department ☒ Others ☐
b.	Required ☐	Elective ☒	
3. Level/year at which this course is offered: Levels 4-5 / Year 2			
4. Pre-requisites for this course (if any): None			
5. Co-requisites for this course (if any): None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

Maximizing or minimizing a certain quantity, that is, an objective function that models a system and satisfies a required set of specifications, called constraints, is a frequent problem in science, engineering, business and economics. The function allows comparison of the different choices for determining which might be "best". For instance, by finding an alternative with the most cost effective or highest achievable performance under the given constraints, by maximizing desired factors and minimizing undesired ones. Numerical Optimization turns out to be considerably important for solving such problems. This course aims at training students for acquiring a basic mathematical understanding of modern approaches to numerical optimization and discussing practical aspects of implementation for solving optimization problems. The students learn how to find analytical solutions to some optimization problems.

2. Course Main Objective

- To provide students a good understanding on constrained and unconstrained optimization whose content is described in detail in this syllabus.
- To perform some algorithms and codes in order to deepen programming and numerical analysis tools used in this course.
- To allow students understanding of the above concepts through study cases and occasional computer-based homework problems.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and Understanding	
1.1	To state the fundamental properties of convexity with applications to optimization problems.	K1, K2
1.2	To outline various types of algorithms for solving optimization problems.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the optimization conditions for unconstrained and constrained problems.	S1, S2
2.2	To develop oral communication and technical writing skills through optimization algorithms and methods.	S4
2.3	To use Internet in searching for evolution strategies and numerical implementation.	S3
2.4	To choose out deep and not short proofs for Karush Kuhn and Tucker theorem.	S1, S2
3	Values:	
3.1	To execute homework's and assignments with independence and responsibility.	V1, V2
3.2	To collaborate and cooperate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Convexity: convex sets, convex functions, characterization of convex functions, properties of convex functions.	14
2	Unconstrained problems: First order and second order local optimization conditions, the case of convex programs.	14
3	Constrained problems: Optimal conditions for constrained problems, Karush Kuhn and Tucker theorem, Lagrange multipliers and duality. The case of convex problems.	14
4	Optimization algorithms and methods: The Simplex method, Deterministic direct search (Nelder Mead); descent-type methods (Gradient, Conjugate gradient, Quasi-Newton methods, BFGS); genetic algorithms; evolution strategies; PSO. Numerical implementation.	18
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To state the fundamental properties of convexity with applications to optimization problems.	• 3 lecture hours/week	• Regular Exams
1.2	To outline various types of algorithms for solving optimization problems.	• 2 tutorial hours/week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the optimization conditions for unconstrained and constrained problems.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through optimization algorithms and methods.	Self-study	Participations
2.3	To use Internet in searching for evolution strategies and numerical implementation.	Deep problems	Short Quizzes
2.4	To choose out deep and not short proofs for Karush Kuhn and Tucker theorem.	Self-study	Participations
3.0	Values		
3.1	To execute homework's and assignments with independence and responsibility.	Personal questions	Participation
3.2	To collaborate and cooperate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homework, Quizzes, Mini-projects	During the term	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.

- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• <i>J. Nocedal, S.J. Wright, Numerical Optimization, Springer, 2nd edition 2006. (Main Reference).</i>
Essential References Materials	• <i>N. Gould, S. Leyffer; An introduction to algorithms for nonlinear optimization; Springer 2003.</i> • <i>Ruszczynski, Nonlinear Optimization, Hardcover 2006.</i> • <i>C.T. Kelley, Iterative Methods for Optimization</i> • <i>S. Chandra, Jayadeva, and A. Mehra, Numerical Optimization with Applications, Alpha Science Intl Ltd; 1 edition, 2009.</i> • <i>D. Goldberg, Genetic algorithms on search, optimization and machine learning, Addison-Wesley Professional, 1989.</i>
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: Externat assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Statistical Theory and Inference
Course Code:	MAT 6247
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Level 4-5 / Year 2
4.Pre-requisites for this course (if any):	
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

Probability and Expectations, Multivariate Distributions and Transformations, Exponential Families, Sufficient Statistics, Point Estimation, Testing Statistical Hypotheses, Large Sample Theory.

2. Course Main Objective

The course gives a rigorous introduction to statistical theory and inference. Topics covered include statistical models; sufficiency and completeness; Cramér-Rao bound; Rao-Blackwell theorem; best estimators; most powerful tests; likelihood ratio tests; elements of Bayes and minimax procedures.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To describe the main properties of statistical inference.	K1, K2

CLOs		Aligned PLOs
1.2	To list relevant properties of methods of estimations and statistical hypotheses.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the large sample theory.	S1, S2
2.2	To develop oral communication and technical writing skills for point estimations	S4
2.3	To use Internet in searching for test hypotheses.	S3
2.4	To demonstrate out deep and not short proofs for multivariate distributions.	S1, S2
3	Values:	
3.1	To do course duties with independence.	V1, V2
3.2	To collaborate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Probability and Expectation: Probability, Counting, Conditional probability and independence, the expected value and variance, the kernel method, mixture distribution.	9
2	Multivariate Distributions and Transformations: Joint, marginal and conditional distributions, expectation, independence and covariance, location-scale families, transformations, sum of random variables, random vector, the multinomial distributions, the multivariate normal distribution, elliptically contoured distribution.	9
3	Exponential Families: Regular exponential families, properties.	6
4	Sufficient Statistics: Statistics and sampling distributions, minimal sufficient statistics.	6
5	Point Estimations I: Maximum Likelihood estimators, method of moments estimators.	6
6	Point Estimations II: MSE and Bias, exponential families, UMVUEs and the FCRLB.	6
7	Test Statistical Hypotheses: Hypothesis tests and power, exponential families, the Nieman-Pearson Lemma and UMP, Likelihood ratio test.	9
8	Large Sample Theory: The CLT, delta method and Exponential Family Limit Theorem, Asymptotically efficient estimators, modes of convergence and consistency, Slutsky's Theorem and related results, order relations and convergence rate, multivariate limit theorems, more multivariate results.	9
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To understand the main properties of statistical inference.	• 3 lecture hours\week	• Regular Exams

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.2	To list relevant properties of methods of estimations and statistical hypotheses.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Participations
2.3	To use Internet in searching for scientific information	Deep problems	Short Quizzes
2.4	To carry out deep and not short proofs.	Self-study	Participations
3.0	Values		
3.1	To do course duties with independence.	Personal questions	Participation
3.2	To collaborate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	D. J. Olive, Statistical Theory and Inferences, Springer 2014. (Main Reference)
Essential References Materials	• A. M. Mood, A. Graybill, D. C. Boes, Introduction to the Theory of Statistics, Third Edition, McGraw Hill 2001. • S. Arnold, Mathematical Statistics; Pearson 1990.

Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Finite Markov Chains and Applications
Course Code:	MAT 6249
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Level 4-5 / Year2
4. Pre-requisites for this course (if any):	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and applications in Finite state Markov Chains. The course includes the essential fundamentals of finite Markov chains, Markov property, Transition matrix, Steady states, recurrences and ergodicity, long-run behavior, discrete time renewal theory. Moreover some examples from biology, social science, electrical engineering, information science.... will be considered through the course.

