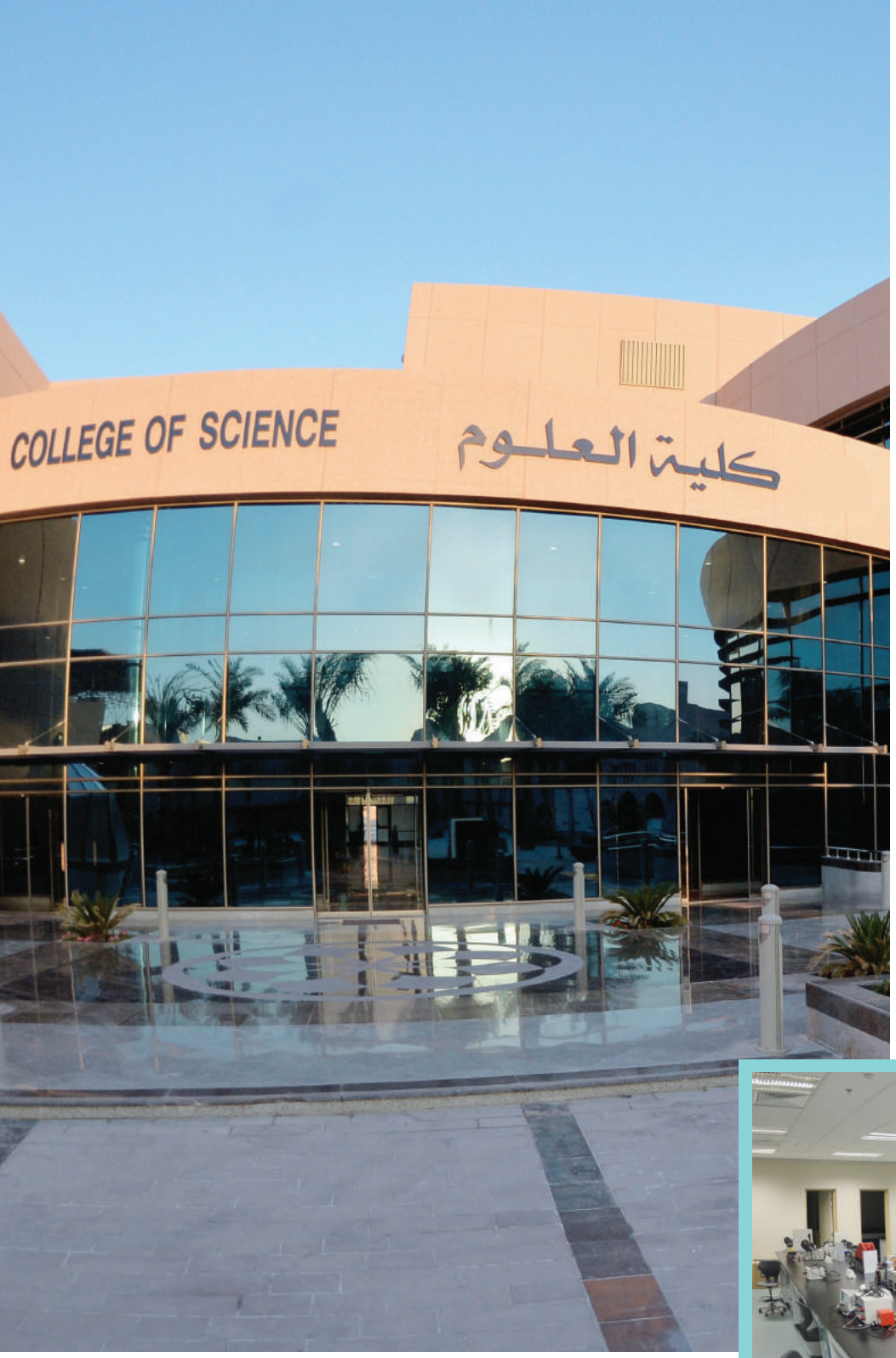

KING FAISAL UNIVERSITY
COLLEGE OF SCIENCE
MATHEMATICS AND
STATISTICS DEPARTMENT

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Course Name	Calculus 1				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math-101	0827101	1	4	-
Course Track	☐ University Requirement ☒ College Requirement ☐ Specialized Core ☐ Electives				

Course Description: This course provides the basic facts of calculus including limits, continuity, the definition of derivative, differentiation rules, implicit differentiation, the mean value theorems, definite and indefinite integral, the fundamental theorem of calculus and applications of differentiation and integration.

Course Outcomes

After the completion of this course, the student will be able to:

1. Recognize usual functions and their properties.
2. Compute different types of limits.
3. Demonstrate the continuity and differentiability of real valued functions.
4. Apply derivative techniques.
5. Evaluate indefinite and definite integrals.
6. Calculate areas and volumes by different integration techniques.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Joel R. Hass, Christopher E. Heil, Maurice D. Weir. "Thomas' Calculus, Single Variable. Pearson Education, 14th edition, (2017).							
References	James Stewart. Calculus: Early Transcendentals. Cengage Learning, 8th edition, (2016).							

Course Name	Introduction to statistics				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hour**	**Prerequisite(s)**
	Math 103	0827103	1	4	-
Course Track	☐ University Requirement ☒ College Requirement ☐ Specialized Core ☐ Electives				

Course Description: This course is designed to describe statistical data graphically and compute measures of centrality and dispersion, and develop concepts of sample space, probability of an event, conditional probability, statistical independence, random variables, discrete and continuous probability distributions and hypothesis testing.

Course Outcomes

After the completion of this course, the student will be able to:

1. Recognize the basic definitions and concepts of probability (space, event, conditional probability, independence, random variables and probability distributions, Mathematical Expectations, variance,…)
2. Summarize a given dataset statistically using both tabular and graphical representation.
3. Interpret distributions proprieties (central tendency, variation and the shape of the distribution.
4. Compute linear correlation, correspondence and the regression line
5. Apply rules of combinatory analysis, conditional probability and particular distributions of probability
6. Test parameters using normal distribution
7. Estimate parameters from samples

Assessment Policy	**Assignment**		**Quiz**	10%	**Lab**		**Project**	20
	Midterm	30%	**Final**	40%	**Others**			
Textbook	William M, Beaver, R and B, Beaver. Introduction to probability and statistics, Thomson Brooks/Cole – USA, 14th Edition, (2013)							
References	Robin H. Lock, Patti Frazer Lock, Kari Lock Morgan, Eric F. Lock, Dennis F. Lock. Statistics: Unlocking the Power of Data, 1st Edition. Wiley,(2017).							

Course Name	Introduction To Computer Sciences				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hour**	**Prerequisite(s)**
	Math 102	0827102	1	3	-
Course Track	☐ University Requirement ☒ College Requirement ☐ Specialized Core ☐ Electives				

Course Description: This course provides basic knowledge of computer usage, computer components, concepts of basic operating systems, binary number system, and representation of data on computer, use computer in mathematical programs Software (Mathematica and Matlab) and word processing software (Word and Scientific Workplace), use computer in spreadsheets, presentations, databases and usage of the Web and utilizing the web based resources.

Course Outcomes

After the completion of this course, the student will be able to:

1. Define where appropriate, a range of Computer Concepts and common computer applications which underpin the principles of Computer Systems
2. Identify appropriate common computer applications, which supports the tasks performed by basic uses of Computer Systems.
3. Write some codes using common computer applications or Mathematical Programs Software
4. Apply some Binary Arithmetic and some specific commands of some mathematical programs Software (Mathematica and Matlab) for solving some mathematical problems.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	1. Stephen J. Chapman. Essentials of MATLAB Programming", Publisher: Cengae Learning,3rd Edition, (2016) 2. Ashok Arora. Computer Fundamentals and Application. Vikas publishing House, (2015)							
References	Mohammad, N. Tutorials on Mathematics to Matlab. 1st Book Library (2003),							

Course Name	Introduction to Computer Sciences-Lab				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hour**	**Prerequisite(s)**
	Math-112	0827112	1	1	-
Course Track	☐University Requirement ☒ College Requirement ☐ Specialized Core ☐ Electives				

Course Description: This course provides basic knowledge of computer usage, use computer in mathematical programs (Mathematica and Matlab) and use computer in Advanced Skills of word processing software (Word and Scientific Workplace), use computer in Advanced Skills of spreadsheets, use computer in Advanced Skills of presentations, databases and uses of the Web and utilizing some web-based resources.

Course Outcomes

After the completion of this course, the student will be able to:

1. Define where appropriate, a range of Computer Concepts and common computer applications which underpin the principles of Computer Systems.
2. Identify appropriate common computer applications that supports the tasks performed by basic uses of Computer Systems.
3. Write some codes using common computer applications or Mathematical Programs Software
4. Apply some Binary Arithmetic and some specific commands of some mathematical programs Software (Mathematica and Matlab) for solving some mathematical problems.
5. Write a program segment to perform a given task for the solution of mathematical problems, either individually or as part of a team, in a timely manner
6. Practice interaction skills through peer group activity to achieve basic Communication skills.
7. Demonstrate the use of IT and Numerical skills.

Assessment Policy	**Assignment**		**Quiz**		**Lab**		**Project**	-
	Midterm	20%	**Final**	40%	**Others(reports)**	40%		
Textbook	Paul R. Wellin. Programming with Mathematica, An Introduction. Cambridge, (2013).							
References	Stephen J. Chapman. Essentials of MATLAB Programming, Cengae Learning, 3rd Edition, (2016).							

<table>
<tr><td>Course Name</td><td colspan="3">Logic and Set Theory</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math-201</td><td>0827201</td><td>3</td><td>4</td><td>-</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course covers logic of statements, quantifiers, Methods of proofs, sets and operations on sets, Relations: Equivalence relations, partial order and linear order, functions and properties of functions, countable sets.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the basic definitions and concepts relating to statements logic, quantifiers ,sets, relations, functions and countable sets
2. Apply the definitions and fundamentals of statements logic including connectives, truth tables and induction rules.
3. Classify the quantifiers including their applications in mathematical logic.
4. Show some mathematical theorems using methods of proofs.
5. Conclude the main properties of the operations on sets.
6. Analyze different concepts related to relations such as equivalence, partial order and linear order.
7. Apply the main results on functions and countable sets.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="7">Kevin Ferland. Discrete Mathematics and Applications, Textbooks in Mathematics, Taylor & Francis INC, 2nd Edition, (2017)</td></tr>
<tr><td>References</td><td colspan="7">Ethan D. Bloch. Proofs and Fundamentals: A First Course in Abstract Mathematics.Undergraduate Texts in Mathematics, 2nd Edition ,(2011)</td></tr>
</table>

Course Name	Calculus 2				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 202	0827202	3	4	Calculus 1 (0827101)
Course Track	☐ University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: Calculus 2 is a fundamental course that deals with the basic knowledge related to: integration techniques, hyperbolic functions and their inverses, improper integrals, sequences, series and their tests of convergence, Taylor-Maclaurin formula, power series and their derivatives and integrals, polar coordinates and conic sections.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions and results related to the main studied concepts.
2. Compute definite and indefinite integrals with the suitable integration technique.
3. Calculate the derivative of hyperbolic and inverse hyperbolic functions.
4. Evaluate some classes of improper integrals by means of the concepts of limits, convergence, and divergence.
5. Justify convergence or divergence of sequences and series.
6. Analyze different aspects of a power series including its radius of convergence, derivative, integral and its link to usual functions by means of the Taylor-Maclaurin formula**.**
7. Apply the concept of polar coordinates to the calculus of areas, lengths of curves, and representations of conic sections.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Joel R. Hass, Christopher E. Heil, Maurice D. Weir. Thomas' Calculus: Early Transcendentals. Pearson, 14th Edition, (2017).							
References	J. Stewart. Calculus. Early Transcendentals. Cengage Learning, 8th Edition (2016).							