2. Course Main Objective

The main purpose of this course is to provide the student with the elementary concepts and theorems in Finite Markov Chains and their applications in real life.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To write the main properties of discrete-time Markov chains.	K1, K2

CLOs		Aligned PLOs
1.2	To list relevant properties of finite Markov chains and their applications in the real life.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for homogeneous finite Markov chains.	S1, S2
2.2	To develop oral communication and technical writing skills through transience, recurrence, and ergodicity.	S4
2.3	To use Internet in searching for of discrete-time renewal processes.	S3
2.4	To show out deep and not short proofs for Perron-Frobenius theorem.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics on Probability: Review on probability, random variables, independence, conditional probability, expectation, conditional expectation, generating function, characteristic function, random vector, change of variable, convergence, law of large number.	13
2	Discrete-time Markov chains: Markov property, homogeneous Markov chain, transition matrix, Markov recurrence, topology of transition matrix, steady state, regeneration.	13
3	Recurrence and Ergodicity: Recurrence and transience states, a criterion of recurrence, structure of the transition matrix, invariant measure, a positive recurrent criterion, the ergodic theorem, the renewal reward theorem.	13
4	Long-Run Behavior: Coupling, convergence to steady state, the positive recurrent case, the null recurrent case, convergence rate via coupling, the Perron-Frobenius theorem, quasi-stationary distributions, Dobrushin's ergodic coefficient.	11
5	Discrete-time Renewal Theory: The renewal process, the renewal equation, the renewal theorem, regenerative processes, renewal equation for regenerative process, regenerative theorem.	10
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To write the main properties of discrete-time Markov chains.	• 3 lecture hours\week	• Regular Exams
1.2	To list relevant properties of finite Markov chains and their applications in the real life.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.1	To develop techniques of proof for homogeneous finite Markov chains.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through transience, recurrence, and ergodicity.	Self-study	Participations
2.3	To use Internet in searching for of discrete-time renewal processes.	Deep problems	Short Quizzes
2.4	To show out deep and not short proofs for Perron-Frobenius theorem.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	P. Bremaud, Markov Chains; Second Edition, Springer 2020. (Main Reference)
Essential References Materials	• J. G. Kemeny, J. L. Snell, Finite Markov Chains, Springer 1976. • E. Seneta, Nonnegative matrices and Markov Chains, Springer 2006. • A. S. Poznyak, K. Najim, E. Gomez-Ramirez, Self-Learning Control of Finite Markov Chains, Marcel Dekker, Inc. 2000

Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Combinatorial Optimization
Course Code:	MAT 6253
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Level 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and algorithms in combinatorial optimization. The course includes the essential fundamentals of graph theory, linear and integer programming, and complexity theory. It covers classical topics in combinatorial optimization as well as very recent ones. The emphasis is on theoretical results and algorithms with provably good performance. Applications and heuristics are mentioned only occasionally.

2. Course Main Objective

The objective of this course is to give a detailed knowledge within combinatorial optimization. Combinatorial (or discrete) optimization is one of the most active fields in the interface of operations research, computer science, and applied mathematics. This course covers classical optimization problems in graphs and networks, matchings, integral polyhedral, the traveling salesman problem, an introduction to matroids and to NP-completeness theory.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To recognize combinatorial optimization models using discrete optimization.	K1, K2
1.2	To record discrete optimization techniques.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for polyhedral combinatorics and matroids.	S1, S2
2.2	To develop oral communication and technical writing skills for flows problems.	S4
2.3	To use Internet in searching for the Traveling Salesman Problem.	S3
2.4	To choose out deep and not short proofs for optimal matchings.	S1, S2
3	Values:	
3.1	To execute course duties with independence and responsibility.	V1, V2
3.2	To lead team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Problems and Algorithms: Optimal Trees and Paths, Measuring Running Times, Minimum Spanning Trees, Shortest Paths; Maximum Flow Problems, Network Flows Problems, Maximum Flow Problems, Minimum Cut Problem, Multicommodity Flows; Minimum Cost Flow Problems.	10
2	Optimal Matchings: Matchings and Alternating Paths, Maximum Matchings, Minimum Weight Perfect Matchings, T-joins and Postman Problem.	10
3	Integral Polyhedral: Convex Hulls, Polytopes, Facets, Integral Polytopes, Total Unimodularity, Total Dual Integrality, Cutting Planes, Separation and Optimization.	10
4	The Traveling Salesman Problem: Introduction, Heuristics for the TSP, Lower Bounds, Cutting Planes, Branch and Bound.	10
5	Matroids: The Greedy Algorithm, Matroids Properties, Axioms, and Constructions, Matroids Intersection, Applications.	10
6	NP and NP-completeness: Introduction, Words, Problems, Algorithms and Running Time, The Class NP.	10
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To recognize combinatorial optimization models using discrete optimization.	• 3 lecture hours/week	• Regular Exams

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.2	To record discrete optimization techniques.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for polyhedral combinatorics and matroids.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for flows problems.	Self-study	Participations
2.3	To use Internet in searching for the Traveling Salesman Problem.	Self-study	Participations
2.4	To choose out deep and not short proofs for optimal matchings.	Deep problems	Short Quizzes
3.0	Values		
3.1	To execute course duties with independence and responsibility.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• W. Cook, W. Cunningham, W. Pulleyblank, and A. Schrijver, Combinatorial Optimization; Wiley-Blackwell, 1997.
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	• B. Korte, and J. Vygen, Combinatorial Optimization; Springer, 2012. • C. Papadimitriou, K. Steiglitz, Combinatorial Optimization: Algorithms and Complexity; Dover Publications Inc., 2000.
Essential References Materials	• D. Avis, A. Hertz, and O. Marcotte (editors), Graph Theory and Combinatorial Optimization, Springer, 2005. • D.-Z. Du, P.M. Pardalos (editors), Handbook of Combinatorial Optimization, Kluwer Academic Publishers, 1999.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Coding Theory & Cryptography
Course Code:	MAT 6261
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

The course is devoted to the fields of cryptography and coding theory. It gives an introduction, with proofs, to the algebra and number theory used in coding and cryptography. Basic problems of cryptography and coding are discussed. Topics include classical ciphers, public key cryptosystems (RSA, Diffie-Hellman key exchange, ElGamal), digital signatures, codes, linear codes, perfect codes and cyclic codes.

2. Course Main Objective

The main purpose of this course is to give the following basic topics in Coding Theory and Cryptography: Linear Codes and their constructions, Public key cryptosystems, Hash Functions and Signature Schemes, the cryptographic standards DES and AES.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	

CLOs		Aligned PLOs
1.1	To define the basic methods of Linear Codes.	K1, K2
1.2	To explain DES and AES.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for cryptography.	S1, S2
2.2	To develop oral communication and technical writing skills for bounds, linear, and cyclic codes.	S4
2.3	To use Internet in searching for Reed-Solomon, Hadamard, Nordstrom, Robinson, Preparata, and Kerdock codes.	S3
2.4	To choose out deep and not short proofs for public-Key cryptography.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics and Linear Codes: Error detection, correction and decoding, Hamming distance and Distance of a code, MLD reliability, Linear codes and their basis, Generator matrix and parity-check matrix, Equivalence of linear codes, Encoding with a linear codes, Cosets of linear codes and the coset leader, Nearest neighbor decoding.	13
2	Bounds and Constructions of linear Codes: Optimal codes, extended codes and parity-check matrices, Bounds for codes and their types, Perfect codes, Hamming codes and their use, Golay codes, Reed-Muller codes and their use.	11
3	Cyclic Codes and Other Codes: Cyclic Hamming codes, BCH codes and their use, Codes over GF(2 ⁿ), Reed-Solomon codes, Quadratic-residue codes, Hadamard matrix codes, Nordstrom, Robinson code, Preparata codes and Kerdock codes, Propagation rules of constructing linear codes, First order and higher Reed-Muller codes, Subfield codes.	13
4	Classic Cryptography: Encryption Schemes, Symmetric key encryption, Fiestel cipher and DES.	11
5	Public-Key Cryptography (PKC): Algorithm and Complexity, Quadratic residues and quadratic reciprocity, Primality testing, Discrete logarithm, Hash functions, RSA, Provable security and EL-Gamal, Cryptography protocols (Diffe Hellman, Zero Knowledge and coin-tossing).	12
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To define the basic methods of Linear Codes.	• 3 lecture hours/week	• Regular Exams