<table>
<tr><td>Course Name</td><td colspan="3">Group Theory</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 203</td><td>0827203</td><td>4</td><td>3</td><td>Logic and Set Theory (0827201)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: Group theory is a fundamental course that deals with the basic knowledge related to : group structure, cyclic groups, symmetric groups, subgroups, Lagrange's theorem, co-sets, normal subgroups, factor groups, and group-isomorphism theorems.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Write the fundamental results related to the main concepts of groups theory.
2. State the basic definitions.
3. Characterize permutations.
4. Analyze group axioms in examples.
5. Apply Lagrange's theorem, the group-isomorphism theorems, and Cayley's theorem.
6. Create examples and counterexamples.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">Marshall Hall. The Theory of Groups. Dover Books on Mathematics, (2018).</td></tr>
<tr><td>References</td><td colspan="6">Harris Z. M. Z. Classical Group Theory. Create Space Independent publishing Platform, (2018).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Linear Algebra 1</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math-204</td><td>0827204</td><td>4</td><td>3</td><td>-</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course provides the basic knowledge of solving systems of linear equations, matrix operations, vector spaces and inner product spaces, linear transformations, matrix representation of a linear transformation, eigenvalues, eigenvectors and matrix diagonalization.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the basic definitions and fundamental results.
2. Calculate solutions of linear systems.
3. Justify linear independence in vector spaces.
4. Apply the change of bases.
5. Apply the main properties of inner products.
6. Analyze the matrix representation of a given linear transformation.
7. Test the diagonalizability of a square matrix.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">Gilbert Strang. Introduction to linear algebra. Wellesley-Cambridge Press (US), (2016).</td></tr>
<tr><td>References</td><td colspan="6">Meckes E. S., M. W. Meckes. Linear Algebra. Cambridge University Press, (2018).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Calculus 3</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hour</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 205</td><td>0827205</td><td>4</td><td>4</td><td>Calculus 2 (0827202)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course deals with the basic facts of vectors in space, dot and cross products, lines and planes in space, curves and surfaces in space, cylindrical and spherical coordinates, vector-valued functions, functions of several variables, partial and total derivatives, directional derivative and gradient, maxima and minima, Lagrange multiplier, multiple integrals and their applications and Green's theorem and curvilinear integration.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the basic definitions and the fundamental results of the main concepts related to 3D-spaces, continuity and differentiability of functions of several variables
2. Analyze continuity and partial differentiability of functions of several variables.
3. Compute the extrema of functions of two variables.
4. Solve some optimization problems with the Lagrange multipliers
5. Evaluate double integrals and triple integrals
6. Apply the main techniques of vector analysis to vector fields, line integrals and Green’s theorem.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="5">George B. Thomas Jr., Maurice D. Weir and Joel R. Hass. Thomas' Calculus. Multivariable,14th Edition, (2017).</td></tr>
<tr><td>References</td><td colspan="5">James Stewart. Calculus: Early Transcendentals. Cengage Learning ,8th edition, (2016).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Principles of Analysis</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 206</td><td>0827206</td><td>4</td><td>4</td><td>Calculus 1 (0827101)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course concerns with the fundamental of complex and real numbers, countable sets, topology on the real line, convergence of real sequences and series and limits of functions and convex functions.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the basic definitions and results related to the main concepts of analysis.
2. Describe the real line as a complete ordered field.
3. Construct functions between sets; equivalent sets, finite, countable and uncountable sets.
4. Judge convergence, divergence, boundedness, monotonicity of sequences.
5. Test different modes of series convergence.
6. Apply properties of monotonicity, limits, continuity and convexity of real functions.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="5">Abbott S. Understanding analysis, Undergraduate text in mathematics. Springer, 2nd Edition, (2016).</td></tr>
<tr><td>References</td><td colspan="5">Ross K.A.,. Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer, 2nd Edition, (2013).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Introduction to Topology</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math 301</td><td>0827301</td><td>5</td><td>3</td><td colspan="2">Logic and Set Theory (0827201)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="7">Course Description: This course provides an introduction to Topological Spaces, Open and closed Sets, Limit Points, Interior, Exterior and boundary Points and the Closure of Sets, Subspace Topology, Bases and Subbases for Topology, Continuous Functions, Topologically Equivalent, Topological Properties, Separation Axioms, Compactness, Connectedness.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the basic definitions, concepts and some fundamental results related to topology.
2. Differentiate between bases and subbases accurately.
3. Analyze the structure of topological spaces.
4. Classify topological spaces with respect to separation axioms.
5. Develop the compactness notion.
6. Explain the notion of connected topological spaces.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>_</td><td rowspan="2">Project</td><td rowspan="2">__</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>_</td></tr>
<tr><td>Textbook</td><td colspan="6">Croom F. Principles of Topology, Dover publications, New York, (2016).</td></tr>
<tr><td>References</td><td colspan="6">Adams,C. and Franzosa,R. Introduction to Topology: Pure and Applied, Pearson-Prentice Hall, (2008).</td></tr>
</table>

Course Name	Real Analysis				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math302	0827302	5	3	Principles of Analysis **(**0827206)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description:

This course provides basic knowledge related to uniform continuity of real functions, the main value theorem, properties of the differentiability of real functions, the intermediate value theorem, the application of the L'Hopital's rules to calculate limits, the Taylor series expansion, the Riemann integral and its properties, the convergence, , convergence and uniform convergence of a sequence or series of real functions and real power series.

Course Outcomes

After the completion of this course, the student will be able to:

1. Recognize the basic definitions and fundamental results related to the main studied concepts.
2. Distinguish the difference between the continuity and uniform continuity.
3. Apply the mean value theorem and Taylor series expansion.
4. Test Riemann integrability of a given function.
5. Evaluate some integrals using Darboux theorem and Riemann series.
6. Test different modes of convergence of sequences and series of real functions.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Quiz**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Abbott S. Understanding analysis, Undergraduate text in mathematics. Springer, 2nd Edition, (2016).							
References	Ross, K.A. Elementary Analysis: The Theory of Calculus. Undergraduate Texts in Mathematics. Springer, 2nd Edition, (2013).							

Course Name	Discrete Mathematics				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 303	0827303	5	3	Logic and Set Theory (0827201)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course deals with algorithms, growth of functions, complexity of algorithms, mathematical induction**,** strong induction and well ordering, recursive algorithms, graphs, graph models and modeling computation.

Course Outcomes

After the completion of this course, the student will be able to:

1. State logic Propositional and modeling computation.
2. Recognize algorithms and their complexity.
3. Write recursive algorithms.
4. Differentiate between some basic structures.
5. Compare complexity of algorithms.
6. Analyze graph models.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Kevin Ferland. Discrete Mathematics and Applications. Textbooks in Mathematics, Taylor & Francis INC, 2nd Edition, (2017).							
References	Ralph P. Grimaldi. Discrete and Combinatorial Mathematics. Pearson Education (US), 2017.							

Course Name	Ordinary differential equation				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 304	0827304	5	3	Calculus 2 (0827202)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course deals with analytical methods for solving several classes of ODEs, Finding the solution of ODEs in a series form, Solving IVP by Laplace transformations and their inverse, solving linear systems of first order ODEs and investigating some applications of ODEs.

Course Outcomes

After the completion of this course, the student will be able to:

1. Recognize all types of ordinary differential equations.
2. Classify first order ODEs.
3. Calculate the solution of differential equations by different methods.
4. Evaluate the solution of a class of ODEs by the power series method.
5. Solve the IVP by the Laplace operator and its inverse.
6. Analyze the solution of a system of linear first order ODEs by different methods.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	William E. Boyce, Richard C. DiPrima, Douglas B. Meade. Elementary differential equations and boundary value problems,Wiley,11th edition, **(**2017).							
References	Shair Ahmad, Antonio Ambrosetti. A text book on ordinary differential equations. Springer, 2nd edition, (2015).							

Course Name	Rings and Fields				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math305	0827305	5	3	Group Theory (0827203)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course is designed to give basic knowledge in rings, fields, (Prime and maximal) ideals, ring homomorphism, factor rings, ring- isomorphism theorems and their use in constructing fields, polynomial rings, irreducible polynomials, unique factorization domains**,** Principal ideal domains and Euclidean domains**,** algebraic and finite field extensions.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions, concepts and some fundamental results in rings and fields theory.
2. Analyze the concepts of principal ideal domains, Euclidean domains and unique factorization domains.
3. Apply the fundamental isomorphism theorems.
4. Interpret the factorization of polynomials over fields.
5. Judge concepts of ideals, quotient rings, prime and maximal ideals.
6. Analyze the hypotheses of a given problem.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Stuart A. Rankin. Abstract Algebra: Introduction to groups, Rings and Fields with Applications. World Scientific Publishing, Co Pte Ltd, (2016).							
References	Shahrian Shahriari. Algebra in Action: A course in groups, Rings and Fields. American Mathematical Society, (2017).							

<table>
<tr><td>Course Name</td><td colspan="3">Mathematical Programming</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math 306</td><td>0827306</td><td>5</td><td>2</td><td colspan="2">Introduction to computer (0827102)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="7">Course Description: This course provides core concepts and principles of programming (variables, comments, data types, operators, special characters, flowchart, conditional statements, loops, break, continue, switch- case,…) and of object oriented programming (class, object, methods, constructor, inheritance, super, polymorphism,…) and their use in mathematical programs.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. Design simple mathematical programs programming concepts in solving given problems.
2. Design the flowchart of a given program.
3. Resolve several mathematical programs using conditional statements, loops, switch-case and arrays.
4. Create several mathematical programs using conditional statements, loops, switch-case and arrays.
5. Differentiate the object oriented programming concepts.
6. Interpret the use of object oriented their use in the programs.
7. Implement simple mathematical programs solving a given problem.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="7">Deitel,P and Deitel,H. Java How to Program. Prentice Hall, 11th Edition, (2017).</td></tr>
<tr><td>References</td><td colspan="7">Walter S, Kenrick ,M. Java: An Introduction to Problem Solving & Programming. Global Edition eBook, 7th Edition, (2015).</td></tr>
</table>

Course Name	Mathematical Programming - Lab				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 316	0827316	5	1	Introduction to computer Science (0827102)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course provides core concepts and principles of programming (variables, comments, data types, operators, special characters, flowchart, conditional statements, loops, break, continue, switch- case,…) and of object oriented programming (class, object, methods, constructor, inheritance, super, polymorphism,…) and their use in mathematical programs.

Course Outcomes

After the completion of this course, the student will be able to:

1. Design the flowchart of a given program.
2. Resolve several mathematical programs using conditional statements, loops, switch-caseand arrays.
3. Create several mathematical programs using conditional statements, loops, switch-case and arrays.
4. Differentiate the object oriented programming concepts.
5. Interpret the use of object oriented their use in the programs.
6. Design simple mathematical programs programming concepts in solving given problems.
7. Implement simple mathematical programs solving a given problem.

Assessment Policy	**Assignment**		**Quiz**	-	**Lab**		**Project**	-
	Midterm	20%	**Final**	40%	**Others(reports)**	40%		
Textbook	Deitel,P and Deitel,H. Java How to Program. Prentice Hall, 11th Edition, (2017).							
References	Walter S, Kenrick ,M. Java: An Introduction to Problem Solving & Programming. Global Edition eBook, 7th Edition, (2015).							

<table>
<tr><td>Course Name</td><td colspan="3">Measure Theory</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 307</td><td>0827307</td><td>6</td><td>3</td><td>Principles of Analysis (0827206)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement☒ Specialized Core☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course deals with the basic knowledge of measurable sets and functions, integral of functions, Synthesize the relation between the Riemann and Lebesgue integral, the L^p-spaces, Apply the convergence theorems, Holder inequalities and theorems of Fubini and Tonelli.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the basic concepts of measurable spaces.
2. Analyze the relation between Riemann’s integral and Lebesgue’s integral.
3. Apply convergence theorems (Fatou lemma, monotone convergence theorem, dominated convergence theorem).
4. Apply Minkowski and Hölder inequalities.
5. Apply Fubini and Tonelli theorems.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="5">Royden, H.L., Fitzpatrick, P. Real Analysis. Pearson, 4th Edition, (2010).</td></tr>
<tr><td>References</td><td colspan="5">Rudin,W. Real and Complex Analysis. McGraw-Hill, 3th Edition (1987).</td></tr>
</table>

Course Name	Numerical Analysis 1				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 308	0827308	6	3	Calculus 2 (0827202)
Course Track	☐ University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course is designed to provide student with basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer. Emphasis are addressed on numerical methods for root-finding of nonlinear equations, approximation of functions, interpolation, numerical differentiation and numerical integration.

Course Outcomes

After the completion of this course, the student will be able to :

1. State the basic definitions of errors, convergence and speed of convergence of numerical methods.
2. Calculate solutions of nonlinear equations with appropriate numerical methods.
3. Write polynomial interpolation for functions.
4. Estimate approximations of derivatives and integrals with numerical algorithms.
5. Calculate best approximations for given functions and data with appropriate numerical methods.
6. Implement numerical algorithms efficiently in a modern scientific programming language.

Assessment Policy	**Assignment**		**Quiz**	10%	**Lab**		**Project**	20%
	Midterm	30%	**Final**	40%	**Others**			
Textbook	Burden R.L., Faires J.D. Numerical analysis. Brooks Cole, 10th edition, (2016)							
References	Wen Shen. Introduction to numerical computation. World Scientific Publishing, (2015).							

Course Name	Analysis of several variables				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 309	0827309	6	3	Calculus 3 (0827205)
Course Track	☐ University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course is designed to cover the basic knowledge related to: topological properties of the Euclidean space IR^n , the space of linear applications from IR^n to IR^m, the differentiability of functions defined on open subsets of IR^n , the chain rules formula, the inversion theorem and the implicit function theorem, the extrema of real valued functions of several variables, the Lagrange multipliers and the change of variables formula.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions and the fundamental theorems and results related to the main concepts of the course.
2. Write the different properties of a given linear application from IR^n to IR^m.
3. Analyze the continuity and the differentiability of a function of several variables.
4. Apply the main theorems of differential calculus including the local inversion theorem, the average theorem and the implicit function theorem.
5. Compute the extrema of a real valued function by the gradient, the Hessian matrix and the Lagrange multipliers.
6. Evaluate the integral of a real valued function of several variables by Fubini theorem and the change of variables formula.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Quiz**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Maria S, T, Peter D-Lax. Multivariable Calculus with Applications. Springer, (2018).							
References	Shifrine, T. Multivariable Mathematics: Linear algebra, multivariable calculus, and manifolds. Wiley Publications,(2004).							