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.2	To explain DES and AES.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for cryptography.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for bounds, linear, and cyclic codes.	Self-study	Participations
2.3	To use Internet in searching for Reed-Solomon, Hadamard, Nordstrom, Robinson, Preparata, and Kerdock codes.	Deep problems	Short Quizzes
2.4	To choose out deep and not short proofs for public-Key cryptography.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• D. Hankerson & others, Coding Theory and Cryptography: The Essentials; Marcel Dekker; 2nd edition, 2000 (Main Reference)
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Essential References Materials	• S. Ling, C. Xing, Coding Theory: A First Course; Cambridge University Press, 1st ed., 2004. • J. van Lint, Introduction to Coding Theory; 3rd Edition, Springer, 1998. • Shu Lin, D. Castello, Error Correcting Codes; 2nd Edition, Prentice Hall, 2004. • J. Katz, Y. Lindell, Introduction to Modern Cryptography, Chapman and Hall/CRC, 1st edition, 2007. • A.J. Menezes, P.C. van Oorschot, and S.A. Vanstone, Handbook of Applied Cryptography, Taylor & Francis, 1996.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Mathematical and Computational Modeling
Course Code:	MAT 6263
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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G. Course Quality Evaluation	6
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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides an introduction into modeling and computational approaches and basic concepts of computation, covering methods and tools mathematics, modeling continuous and discrete systems and modeling with partial differential equations. Students will use a software to explore a range of programming and modeling concepts. They will analyze one of a variety of scientific problems by designing a representative model, implementing the model, completing a verification and validation process of the model, and changing the model to reflect corrections, improvements and enhancements.

2. Course Main Objective

This course introduces students to mathematical modeling, so that students will be able to analyze, design and begin to control rigorous mathematical models. This course has three main aims:

(1). To provide an understanding of processes undertaken to arrive at a suitable mathematical model.

- (2). To teach the fundamental analytical techniques and computational methods used to develop insight into system behavior.
- (3). To introduce a range (e.g., industrial, biological, and environmental) of problems, associated conceptual models and their solutions using graphical, numerical and analytical approaches.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To state real problems in mathematical terms, making appropriate simplified assumptions.	K1, K2
1.2	To interpret the conformity of a given model with respect to the behavior of the physical problem under real situations.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in modeling dynamical systems and physical systems.	S1, S2
2.2	To develop oral communication and technical writing skills for population dynamics, logistic, and growth models.	S4
2.3	To use Internet in searching for representation and visualization of simulation experiments.	S3
2.4	To show out deep and not short proofs for numerical solutions of differential equations.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Mathematical Modeling Tools: Needs and Techniques of mathematical modeling; Idea of mathematical modeling; Steps in mathematical modeling; Characteristics of mathematical modeling.	9
2	Case Studies: Models in mechanical vibration (Spring mass system, pendulum problems); Models in population dynamics (One species model, logistic model, growth model in time delays, Predator-Prey models, Volterra-Lotka models); Models of chemical processes, Electrical network and Diffusion processes; Traffic Flow Models.	11
3	Modeling Dynamical Systems: Differential equations and their numerical solutions, linear and nonlinear dynamics, stability, convergence, attractors.	11
4	Physical Systems: System types and characteristics behaviour, Continuous-time, discrete Vs time and discrete, event systems, linear and nonlinear systems.	16
5	Exploration of Behavior through Simulation: Developing simulations of dynamical systems using Matlab/Simulink: representation and visualization of simulation experiments, analyzing behavioral characteristics for a range of classes of physical and computational systems eg. Predictor- prey models, evolutionary systems and cellular system.	13
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To state real problems in mathematical terms, making appropriate simplified assumptions.	• 3 lecture hours\week	• Regular Exams
1.2	To interpret the conformity of a given model with respect to the behavior of the physical problem under real situations.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in modeling dynamical systems and physical systems.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for population dynamics, logistic, and growth models.	Self-study	Participations
2.3	To use Internet in searching for representation and visualization of simulation experiments.	Deep problems	Short Quizzes
2.4	To show out deep and not short proofs for numerical solutions of differential equations.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.

- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• J. N. Kapur, Mathematical Modeling, New Age International, Jan 1, 2008. (Main reference)
Essential References Materials	• M.M. Gibbons, A Concrete Approach to Mathematical Modeling, Wiley-Interscience, 2007. • H. Neunzert, A. Siddiqui, Topics in Industrial Mathematics; Kluwer Academic Publishers, 2000. • D. Basmadjian, Mathematical Modeling Physical systems: An Introduction; Oxford University press, USA, 2002. • S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 5th Edition, McGraw Hill, 2006.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Extent of achievement of course learning outcomes	Course Responsible	Indirect: Course report. Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Mathematical Modeling of Infectious Diseases
Course Code:	MAT 6265
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any): Student should have taken, Ordinary Differential Equations and Numerical Analysis course	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

Almost everyone globally has been impacted by the on-going COVID-19 pandemic; if you want to learn how mathematical modeling approaches shape how society responds to these crises. This course partly answers to these questions.

Mathematical models is the heart of both understanding the dynamics of how infectious diseases spread through a population and models help us, how we can respond to minimize their impact. In this class we will introduce the key modeling approaches used in modern epidemiology. Topics covered will include classical compartment models (such as the widely used SIR, SIRVI and SEIR models), stochastic simulation methods, statistical models, and how to address heterogeneity in populations. Additionally, we will discuss some of the challenges in dealing with epidemiological data.

The class will draw heavily on work from the primary literature, with a particular emphasis on using real data from the COVID-19 pandemic and will have a significant hands-on component using Maple and Matlab. All students will participate in a term group-project addressing some aspect of the pandemic.

2. Course Main Objective

Student will be familiar with basic concepts in epidemiology and appreciate the variety of models for different diseases. They construct simple mathematical models for a number of infectious diseases, compare model simulations with data as a means of validating different models and investigate new models for infectious diseases. They will also know, basic mathematical tools and techniques. For example, apply nonlinear least-squares method for parameter estimation and explore local and global stability analysis.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To write a short report for a mathematical epidemiology journal.	K1, K2
1.2	To estimate appropriate data analyses to assist modeling.	
2	Skills:	
2.1	To develop model, first analyze then develop numerical scheme.	S1, S2
2.2	To develop oral communication and technical writing skills through techniques for analyzing infectious disease outbreaks.	S4
2.3	To use Internet in searching for the literature on mathematical modeling of infectious diseases.	S5
2.4	To demonstrate out deep mathematical model.	S3
3	Values:	
3.1	To demonstrate independence and responsibility.	V1, V3
3.2	To collaborate with team works.	V1, V2

C. Course Content

No	List of Topics	Contact Hours
1	Important Concepts in Mathematical Modeling of Infectious Diseases: Issues and Approaches, Deterministic Epidemic Models, Compartmental Approach, Kermack–McKendrick Model, Important Concepts in Compartmental Epidemic Models.	10
2	Five Classic Epidemic Models and Their Analysis: 2.1 Kermack–McKendrick Model, A Model for Diseases with No Immunity, A Model with Demography, An SIR Model with Varying Total Population: Homogeneous Systems, Ross–MacDonald Model for Malaria: A Monotone System. 2.2 Age-Structured Epidemic Models, Spatial Heterogeneity in Epidemiological Models	16
3	Basic Mathematical Tools and Techniques: Stability of Equilibrium Solutions, Stability Analysis by Linearization, Stability Analysis Using Lyapunov Functions, Stability of Periodic Solutions: The Floquet Theory, Global Dynamics of 1-Dimensional Systems: Phase-Line Analysis, Global Dynamics of 2-Dimensional Systems: Phase-Plane Analysis, Uniform Persistence, Metzler Matrices and Monotone Systems. Bifurcation theory: Hopf bifurcation, Neuronal Oscillations and Endangered Species.	14

4	Parameter Estimation and Nonlinear Least-Squares Methods: Curve-Fitting and Linear Least-Squares Problem, Nonlinear Least-Squares Problem, Parameter Estimation for Epidemic Models.	10
5	Special Topics: COVID-19 models, higher dimensional models.	10
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To write a short report for a mathematical epidemiology journal.	3 lecture hours\week	Regular Exam
1.2	To estimate appropriate data analyses to assist modeling.	2 tutorial hours\week Self-study	Assignments Short Quizzes
2.0	Skills		
2.1	To develop model, first analyze then develop numerical scheme.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through techniques for analyzing infectious disease outbreaks.	Self-study	Participations
2.3	To use Internet in searching for the literature on mathematical modeling of infectious diseases.	Deep problems	Short Quizzes
2.4	To demonstrate out deep mathematical model.	Self-study	Participations
3.0	Values		
3.1	To demonstrate independence and responsibility.	Personal questions	Participation
3.2	To collaborate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :
Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC),.