Course Name	Probability theory				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hour**	**Prerequisite(s)**
	Math 310	0827310	6	3	Introduction to statistics (0827103)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course provides basic concepts of probability and determines the proprieties of probability distributions such as sample space, probability measure, conditional probability, Bayes and total probability theorems, centrality and dispersion measures, the moments of probability distributions, Chebyshev and Markov inequalities.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the main definitions and theorems involved in probability theory.
2. Determine the cardinality of a finite set by the appropriate method of combinations.
3. Involve the main probability theorems/concept (sample space, probability measure, conditional probability, Bayes and total probability theorems …) on real-life problems.
4. Compute centrality, dispersion measures and the moments of probability distributions.
5. Apply Chebyshev and Markov inequalities to determine a lower or upper bound of a probability.
6. Construct random experiment to generate a specific probability distribution.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**		**Project**	
	Midterm	30%	**Final**	40%	**Others**			
Textbook	Jay Devore. Probability and Statistics for Engineering and the Sciences. Duxbury Press, 9th Edition, (2012)							
References	William M, Beaver, R and B, Beaver. Introduction to probability and statistics, Thomson Brooks/Cole – USA, 14th Edition, (2013)							

<table>
<tr><td>Course Name</td><td colspan="3">Linear Algebra 2</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math-311</td><td>0827311</td><td>6</td><td>3</td><td colspan="2">Linear Algebra1 (0827204)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="7">Course Description: This course provides basic understanding of eigenvectors, eigenvalues, diagonalization and triangularization, the Jordan Reduction, sequences and series of matrices, linear differential systems, quadratic and Hermitian forms, Euclidean and Hermitian spaces.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. State diagonalization and trigonalization theorems.
2. Recognize quadratic forms and Hermitian forms.
3. Differentiate between a diagonalizable and a trigonalizable matrix.
4. Compute the exponential of a matrix.
5. Apply the exponential of a matrix for linear differential systems.
6. Calculate the Jordan reduction of a matrix.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="7">Steven, R. Advanced linear algebra. Springer, (2014).</td></tr>
<tr><td>References</td><td colspan="7">Hugo J Woerdeman. Advanced linear algebra. Taylor & Francis INC, (2015).</td></tr>
</table>

Course Name	Summer Training				
Program Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hour**	**Prerequisite(s)**
	Math 399	0827399	6	3	83 gained credit hours
Program Track	☐University Requirement ☐ College Requirement ☒Specialized Core ☐ Electives				

Course Description: An internship during the summer of the third year (after the Sixth level) where the student has to spend an average of five hours per day (Minimum 200 contact hours during the internship). The training will be done in a professional workplace on projects related to math and statistics.

Course Outcomes

After the completion of this course, the student will be able to:

1. Remember revelant facts and technologies used in the training place.
2. Demonstrate the contribution of Mathematics in other fields and subjects.
3. Develop mathematical skills and spirit of innovation via practical experience.
4. Enhance student ability to collect, analyze, manipulate data, draw conclusions, and perform error analysis
5. Demonstrate the ability to work independently and in groups including leadership responsibilities.
6. Construct a fruitful relation with co-workers.
7. Communicate comprehensively in writing and orally using proper scientific language.
8. Apply an appropriate software, if needed, to deal with issues based on real life.
9. Write a detailed report including the intern's contribution and action of improvement.
10. Discuss the final report in a seminar

Assessment Policy	**Weekly Reports**	15%	**Evaluation (Training center)**	35%	**Lab**	-	**Project**	-
	Final Report	35%	**Presentation**	15%	**Others**	-		
Textbook	-							
References	-							

<table>
<tr><td>Course Name</td><td colspan="3">Numerical Analysis 2</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="3">Prerequisite(s)</td></tr>
<tr><td>Math-401</td><td>0827401</td><td>7</td><td>3</td><td colspan="3">-Ordinary Differential Equations (0827304)
- Linear Algebra 2 (0827311)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="7">Course Description: This course is designed to provide student with basic understanding of numerical methods for solving initial value problems and boundary value problems for ordinary differential equations, direct methods for solving linear systems, iterative methods for solving linear systems and numerical methods for approximating eigenvalues.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able To :
1. State the basic concepts of numerical linear algebra and numerical methods for ordinary differential equations;
2. Calculate solutions of Initial Value Problems for ordinary differential equations with appropriate numerical method;
3. Calculate solutions of Boundary Value Problems for ordinary differential equations with appropriate numerical method;
4. Calculate solutions of linear systems with direct and iterative methods;
5. Estimate eigenvalues and eigenvectors with appropriate methods;
6. Implement numerical algorithms in a modern scientific programming language.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td></td><td>Quiz</td><td>10%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2">20%</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">Burden R.L., Faires J.D. Numerical analysis. Brooks Cole, 10th Edition, (2016)</td></tr>
<tr><td>References</td><td colspan="6">Wen S. Introduction to numerical computation, World Scientific Publishing, (2015).</td></tr>
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<table>
<tr><td>Course Name</td><td colspan="3">Special Functions</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math-402</td><td>0827402</td><td>7</td><td>3</td><td colspan="2">Calculus 3 (0827205)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="7">Course Description: This course provides basic understanding of Gamma and Beta Functions, Hypergeometric functions, Bessel functions and confluent hypergeometric functions, Orthogonal polynomials (Legendre, Laguerre, Hermit).</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the analytical properties and integral representations of some special functions.
2. Identify the properties of orthogonal polynomials.
3. Apply the definitions of Euler’s fractional integral representation for the Gauss hypergeometric function F.
4. Explain the Barnes approach to the hypergeometric functions.
5. Establish the orthogonality of Bessel functions.
6. Write some functions in series of orthogonal polynomials.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="7">Richard Beals and Doderick Wong. Special function and Orthogonal Polynomials,Cambridge Studies in Advanced Mathematics, (2016) .</td></tr>
<tr><td>References</td><td colspan="7">Freeden W, Gutting M . Special functions of mathematical (geo-)sciences. Birkhäuser, Basel, (2013).</td></tr>
</table>