The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.

Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.

A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	1- Maia Martcheva, Mathematical Modeling of Infectious Diseases, 2015 (Main Reference) 2-CS Chou, A Friedman, Introduction to Mathematical Biology, Springer (2016) 3-NF Britton, NF Britton, Essential mathematical biology, Springer (2003) 4-R.M. Anderson and R.M. May, Infectious Diseases of Humans: Dynamics and Control, Oxford University Press. 5-O. Diekmann, H. Hesterbeek and T. Britton, Mathematical Tools for Understanding Infectious Disease Dynamics, 2013, Princeton University Press
Essential References Materials	M.Y. Li, An introduction to mathematical modeling of infectious diseases, Springer (2018)
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
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Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory-GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Selected Topics in Applied Mathematics (1)
Course Code:	MAT 6281
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description
Course dependent.
2. Course Main Objective
- This course is designed to enable students to study different special topics of interest, which are carefully selected from Applied Mathematics topics. The course covers selected topics in mathematics suggested by the student's supervisor and approved by the chairman and the department council each time this course is offered. - To learn topics those are not formally offered by the program and receive appropriate academic credit.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	Specific to each course of study.	K1, K2

CLOs		Aligned PLOs
2	Skills:	
2.1	To develop techniques of proof in the corresponding subject.	S1, S2
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	S4
2.3	To use Internet in searching for scientific information	S3
2.4	To show out deep and not short proofs.	S1, S2
3	Values:	
3.1	To demonstrate responsibility and independence through course duties.	V1, V2
3.2	To lead team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Specific to each course of study	60
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	Specific to each course of study	• 3 lecture hours/week • 2 tutorial hours/week • Self-study	• Regular Exams • Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Participations
2.3	To use Internet in searching for scientific information	Deep problems	Short Quizzes
2.4	To show out deep and not short proofs.	Self-study	Participations
3.0	Values		
3.1	To demonstrate responsibility and independence through course duties.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the course syllabus
Essential References Materials	To be specified according to the course syllabus
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students Course Responsible	Direct: Questionnaire. Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Selected Topics in Applied Mathematics (2)
Course Code:	MAT 6283
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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F. Learning Resources and Facilities.....	5
1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description
Course dependent.
2. Course Main Objective
- This course is designed to enable students to study different special topics of interest, which are carefully selected from Applied Mathematics topics. The course covers selected topics in mathematics suggested by the student's supervisor and approved by the chairman and the department council each time this course is offered. - To learn topics those are not formally offered by the program and receive appropriate academic credit.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	Specific to each course of study.	K1, K2

CLOs		Aligned PLOs
2	Skills:	
2.1	To develop techniques of proof in the corresponding subject.	S1, S2
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	S4
2.3	To use Internet in searching for scientific information	S3
2.4	To show out deep and not short proofs.	S1, S2
3	Values:	
3.1	To demonstrate responsibility and independence through course duties.	V1, V2
3.2	To lead team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Specific to each course of study	60
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	Specific to each course of study	• 3 lecture hours/week • 2 tutorial hours/week • Self-study	• Regular Exams • Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Participations
2.3	To use Internet in searching for scientific information	Deep problems	Short Quizzes
2.4	To show out deep and not short proofs.	Self-study	Participations
3.0	Values		
3.1	To demonstrate responsibility and independence through course duties.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the course syllabus
Essential References Materials	To be specified according to the course syllabus
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students Course Responsible	Direct: Questionnaire. Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Introduction to Operator Theory
Course Code:	MAT 6217
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type				
a.	University ☐	College ☐	Department ☒	Others ☐
b.	Required ☐	Elective ☒		
3. Level/year at which this course is offered:	Levels 4-5 / Year 2			
4. Pre-requisites for this course (if any):	None			
5. Co-requisites for this course (if any):	None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

In this course we introduce fundamental topics in operator theory at the graduate level. We provide a comprehensive treatment of the theory of linear operators on infinite-dimensional spaces. Further, we study the spectrum of bounded operators on Banach spaces and a part will be devoted to the theory of Banach algebras. Also, the course discusses the spectral theorem for normal operators, the Riesz theory of compact operators and an introduction to unbounded operators with their basic properties.

2. Course Main Objective

Students will be introduced to some topics of operator theory with an emphasis on spectral theory and to the fundamentals of Banach algebra theory assuming a background in functional analysis.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	State the continuity of linear operators, understand whether or not a linear operator is compact and define the spectrum of linear operators.	K1, K2

CLOs		Aligned PLOs
1.2	Develop the functional calculus and the spectral decompositions of self-adjoint operators and normal operators.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the spectral theory.	S1, S2
2.2	To develop oral communication and technical writing skills through the study of unbounded operators.	S4
2.3	To use Internet in searching for operators on Hilbert spaces.	S5
2.4	To demonstrate out deep and not short proofs for spectral theorem and Cayley transform.	S3
3	Values:	
3.1	To work individually.	V1, V3
3.2	To work in groups.	V1, V2

C. Course Content

No	List of Topics	Contact Hours
1	Operators on Hilbert spaces: Review of Hilbert and Banach spaces, linear operators and their adjoints, elementary properties and examples, projections and idempotents, invariant and reducing spaces.	18
2	Spectral theory: Banach algebras elementary properties, Riesz functional calculus, introduction to the spectral theory of bounded linear operators, spectral theory of self-adjoint and normal operators, compact operators, spectral theory of compact operators, self-Adjoint compact operators.	23
3	Unbounded operators: Introduction to the class of unbounded operators, basic properties and examples, symmetric and self-adjoint operators and the spectral theorem, the Cayley transform.	19
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	State the continuity of linear operators, understand whether or not a linear operator is compact and define the spectrum of linear operators.	• 3 lecture hours\week	• Regular Exams
1.2	Develop the functional calculus and the spectral decompositions of self-adjoint operators and normal operators.	• 2 tutorial hours\week • Self-study	• Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the spectral theory.	Deep problems	Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.2	To develop oral communication and technical writing skills through the study of unbounded operators.	Self-study	Participations
2.3	To use Internet in searching for operators on Hilbert spaces.	Deep problems	Short Quizzes
2.4	To demonstrate out deep and not short proofs for spectral theorem and Cayley transform.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	John B. Conway , <i>A Course in Operator Theory</i> , Graduate Studies in Mathematics, American Mathematical Society, 2000, ISBN 0821820656 (Main Reference) Takashi Yoshino , <i>Introduction to Operator Theory</i> . Chapman and Hall/CRC, 1993, ISBN 978-0582237438.
Essential References Materials	H.L. Royden and P.M. Fitzpatrick , <i>Real Analysis</i> , 4th Edition, Prentice Hall, 2010.
Electronic Materials	None

Other Learning Materials	None
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2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Introduction to Ergodic Theory
Course Code:	MAT 6219
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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E. Student Academic Counseling and Support	5
F. Learning Resources and Facilities.....	5
1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type				
a.	University ☐	College ☐	Department ☒	Others ☐
b.	Required ☐	Elective ☒		
3. Level/year at which this course is offered:	Level 4-5 / Year 2			
4. Pre-requisites for this course (if any):	MAT 6111			
5. Co-requisites for this course (if any):	None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and applications in elementary Ergodic Theory. The course includes the essential fundamentals of Lebesgue measure theory, Markov operators, ergodic transformations and stationary densities. It covers the different ergodic theorems, the existence of stationary densities, the computation of stationary densities.