Course Name	Statistics and Applications					
Course Information	**Course Code**	**Course No.**	**Course Level**		**Credit Hours**	**Prerequisite(s)**
	MATH 403	0827403	7		3	Probability theory (0827310)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives					

Course Description: This course is designed to provide student with understanding of some specific discrete and continuous distributions, central limit theorem, bivariate random variables, distribution of function of random variables and statistical estimation.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions and the fundamental results related to specific distributions and the statistical estimation.
2. Create random variables of specific probability distributions.
3. Write the properties of specific probability distributions.
4. Determine the marginal and conditional distributions
5. Deduce the probability density function of a function of random variables by the appropriate method.
6. Judge the quality of an estimator
7. Estimate parameters by confidence intervals.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**		**Project**	
	Midterm	30%	**Final**	40%	**Others**			
Textbook	Vijay R, and E, Saleh. An introduction to probability and statistics. Wiley Series in probability and statistics, 3rd Edition, (2015)**.**							
References	William M, Beaver, R and B, Beaver. Introduction to probability and statistics, Thomson Brooks/Cole – USA, 14th Edition, (2013)							

Course Name	Complex Analysis				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 404	0827404	7	3	Real Analysis (0827302)
Course Track	☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives				

Course Description: This course is designed to provide the basic knowledge of complex numbers and functions, analytic and harmonic functions, power series representation of analytic and meromorphic functions, Cauchy's theorem, applications of Cauchy's Integral Formula, zeros of Analytic function, Maximum Modulus Principal, singularities, Residue Calculus and its applications.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions, concepts and some fundamental results.
2. Describe the geometric and algebraic representations of complex objects.
3. Test the analyticity and harmonicity of functions.
4. Evaluate complex integrals with a variety of methods.
5. Classify singularities of complex functions.
6. Apply the residues theorem.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	*La*rs Ahlfors. Complex Analysis. TMH, 3rd Edition, (2013).							
References	Dennis G. Zill, Patrick D., Complex Analysis: A First Course with Applications. Hardcover,3rd Edition,(2013).							

<table>
<tr><td>Course Name</td><td colspan="3">Partial Differential Equations</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 405</td><td>0827405</td><td>8</td><td>3</td><td>Ordinary Differential Equations (0827304)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course treats the basic concepts of partial differential equations, Order and linearity of partial differential equations; First order partial differential equations and characteristics, Conservation laws and their weak solutions, Classification of second order partial differential equations and their solutions, Existence and properties of solutions for Laplace, heat and wave equations.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the concept of PDEs
2. Solve first order PDEs with suitable methods..
3. Obtain weak solutions for some first order PDEs.
4. Solve second order PDEs.
5. Analyze the existence and uniqueness of Laplace equation, Heat equation and wave equation.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">J. Robert Buchanan and Zhoude Shao, A First Course in Partial Differential Equations. World scientific publishing Company, (2017).</td></tr>
<tr><td>References</td><td colspan="6">W. A. Strauss, Partial Differential Equations: An Introduction. John Wiley & Sons, 2nd Edition, (2008)</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Number Theory</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math-406</td><td>0827406</td><td>8</td><td>3</td><td>Group Theory (0827203)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: This course is designed to study integers, divisibility, representation of integers, prime numbers, linear Diophantine equations, and systems of equations defined by congruence, Chinese remainder theorem, Wilson and Fermat theorem.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Define divisibility, congruence, arithmetical functions, and quadratic residues.
2. Recognize quadratic fields and their applications.
3. Prove and apply properties of prime numbers and multiplicative functions.
4. Solve linear Diophantine equations.
5. Determine the existence of solutions for quadratic congruence by quadratic residues.
6. Solve Pell equations through of quadratic fields.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2">----</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="5">Harold M. Stark , An Introduction to Number Theory. The MIT Press, (2015).</td></tr>
<tr><td>References</td><td colspan="5">Pete L. Clark, Number Theory: A Contemporary Introduction, Georgia University, (2017).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Research project</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hour</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 407</td><td>0827407</td><td>8</td><td>2</td><td>Completion of 90 hours</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☒ Specialized Core ☐ Electives</td></tr>
<tr><td colspan="6">Course Description: In this course, a selected research project by the faculty member is assigned to the student in order to analyze theoretical research requiring a report containing an appropriate description of the research work.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Collect related topics using library facilities, internet or other information sources.
2. Write a research plan.
3. Investigate the area of interest.
4. Analyze data or gathered results.
5. Compose all ideas in a written report.
6. Apply appropriate software and web resources
7. Discuss results and conclusions in a seminar.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>-</td><td>Quiz</td><td>-</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">40%</td></tr>
<tr><td>Midterm</td><td>-</td><td>Presentation and discussion</td><td>30%</td><td>Others(Research Proposal report assess by the panel)</td><td>30%</td></tr>
<tr><td>Textbook</td><td colspan="7">Mathematical journals, online search, books and reviews</td></tr>
<tr><td>References</td><td colspan="7">-</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Field Extensions</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math-420</td><td>0827420</td><td>7/8</td><td>3</td><td>Group Theory(0827203)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="6">Course Description: This course provides basic knowledge of rings, fields, polynomial rings, irreducible polynomials, splitting field, algebraic and Galois field extension, finite fields and ruler and compass constructions.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the main concepts and theorems for rings and fields.
2. Differentiate between specific elements of a field extension.
3. Describe the nature of the field extension.
4. Compare structures of Galois groups.
5. Calculate the Galois group of a field extension.
6. Apply the Primitive element theorem for field extensions.
7. Analyze the hypotheses of a given problem.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="7">Ian Stewart. Galois Theory. Apple Academic Press INC, 4th Edition, (2015).</td></tr>
<tr><td>References</td><td colspan="7">Mohamed Ayad. Galois Theory and Applications, Solved exercises and Problems. World Scientific Publishing Co Pte Ltd, (2018).</td></tr>
</table>

<table>
<tr><td>Course Name</td><td colspan="3">Combinatorics</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hour</td><td>Prerequisite(s)</td></tr>
<tr><td>Math421</td><td>0827421</td><td>7/8</td><td>3</td><td>Discrete Math(0827303)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="6">Course Description: This course provides basic knowledge of counting, Graphs, Generating functions, Recurrence relations, the method of characteristic roots, Equivalence relations, Group action, coloring, finite fields, coding theory.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Apply elementary techniques to simple combinatorial problems.
2. Apply generating functions methods to some combinatorial questions, including (in some cases) the problem of finding a formula for a sequence when given a recurrence relation.
3. Apply the principle of Inclusion-Exclusion to a variety of problems.
4. Calculate a sequence with its generating function.
5. Compare different methods of counting.
6. Compute the probability of an event.
7. Analyze the nature of a graph.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2"></td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">Walter D. Wallis and John C. George. Introduction to Combinatorics. CRC Press, Taylor & Francis group, 2nd (2017).</td></tr>
<tr><td>References</td><td colspan="6">Robin Wilson. Combinatorics, A very short Introduction. Oxford University Press, (2016).</td></tr>
</table>