2. Course Main Objective

The main purpose of this course is to provide the student with the elementary concepts and theorems in Ergodic Theory using measure-theoretic approach.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	To explain the main properties of ergodic transformations.	K1, K2

CLOs		Aligned PLOs
1.2	To list relevant properties of Markov operators and stationary densities.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for the existence of invariant measures.	S1, S2
2.2	To develop oral communication and technical writing skills through ergodicity and mixing.	S4
2.3	To use Internet in searching for Ulam's and Markov's methods.	S3
2.4	To use out deep and not short proofs for ergodic theorems.	S1, S2
3	Values:	
3.1	To execute course duties with independence.	V1, V2
3.2	To cooperate with team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Foundations on Measure Theory: Review on measures and measure spaces, Lebesgue integration, the Radon-Nikodym theorem, The spaces L^p , convergence of sequences of functions, compactness, quasi-compactness.	11
2	Rudiments in Ergodic Theory: Measure preserving transformations, ergodicity, mixing, exactness, ergodic theorems, topological dynamical systems.	11
3	Transfer Operators: Markov operators, Frobenius-Perron operators, Koopman operators, ergodicity and Frobenius-Perron operators, decomposition theorem and spectral analysis.	11
4	Invariant Measures-Existence: General existence result, functions of bounded variations, piecewise sketching mappings, piecewise convex mapping, piecewise expanding mappings.	16
5	Invariant Measures-Computation: Ulam's method for one dimensional mappings, the Markov method for one dimensional mappings.	11
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To explain the main properties of ergodic transformations.	3 lecture hours/week	Regular Exams
1.2	To list relevant properties of Markov operators and stationary densities.	2 tutorial hours/week Self-study	Assignments Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Participations
2.3	To use Internet in searching for scientific information	Deep problems	Short Quizzes
2.4	To carry out deep and not short proofs.	Self-study	Participations
3.0	Values		
3.1	To execute course duties with independence.	Personal questions	Participation
3.2	To cooperate with team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	J. Ding, A. Zhou, Statistical Properties of Deterministic Systems; Springer 2009. (Main Reference)
Essential References Materials	• A. Lasota, M.C. Mackey, Chaos, Fractals, and Noise, Stochastic Aspects of Dynamics; Second Edition, Springer 1994. • A Boyarski, P. Gora, Laws of chaos, Birkhauser 1997. • I. P. Cornfeld, S. V. Fomin, Y. G. Sinai, Ergodic Theory, Springer 1982. • P. Walters, Introduction to Ergodic Theory, Springer 1982
Electronic Materials	None

Other Learning Materials	None
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2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Algebra (2)
Course Code:	MAT 6224
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered: Levels 4-5 / Year 2	
4. Pre-requisites for this course (if any): MAT 6123	
5. Co-requisites for this course (if any): None	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description This course aims to achieve the following goals: - To introduce the advanced modern abstract algebra beyond the theory of rings and their modules. - To proficiency in writing proofs. - To acquire more familiarity with abstract mathematical reasoning and proofs in general.
2. Course Main Objective The main objective of the course is to enhance the student's knowledge in depth of in the areas of modules, rings and commutative algebra at postgraduate research level so that to be ready to do research in the area of theory of groups and related topics.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and understanding	
1.1	To list main properties relevant to rings and modules.	K1, K2
1.2	To recognize fundamental concepts in commutative algebra.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the power series ring.	S1, S2
2.2	To develop oral communication and technical writing skills for modules.	S4
2.3	To use Internet in searching for Noetherian and Artinian Rings.	S3
2.4	To illustrate out deep and not short proofs for Nilradical and Jacobson's Radicals.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Modules: Review of basics on rings and modules, Submodules, quotient modules, Direct products and direct sums of modules, Free modules and finitely generated modules	17
2	Rings: Chain Conditions on Rings, Noetherian and Artinian Rings; composition series and Jordan-Holder's theorem.	13
3	Commutative Algebra: Power Series Ring, Localization of a ring and its total quotient ring, Nilradical and Jacobson's Radicals.	17
4	Primary Decompositions in Noetherian rings, Tensor product of rings and flatness, Integrality and Integral extensions of a ring.	13
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Co de	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To list main properties relevant to rings and modules.	3 lecture hours\week	Regular Exams
1.2	To recognize fundamental concepts in commutative algebra.	2 tutorial hours\week Self-study	Assignments Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the power series ring.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills for modules.	Self-study	Participations
2.3	To use Internet in searching for Noetherian and Artinian Rings.	Deep problems	Short Quizzes
2.4	To illustrate out deep and not short proofs for Nilradical and Jacobson's Radicals.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	T.W. Hungerford, <i>Algebra</i>; Springer, 1st Edition, 1980. (Main Reference)
Essential References Materials	M. Atiyah, I. MacDonald; <i>Introduction to Commutative Algebra</i>; Westview Press 1st ed. 2002.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g., if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist- Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist- Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist- Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Number Theory
Course Code:	MAT 6226
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours: 4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type			
a.	University ☐	College ☐	Department ☒
b.	Required ☐	Elective ☒	Others ☐
3. Level/year at which this course is offered: Levels 4-5 / Year 2			
4. Pre-requisites for this course (if any): None			
5. Co-requisites for this course (if any): None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and basic methods of the theory of modular arithmetic. The course includes the canonical problems with their solution algorithms. It covers classical topics in elementary theory of multiplicative functions, and also some miscellaneous questions demonstrating variety of directions in this subject.

2. Course Main Objective

The main purpose of this course is to give basic methods of the theory of modular arithmetic, providing canonical problems with their solution algorithms, an introduction to elementary theory of multiplicative functions, and also some miscellaneous questions demonstrating variety of directions in this subject.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and understanding	
1.1	To state basic properties of modular congruencies and methods of their solution.	K1, K2

CLOs		Aligned-PLOs
1.2	To outline algorithms of quick computations of Legendre and Jacobi symbols.	K1, K2
1.3	To memorize methods of computation for multiplicative functions.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the Lagrange's theorem for quadratic forms.	S1, S2
2.2	To develop oral communication and technical writing skills through elliptic curves.	S4
2.3	To use Internet in searching for continued fractions approximation of a real number.	S3
2.4	To analyze out deep and not short proofs for Pell's Equations.	S1, S2
3	Values:	
3.1	To demonstrate independence.	V1, V2
3.2	To demonstrate ability to work with groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics: Divisibility and ideals, congruencies and their properties, Chinese remainder theorem, Hensel's Lemma, Quadratic residues, Gauss' lemma, Quadratic reciprocity law, arithmetic functions.	16
2	Quadratic forms: Definitions and basic properties, Equivalence of quadratic forms, reduced quadratic forms, Quadratic representation, two squares sum representation, Sums of four squares sum representation and Lagrange's Theorem.	14
3	Elliptic curves: Pythagorean triples, The method of descent, Rational points on curves, the projective line, the projective plane, Elliptic curves.	14
4	Continued Fractions: Definitions and basic properties, characterizing rationales by finite continued fractions, Finding a particular solution of the linear congruence equation, Continued fractions approximation of a real number, purely periodic continued fraction, Pell's Equations.	16
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To state basic properties of modular congruencies and methods of their solution.	3 lecture hours\week	Regular Exams
1.2	To outline algorithms of quick computations of Legendre and Jacobi symbols.	2 tutorial hours\week	Assignments
1.3	To memorize methods of computation for multiplicative functions.	Self-study	Short Quizzes
2.0	Skills		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.1	To develop techniques of proof in the Lagrange's theorem for quadratic forms.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through elliptic curves.	Self-study	Participations
2.3	To use Internet in searching for continued fractions approximation of a real number.	Deep problems	Short Quizzes
2.4	To analyze out deep and not short proofs for Pell's Equations.	Self-study	Participations
3.0	Values		
3.1	To demonstrate independence.	Personal questions	Participation
3.2	To demonstrate ability to work with groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• Niven, H. Zuckerman, and H. Montgomery, <i>An Introduction to the Theory of Numbers</i>; 5th Edition, Wiley, 1991 (Main Reference) • A. Baker, <i>A Comprehensive Course in Number Theory</i>; Cambridge Univ. Press. 2012.
Essential References Materials	• George E. Andrews, <i>Number Theory</i>; Dover Publications, 1st edition, 1994. • J. Tattersall, <i>Elementary Number Theory in Nine Chapters</i>; Cambridge University Press, 2nd ed. 2005.

Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g., if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist- Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessorat report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist- Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist- Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Group Representation
Course Code:	MAT 6228
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours: 4 (3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type			
a.	University ☐	College ☐	Department ☒ Others ☐
b.	Required ☐	Elective ☒	
3. Level/year at which this course is offered: Levels 4-5 / Year 2			
4. Pre-requisites for this course (if any): None			
5. Co-requisites for this course (if any): None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results in Representations Theory. The course includes the essential fundamentals of Representations, modules and Characters. It covers classical topics as Mischke's theorem, Schur's Lemma and Tensor Product of representations and their characters. The emphasis is on theoretical results with provably good performance. Applications and heuristics are mentioned only occasionally.

2. Course Main Objective

The main purpose of this course is to introduce in depth the following basic topics in Group Representations Theory: Representations, Regular representation, Permutation Representation, Irreducible modules and completely reducible modules, Module homomorphism and isomorphic modules, Mischke's theorem, Schur's Lemma and applications. Characters, Irreducible, regular and faithful Characters, Inner Products of Characters, Character tables, Orthogonality relations of characters, Lifting characters, Tensor Product of representations and their characters, Characters of finite direct product of groups.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and understanding	
1.1	To state the basic methods of group representation theory.	K1, K2
1.2	To describe characters and irreducible representation.	K1, K2
1.3	To outline the use of general linear group and special linear group.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for module homomorphisms and isomorphic modules.	S1, S2
2.2	To develop oral communication and technical writing skills through group characters and their tensor product.	S4
2.3	To use Internet in searching for character tables.	S3
2.4	To justify out deep and not short proofs for Mschke's theorem and Schur's Lemma.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Basics Definitions and Related Topics: Definitions and examples, equivalent Representations, Group Algebras, group algebras modules and submodules, Regular representation, Permutation Representation.	12
2	Modules and Homomorphisms: Irreducible modules and completely reducible modules, Module homomorphisms and isomorphic modules, Mschke's theorem, Schur's Lemma and applications.	12
3	Group Characters: The Conjugacy class equation, Center of group algebra, Characters, Irreducible, regular and faithful Characters, Inner Products of Characters, The number of Irreducible Characters.	12
4	Character Tables: Definition of character table, Row and Column orthogonality relations of characters, Computing characters tables of small orders groups, Lifted characters	12
5	Tensor Product of Characters: Finding linear characters by lifting, Tensor Product of representations and their characters, Characters of finite direct product of groups.	12
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To state the basic methods of group representation theory.	3 lecture hours/week	Regular Exams
1.2	To describe characters and irreducible representation.	2 tutorial hours/week	Assignments

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.3	To outline the use of general linear group and special linear group.	Self-study	Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof for module homomorphisms and isomorphic modules.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through group characters and their tensor product.	Self-study	Participations
2.3	To use Internet in searching for character tables.	Deep problems	Short Quizzes
2.4	To justify out deep and not short proofs for Mschke's theorem and Schur's Lemma.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• G. James, M.W. Liebeck, <i>Representations and Characters of Groups</i>; 2nd Edition, Cambridge, 2011. (Main Reference).
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Essential References Materials	• M. Burrow, <i>Representation Theory of Finite Groups</i>; Dover Publications 2011. • L. Dornhoff, <i>Group Representation theory - Part A</i>, Marcel Dekker 1971. • I. M. Isaacs, <i>Character Theory of Finite Groups</i>; Dover, New York, 1994.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire. Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Ordinary Differential Equations
Course Code:	MAT 6233
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course deals with the mathematical structure of differential equations rather than applications and mathematical modeling. Nevertheless, the course covers the rigorous, abstract theory of ordinary differential equations aiming at understanding mathematical models and make “real-world predictions” described by differential equations; it deals with the study well-posedness, existence of solution(s), and uniqueness. Next, once a model is well-posed, it is of interest to know how to find and/or compute its solution and to provide a straightforward way in the study of differential equations through a package of theorems like Picard–Lindelöf theorem, Cauchy–Peano Theorem, and Kneser Theorem. This investigation is extended to linear systems of differential equations as well as to Hamiltonian systems. Also, a qualitative study is needed with regards to the questions of stability and behavior of possible solutions. Methods such as Lyapunov Direct method are employed to identify, analyze, and interpret the asymptotic behavior of solutions.

2. Course Main Objective

This course is an elective course in the master program of mathematics. It provides in depth exposition of the theory of ordinary differential equations (ODEs) and systems and ODEs. It strongly focuses on theoretical, analytical techniques, and their applications. The interests of this module include existence, uniqueness, the stability, and behavior of ODEs and systems of ODEs. This course could form the basis for further courses on partial differential equations, dynamical systems, bifurcation theory, mathematical modeling, and related topics.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and understanding	
1.1	To state a solid understanding of the qualitative theory of ODEs and linear systems.	
1.2	To describe stability methods used to analyze and interpret the asymptotic behavior of solutions.	
2	Skills:	
2.1	To develop techniques of proof in the stability of solutions of ODEs.	S1, S2
2.2	To develop oral communication and technical writing skills through linear systems of differential equations.	S4
2.3	To use Internet in searching for Lyapunov's Direct Method for stability.	S3
2.4	To use out deep and not short proofs of Picard-Lindelöf, Cauchy-Peano, and Poincare-Bendixon Theorems.	S1, S2
3	Values:	
3.1	To demonstrate independence and responsibility.	V1, V2
3.2	To lead team works.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Fundamental theory of ordinary differential equations: Grown wall's inequality, existence of solutions via Picard-Lindelöf theorem and Cauchy-Peano theorem; global properties of solutions; Analytic differential equations and dependence on initial conditions and parameters; examples of non-uniqueness; Kinser's Theorem; Solution curves, maximal and minimal solutions; comparison theorem; sufficient conditions for uniqueness.	22
2	General Theory of linear systems: Fundamental solutions, matrix exponent, solutions of linear systems with constant coefficients; linear systems with periodic coefficients; Fouquet's theorem; linear Hamiltonian systems.	16
3	Dynamical Systems: Stability of Dynamical Systems, Lyapunov Functions, Stability of Linear and Perturbed Linear Systems, Lyapunov's Direct Method, Asymptotic Behavior and Stability, Stability of Periodic Orbits, Poincare-Bendixon Theorem.	22
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding		
1.1	To state a solid understanding of the qualitative theory of ODEs and linear systems.	3 lecture hours\week	Regular Exams
1.2	To describe stability methods used to analyze and interpret the asymptotic behavior of solutions.	2 tutorial hours\week Self-study	Assignments Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the stability of solutions of ODEs.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through linear systems of differential equations.	Self-study	Participations
2.3	To use Internet in searching for Lyapunov's Direct Method for stability.	Deep problems	Short Quizzes
2.4	To use out deep and not short proofs of Picard-Lindelöf, Cauchy-Peano, and Poincare-Bendixon Theorems.	Self-study	Participations
3.0	Values		
3.1	To demonstrate independence and responsibility.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	HomeWorks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.

- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses are given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	a. P. Hsieh & Y. Sibuya, <i>Basic Theory of ODE</i>, Springer, 1999 (Main reference) b. L. Perko, <i>Differential Equations and Dynamical Systems</i>; Texts in Applied Mathematics, vol. 7, Springer, 3rd Edition, 2001. c. M.W. Hirsch, S. Smale, and R.L. Devaney, <i>Differential Equations, Dynamical Systems, and Introduction to Chaos</i>; Academic Press, Elsevier, 3rd Edition, 2013 d. Brauer, J. Nohel, <i>The Qualitative Theory of ODE</i>, An Introduction, Dover Publications, 1989. e. Walter, <i>Ordinary Differential Equations</i>, Graduate Texts in Mathematics, Springer-Verlag, New York, 1998.
Essential References Materials	K. Schmitt, R. Thompson , <i>Nonlinear Analysis and Differential Equations</i> , 2004.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct : Questionnaire.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect : External assessoral report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
	Students	Indirect: Second examiner checklist-Course report.
Quality of learning resources	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Combinatorics & Graph Theory
Course Code:	MAT 6251
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the most important ideas, theoretical results, and algorithms in graph theory and combinatorics. The course includes the essential fundamentals of graph theory, and an introduction to combinatorics. It covers classical topics in these areas as well as new ones. The emphasis is on theoretical results and algorithms with provably good performance. Applications and heuristics are mentioned only occasionally.

2. Course Main Objective

Students will have a deep knowledge of the definitions of relevant vocabulary from graph theory and combinatorics, and know the statements and proofs of many important theorems in the subject, and be able to perform related calculations.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	Recognize discrete mathematics problems using graph theory.	K1, K2

CLOs		Aligned PLOs
1.2	Record combinatorics techniques.	K1, K2
2	Skills:	
2.1	To develop techniques of proof for Flows in Networks and Electrical Networks.	S1, S2
2.2	To develop oral communication and technical writing skills through graph theory.	S4
2.3	To use Internet in searching for Burside's theorem, the cycle index theorem, and Polya's enumeration formula.	S3
2.4	To demonstrate out deep and not short proofs for the four-color problem.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Graph Theory: Introduction to Graphs, Subgraphs, Connected Graphs, Trees, Nonseparable Graphs, Tree-Search Algorithms.	7
2	Flows in Networks: Complexity of Algorithms, Connectivity, Planar Graphs, The Four-Color Problem, Matchings, Hamilton Cycles, Coverings and Packings.	10
3	Electrical Networks: Integer Flows and Coverings, Stable Sets and Cliques, Colorings, Unsolved Problems.	10
4	Combinatorics: Counting principles, Arrangements and combinations, Numerations of object distributions.	9
5	Generating functions: Generating functions and their coefficients, Partitions, Exponential generating functions and applications.	7
6	Recurrence relations: Examples of recurrence relations, Homogeneous recurrence relations, nonhomogeneous recurrence relations, Solving recurrence relation by generating functions.	7
7	Inclusion-Exclusion formula and applications: Arranging objects with restricted positions, Burside's theorem, The cycle index theorem, Polya's enumeration formula.	10
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	Recognize discrete mathematics problems using graph theory.	3 lecture hours/week	Regular Exams
1.2	Record combinatorics techniques.	2 tutorial hours/week Self-study	Assignments Short Quizzes
2.0	Skills		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.1	To develop techniques of proof for Flows in Networks and Electrical Networks.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through graph theory.	Self-study	Participations
2.3	To use Internet in searching for Burside's theorem, the cycle index theorem, and Polya's enumeration formula.	Deep problems	Short Quizzes
2.4	To demonstrate out deep and not short proofs for the four-color problem.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	• J. A. Bondy, U.S.R. Murty, Graph Theory; Springer, 1st Edition, 2008. (Main Reference 1) • A. Tucker, Applied Combinatorics, Wiley and Sons, 6th ed. 2012. (Main Reference 2)
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Essential References Materials	• Journal of Graph Theory and Journal Discrete Mathematics. • R.J. Wilson, Introduction to Graph Theory, Pearson Education, Singapore, 4th edition, 2003. • P.J. Cameron, Combinatorics: Topics, Techniques, Algorithms; Cambridge University Press, 1st edition, 1995.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Algebraic Graph Theory
Course Code:	MAT 6255
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description

This course describes the basic ideas of graph theory, linear algebra and group theory and deals with the connection of graph theory and the other two topics. Also, the course discusses the chromatic polynomial of a graph and its properties, and we give the main theorems on counting of spanning trees. We introduce the spectrum of a graph, and we discuss the properties of a graph from its eigen-values of its related matrices. We discuss the automorphism group of a given graph and deals with Cayley's graph.

2. Course Main Objective

Students will have deep knowledge of the fundamentals of graph theory, linear algebra and group theory. There is a main connection between graph theory and linear algebra. This arises from the matrices associated to a given graph. Another connection between graph theory and groups comes from the automorphism group of a graph. At the end of this course the student will be able to: Represent graphs using matrices, Evaluate various spectra related to some families of graphs, Study the properties of graph through their adjacency matrices and be able to describe Cayley graph for some groups.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	Recognize various problems on graph theory with the connection of linear algebra.	K1, K2
1.2	Describe the automorphism group of a graph and construct Cayley graph for various groups.	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the subject of Spectrum of a graph.	S1, S2
2.2	To develop oral communication and technical writing skills through automorphism group of a graphs.	S4
2.3	To use Internet in searching for Chromatic polynomials.	S5
2.4	To appraise out deep and not short proofs for Cayley's formula, Kirchhoff's Theorem, and Prufer sequence.	S3
3	Values:	
3.1	To demonstrate independence and responsibility.	V1, V3
3.2	To lead team works.	V1, V2

C. Course Content

No	List of Topics	Contact Hours
1	Basics of graph theory: Graphs and Directed graphs, Variations of graphs, Adjacency and degrees. Matrices related to a graph. Walks, Distance, Subgraphs, Bipartite graphs, Trees, Special graphs, Operations on graphs, Planarity, and Line graphs. Linear algebra: The space $\mathbb{R}^n$, Metric properties, Vector spaces, Subspaces, Bases and dimension, Euclidean spaces, Types of matrices, Operations on matrices, Determinants, Eigenvalues and eigenvectors, and Diagonalizing matrices. Group theory: Groups, Subgroups, Homomorphisms, Finite simple groups, Permutation groups, Automorphism groups of graphs, and Group actions on a set.	13
2	Chromatic polynomials: The chromatic number, Chromatic polynomials, Deletion-Contraction Theorem, Algebraic properties.	9
3	Counting spanning trees: Cayley's formula, Kirchhoff's Theorem (The matrix tree Theorem), Prufer sequence, Circulant determinant, Chebyshev Polynomials, Applications of spanning trees.	10
4	Spectrum of a graph: Eigenvalues of a walks, Eigenvalues of typical graphs, Eigenvalues and labeling of graphs, lower and upper bounds for the eigenvalues of graphs, Regular and line graphs.	10
5	Laplacian spectrum: Laplacian matrix, Laplacian eigenvalues, The largest Laplacian eigenvalue.	9
6	Automorphism group of a graph: Cayley graph, Automorphisms of typical graphs. Frucht's Theorem Graphs with given group, groups of graph products, Transitivity.	9
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	Recognize various problems on graph theory with the connection of linear algebra.	3 lecture hours\week	Regular Exams
1.2	Describe the automorphism group of a graph and construct Cayley graph for various groups.	2 tutorial hours\week Self-study	Assignments Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the subject of Spectrum of a graph.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through automorphism group of a graphs.	Self-study	Participations
2.3	To use Internet in searching for Chromatic polynomials.	Deep problems	Short Quizzes
2.4	To appraise out deep and not short proofs for Cayley's formula, Kirchhoff's Theorem, and Prufer sequence.	Self-study	Participations
3.0	Values		
3.1	To demonstrate independence and responsibility.	Personal questions	Participation
3.2	To lead team works.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC),.
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	C. Godsil, and G. Royle , Algebraic Graph Theory, Springer Verlag New York 2001 (Main Reference). R. J. Wilson, and I. W. Beineke , Topics in Algebraic Graph Theory, Cambridge University Press 2004
Essential References Materials	N. Biggs , Algebraic Graph Theory, 2 nd Edition, Cambridge University Press 1993
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Each class room should be equipped with a whiteboard and a projector. - Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students	Direct: Questionnaire.
	Course Responsible	Direct: Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Differential Geometry
Course Code:	MAT 6275
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Level 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course introduces the most important ideas and theoretical results of differential geometry. It deals with Differentiable Manifolds. Submanifolds of $\mathbb{R}^n$ and Classical Lie groups, Tangent spaces and Differentiable mappings between manifolds. Also, it deal with the inverse and Implicit function theorems on manifolds, Tangent vectors, tangent bundle, vector fields and flows, Lie derivatives, Differential of a map, immersions, submersions, Differential forms and Integration on manifolds.