Course Name	Functional Analysis				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math-422	0827422	7 /8	3	Measure theory (0827307)
Course Track	☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives				

Course Description: This course provides basic knowledge of metric spaces, Banach spaces, Linear bounded operators, Inner product spaces, Open mapping theorem, Closed range theorem and Hilbert spaces.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions and concepts related to metric, normed, Hilbert spaces and linear operators.
2. Identify the compact sets in metric spaces and finite dimensional spaces.
3. Apprize the important properties of finite dimensional normed spaces, Hilbert spaces and linear bounded operators.
4. Analyze the relationships between topological normed, metric, inner product spaces.
5. Apply Arzela-Ascoli, Hahn Banach, Uniform boundedness, open mapping and closed range theorems.

Assessment Policy	**Assignment**	20%	**Quiz**	10%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Muscat,J. Functional Analysis: An introduction to Metric spaces, Hilbert spaces and Banach spaces. Springer, (2014).							
References	Rudin,W: Functional Analysis . McGraw-Hill Education, (1991).							

Course Name	Fourier Analysis and applications							
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**			
	Math 423	0827423	7/ 8	3	Measure theory (0827307)			
Course Track	☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives							

Course Description: This course introduces the Fourier Transform (FT) of functions in L^1 and L^2, and their convolution. Some density theorems are needed to compute FT in L^2; in particular, Schwarz spaces will play a fundamental role in this study. Techniques of FT will be applied to solve some partial differential equations.

Course Outcomes

After the completion of this course, the student will be able to:

1. List basic concepts of Lebesgue measure on IR and L^p-spaces.
2. Recall basic concepts of L^p(IR) with some fundamental examples.
3. Analyze the Fourier transform (FT) and the inverse Fourier transform (IFT) in both L^1(IR) and the Schwarz space.
4. Apply the Plancherel Formula and Parseval Formula.
5. Solve some partial derivative equations using FT or IFT on L^1(IR) or L^2(IR)

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Anders Vretblad. Fourier Analysis and Its Applications. Graduate Texts in Mathematics 223, Springer, (2008).							
References	Loukas Grafakos. Classical Fourier analysis. Graduate Texts in Mathematics 249, Springer , (2003).							

Course Name	Differential Geometry				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 424	0827424	7/8	3	Analysis of several variables (0827309)
Course Track	☐ University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives				

Course Description: The course deals with curves, surfaces in plane, space with various notions of curvature using exterior differential calculus and knowledge of Riemannian geometry in higher dimensions concentrating in three main parts: curves, surfaces and geodesic.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic notions of the local theory of space curves, and the local theory of surfaces.
2. Recognize the concepts of Geometry of Surfaces and manifolds.
3. Calculate curvature and arc length**.**
4. Apply first and second fundamental forms.
5. Evaluate the principal curvatures, the mean curvature, and Gauss curvature of a given surface.
6. Develop the Gauss map notion.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	M. P. doCarmo. Differential Geometry of Curves and Surfaces. Prentice-Hall, Saddle River NJ, 1976. Revised edition, (2016).							
References	Kuhnel ,W. Differential geometry, curves - surfaces –manifolds. AMS, 3rd edition, (2015)							

Course Name	Euclidean and Non Euclidean Geometry				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math-425	0827425	7/8	3	Logic and Set Theory(0827201)
Course Track	☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives				

Course Description: This course examines the five groups of axioms, their compatibility and mutual independence. It Introduces non Euclidean Geometry and makes a comparison of Hyperbolic and Euclidean properties.

Course Outcomes

After the completion of this course, the student will be able to:

1. Recognize the five categories of axioms.
2. Recall some properties of the hyperbolic geometry (non-Euclidean) of Bolyai-Lobachevsky**.**
3. Construct some models for an axiomatic system
4. Apply the axioms of Euclidean and Hilbert geometries
5. Prove independence of Axioms.
6. Solve some classical problems of non-Euclidean Geometry.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Matthew,H. Geometry Illuminated: An Illustrated Introduction to Euclidean and Hyperbolic Plane Geometry. Mathematical Association of America, (2015).							
References	Edward John Specht, Harold Trainer Jones, Keith G. Calkins, Donald H.Rhoads, Euclidean Geometry and its Subgeometries, Birkhäuser, (2016).							

Course Name	Stochastic processes				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 426	0827426	7/8	3	Probability theory(0827310)
Course Track	☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives				

Course Description: This course provides the basic facts of conditional expectation, Markov chains in discrete time, classification of states, branching processes, Poisson processes, continuous time Markov chains and birth and death processes.

Course Outcomes

After the completion of this course, the student will be able to:

1. State the basic definitions and the fundamental results related to some classes of stochastic processes.
2. Construct a stochastic model for a variety of problems.
3. Apply the method of conditioning and the method of conditional expectation.
4. Apply the method of generating functions.
5. Classify states of a Markov chain.
6. Summarize the properties of Poisson processes.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Lab**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Sheldon M. Ross, "Introduction to Probability Models", Academic Press-Elsevier, 11th Edition (2014).							
References	Mark A. Pinsky and Samuel Karlin. An Introduction to Stochastic Modelling. Elsevier, 4th Edition ,(2011).							