2. Course Main Objective

This course aims at training students to acquire the basic mathematical understanding of modern approaches to the study of Differentiable Manifolds. Submanifolds as well as discussing some of their practical aspects. Differential geometry consists of studying properties Differentiable Manifolds. Sub-manifolds, which allows the understanding of the physics of moving particles and objects, as well as the geography of the earth and planets. Differential geometry has far reaching applications extending to the theory of general relativity, which students can go on to study upon the completion of this course. To introduce a range (e.g.,

industrial, biological, and environmental) of problems, associated conceptual models and their solutions using graphical, numerical and analytical approaches.

3. Course Learning Outcomes

CLOs		Aligned-PLOs
1	Knowledge and Understanding	
1.1	To write fundamental properties of differentiable manifolds and sub-manifolds.	K1, K2
1.2	To state the main properties of the differentiable mappings between manifolds	K1, K2
2	Skills:	
2.1	To develop techniques of proof in the subject of differentiable manifolds.	S1, S2
2.2	To develop oral communication and technical writing skills for Submersions, Immersions, and Embedding .	S4
2.3	To use Internet in searching for vector fields and flows.	S5
2.4	To use out deep and not short proofs for classical Lie groups.	S3
3	Values:	
3.1	To work individually.	V1, V3
3.2	To work in groups.	V1, V2

C. Course Content

No	List of Topics	Contact Hours
1	Differentiable Manifolds: Definition of Differentiable Manifolds and some examples.	7.5
2	Sub-manifolds of $\mathbb{R}^n$: Classical Lie groups; Tangent spaces, Differentiable mappings between manifolds.	11
3	Submersions, Immersions, and Embedding: Inverse and Implicit function theorems on manifolds.	11
4	Functions of Several Variables and Mappings: Tangent vectors; tangent bundle; vector fields and flows; Lie derivatives.	11
5	Smooth Maps: Differential of a map, immersions, submersions.	7.5
6	Integration on Manifolds: Differential forms and Integration on manifolds	12
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	To write fundamental properties of differentiable manifolds and sub-manifolds.	3 lecture hours/week	Regular Exams
1.2	To develop techniques of proof in the subject of differentiable manifolds.	2 tutorial hours/week Self-study	Assignments Short Quizzes

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.1	To develop oral communication and technical writing skills for Submersions, Immersions, and Embedding.	Deep problems	Short Quizzes
2.2	To use Internet in searching for vector fields and flows.	Self-study	Participations
2.3	To use out deep and not short proofs for classical Lie groups.	Deep problems	Short Quizzes
2.4	To develop techniques of proof in the subject of differentiable manifolds.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
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*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

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- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	Erwin Kreyszig, <i>Differential Geometry</i> , Dover Publications, 2012 (Main Reference).
Essential References Materials	• <u>M. P. Do Carmo</u>, <i>Differential Geometry of Curves and Surfaces</i>, Pearson, 2st Ed., 2016. • Andrew Pressley, <i>Elementary Differential Geometry</i>, Springer-Verlag, 1st Edition, 2010.

	• Wolfgang Kühnel, <i>Differential Geometry: Curves - Surfaces – Manifolds</i>, American Mathematical Society, 2nd Edition, 2004. • Cannas da Silva, A. <i>Lectures on Symplectic Geometry</i> (Lecture Notes in Mathematics). New York City, NY: Springer, 2001. ISBN: 9783540421955.
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources	Students	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Selected Topics in Pure Mathematics (1)
Course Code:	MAT 6285
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Seminars	0
4	Tutorials	24
5	Others (specify)	0
Total		60

B. Course Objectives and Learning Outcomes

1. Course Description
Course dependent.
2. Course Main Objective
- This course is designed to enable students to study different special topics of interest, which are carefully selected from Pure Mathematics topics. The course covers selected topics in mathematics suggested by the student's supervisor and approved by the chairman and the department council each time this course is offered. - To learn topics those are not formally offered by the program and receive appropriate academic credit.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	Knowledge and Understanding	
1.1	Specific to each course of study.	K1, K2

CLOs		Aligned PLOs
2	Skills:	
2.1	To develop techniques of proof in the corresponding subject.	S1, S2
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	S4
2.3	To use Internet in searching for scientific information	S3
2.4	To choose out deep and not short proofs.	S1, S2
3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Specific to each course of study	60
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	Knowledge and Understanding		
1.1	Specific to each course of study	• 3 lecture hours/week • 2 tutorial hours/week • Self-study	• Regular Exams • Assignments • Short Quizzes
2.0	Skills		
2.1	To develop techniques of proof in the corresponding subject.	Deep problems	Short Quizzes
2.2	To develop oral communication and technical writing skills through writing and oral presentation.	Self-study	Participations
2.3	To use Internet in searching for scientific information	Deep problems	Short Quizzes
2.4	To choose out deep and not short proofs.	Self-study	Participations
3.0	Values		
3.1	To work individually.	Personal questions	Participation
3.2	To work in groups.	Team work	Homework and Mini-projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homeworks, Quizzes, Mini-projects	During the semester	30%
2	Midterm	Week 6-7	30%
4	Final Exam	Week 13	40%

*Assessment task (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Students admitted to the master program will receive the appropriate academic counseling and support from the mathematics graduate committee (MGC).
- The lecturer for each course allocates 6 office hours per week advertised on his /her own timetable, and reserved as part of his/her teaching schedule to help the students on any academic problems/difficulties.
- Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls.
- A list of teaching staff members with their room numbers, their phone numbers and their e-mail addresses is given in the MSc Mathematics Handbook and Department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	To be specified according to the course syllabus
Essential References Materials	To be specified according to the course syllabus
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology Resources (AV, data show, Smart Board, software, etc.)	The rooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students Course Responsible	Direct: Questionnaire. Direct: Course e-Portfolio.

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		Indirect: Second examiner checklist-Course report.
	Peer Reviewer	Direct: Questionnaire. Indirect: External assessor report.
Effectiveness of assessment	Program Leaders	Direct: Course e-Portfolio. Indirect: Course report.
Extent of achievement of course learning outcomes	Course Responsible	Direct: Exams - Course e-Portfolio. Indirect: Second examiner checklist-Course report.
	Program Leaders	Indirect: Exams.
Quality of learning resources	Students	Indirect: Second examiner checklist-Course report.
	Faculty (Academic Advisory- GCC)	Direct: course Entrance/Exit. Indirect: Observations - Accreditation review.
	Program Leaders	Direct: Course e-Portfolio.
	Course Responsible	Indirect: Course evaluation survey- Observations- Syllabus review- Accreditation review.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)

Course Title:	Selected Topics in Pure Mathematics (2)
Course Code:	MAT 6287
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

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1.Learning Resources	5
2. Facilities Required.....	6
G. Course Quality Evaluation	6
H. Specification Approval Data	7

A. Course Identification

1. Credit hours:	4 (3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a.	University ☐ College ☐ Department ☒ Others ☐
b.	Required ☐ Elective ☒
3. Level/year at which this course is offered:	Levels 4-5 / Year 2
4. Pre-requisites for this course (if any):	None
5. Co-requisites for this course (if any):	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100 %
2	Blended		
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5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Learning Hours
1	Lecture	36
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3	Values:	
3.1	To work individually.	V1, V2
3.2	To work in groups.	V1, V3

C. Course Content

No	List of Topics	Contact Hours
1	Specific to each course of study	60
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
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Evaluation Areas/Issues	Evaluators	Evaluation Methods
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H. Specification Approval Data

Council / Committee	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
Reference No.	11/1444
Date	22/04/1444 (16/11/2022)