<table>
<tr><td>Course Name</td><td colspan="3">Linear Programming</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math 427</td><td>0827427</td><td>7/8</td><td>3</td><td colspan="2">Linear Algebra 2 (0827311)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="7">Course Description: This course is designed to formulate linear programming models, solve 2-dimension problem by graphical method, understand technics of simplex and dual algorithms to solve any linear program, solve transportation problem, solve linear programming problems by an appropriate software such as: Lindo, Cplex, Matlab, Excel,…, etc.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. Recall basic tools and concepts associated with linear programming problems.
2. Formulate a given simplified description of a suitable real-world problem as a linear programming model.
3. Sketch a graphical representation of a two-dimensional linear programming model.
4. Solve linear programming models in variant fields using the simplex method or graphical method.
5. Design a linear programming model from a transportation problem to minimize the cost.
6. Solve linear programming problems by computer software such as: Lindo, Cplex, Matlab, Excel,…, etc.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td></td><td>Quiz</td><td>10%</td><td>Lab</td><td></td><td rowspan="2">Project</td><td rowspan="2">20%</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td></td></tr>
<tr><td>Textbook</td><td colspan="6">Vanderbei, Robert J.Linear Programming: Foundations and Extensions. Springer, (2014).</td></tr>
<tr><td>References</td><td colspan="6">Alan Sultan. Linear Programming: An Introduction with Applications. Elsevier, (2014).</td></tr>
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<tr><td>Course Name</td><td colspan="3">Financial Mathematics</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 428</td><td>0827428</td><td>7/8</td><td>3</td><td>Probability theory (0827310)</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="6">Course Description: This course establishes the basics of the one-period model, hedging. returns, arbitrage and state prices, complete and incomplete markets, the multi-period binomial model for stock prices and option, and Black-Scholes option pricing formula.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the basics of financial instruments such as stocks, bonds, futures, forwards, options, arbitrage free pricing and hedging.
2. Use the role of risk neutral probability measure and of elementary stochastic analysis in mathematical finance.
3. Apply the binomial model for stock prices, for pricing and hedging European and American type options..
4. Solve problems related to the concepts of the course.
5. Apply mathematical software (MATLAB, Mathematica) to price and hedge financial instruments in discrete time models..</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>-</td><td>Quiz</td><td>10%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">20%</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="5">Ansgar Steland. Financial statistics and mathematical finance: methods, models and applications. John Wiley & Sons, Ltd,(2012).</td></tr>
<tr><td>References</td><td colspan="5">Pliska,S.R. Introduction to Mathematical Finance: Discrete Time Models. Blackwell Publishers Inc, (2002).</td></tr>
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<tr><td>Course Name</td><td colspan="3">Dynamical Systems and Chaos</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td colspan="2">Prerequisite(s)</td></tr>
<tr><td>Math 429</td><td>0827429</td><td>7/8</td><td>3</td><td colspan="2">Ordinary Differential Equations (0827304)</td></tr>
<tr><td>Course Track</td><td colspan="6">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="7">Course Description: This course is designed to provide student with basic understanding of the dynamical systems, existence and uniqueness theorem, phase portrait, stability analysis of fixed points, bifurcation theory, the Smale horseshoe chaos, Melinkov’s method for Homoclonic orbits, Lyapounov exponents, Chaos and strange attractors, applications in biology, electric circuits and physics.</td></tr>
<tr><td colspan="7">Course Outcomes
After the completion of this course, the student will be able to:
1. Recognize the basic definition of dynamical system, Equilibria, stability, bifurcations and chaos.
2. Classify the equilibria of a fixed point for the dynamical systems.
3. Analysis the phase portrait for autonomous systems.
4. Apply the bifurcation theory.
5. Utilize oscillation theory.
6. Examine the chaos and their applications.</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="7">Layek , C,G. An introduction to dynamical systems and Chaos. Springer, (2015).</td></tr>
<tr><td>References</td><td colspan="7">Bhimsen K. Shivamoggi. Nonlinear Dynamics and Chaotic Phenomena: An Introduction. Springer, (2014)</td></tr>
</table>

Course Name	An introduction to the Optimization Theory				
Course Information	**Course Code**	**Course No.**	**Course Level**	**Credit Hours**	**Prerequisite(s)**
	Math 430	0827430	**7**/8	3	Calculus 3 (0827205)
Course Track	☐University Requirement ☐ College Requirement☐Specialized Core ☒ Electives				

Course Description: This course provides the basic facts related to the differentiability of real valued functions, the first and the second order conditions for minimization problems without constraints, the Lagrange multipliers, the KKT conditions for minimization problems of with constraints, the convex optimization, the gradient algorithm, the projection on closed and convex subset and the convergence of the projected gradient method.

Course Outcomes

After the completion of this course, the student will be able to:

1. State and recognize the main theorems related to the optimization theory.
2. Examine the nature of critical points of a real valued function with several variables.
3. Solve constrained optimization problem with Lagrange multipliers theorem.
4. Apply the KKT Theorem to solve optimization problems with constrained inequalities.
5. Prove the convergence of some optimization algorithms.
6. Apply the gradient method and the projected gradient for some optimization problems.

Assessment Policy	**Assignment**	10%	**Quiz**	20%	**Quiz**	-	**Project**	-
	Midterm	30%	**Final**	40%	**Others**	-		
Textbook	Chong, E.K.P. and Zak, S.H. An Introduction to Optimization. New York: John Willey & Sons, 4th Edition, (2013).							
References	Bertsekas, D.P. Nonlinear programming. Massachuset: Athena Scientific, 3th Edition, (2016).							

<table>
<tr><td>Course Name</td><td colspan="3">Evolution of Mathematics</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Course Information</td><td>Course Code</td><td>Course No.</td><td>Course Level</td><td>Credit Hours</td><td>Prerequisite(s)</td></tr>
<tr><td>Math 431</td><td>0827431</td><td>7/8</td><td>3</td><td>-</td></tr>
<tr><td>Course Track</td><td colspan="5">☐University Requirement ☐ College Requirement ☐ Specialized Core ☒ Electives</td></tr>
<tr><td colspan="6">Course Description: This course gives a survey of all Mathematical concepts/theorems made by savants in Medieval Islam, Solve Problems from Medieval Islam requiring mathematical modelling and Impact of Mathematics in medieval Islam on Engineering.</td></tr>
<tr><td colspan="6">Course Outcomes
After the completion of this course, the student will be able to:
1. State the main contribution of Islamic savants in mathematics
2. Describe the evolution of concepts in mathematics
3. Model problems from Medieval Islam until now
4. Interpret rhetoric text in mathematics using modern symbols
5. Solve problems issued on medieval Islam</td></tr>
<tr><td rowspan="2">Assessment Policy</td><td>Assignment</td><td>10%</td><td>Quiz</td><td>20%</td><td>Lab</td><td>-</td><td rowspan="2">Project</td><td rowspan="2">-</td></tr>
<tr><td>Midterm</td><td>30%</td><td>Final</td><td>40%</td><td>Others</td><td>-</td></tr>
<tr><td>Textbook</td><td colspan="6">Roshdi Rashed. Encyclopedia of the history of Arabic Science, Volume 2: Mathematics and the physical sciences. Taylor & Francis e-Library , (2009).</td></tr>
<tr><td>References</td><td colspan="6">Berggren J.L., .Episodes in the Mathematics of Medieval Islam, Berlin, Heidelberg, New York: Springer, 2nd Edition, (2016).</td></tr>
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