Faculty of Science
Department of Mathematics

Study Plan for
Bachelor Degree in Mathematics

2016/2017

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Vision, Mission, Goals

Vision

The Mathematics Program at Yarmouk University seeks to advance knowledge in the field of theoretical and applied Mathematics, and develop its use to suit the needs of the community.

Mission

To prepare qualified graduates to meet the distinct needs of the local and regional community in Mathematics. The department provides its students with the principles of knowledge, scientific and logical thinking, and research skills in various Mathematics fields.

Goals

The goals of the Mathematics program is to

1. Provide an excellent level of education and teaching in undergraduate level.
2. Prepare graduates and cadres majoring in Mathematics, in order to contribute to distinctive services and community development.
3. Provide the society with qualified graduates who are able to teach Mathematics in all the different teaching stages.
4. Enrich highly qualified students with the essential learning needs to be able to complete their graduate studies.
5. Enhance researchers to keep up with scientific advances with regard to Mathematics locally and globally.
6. Train students on the methods of scientific research and problem solving.
7. Supply the community with advisory and training services with respect to various aspects of Mathematics.
8. Meet the needs of other academic University Departments with service courses that fit with their specialties.

Accreditation Criteria in Mathematics

According to the Regulations of the Higher Education Accreditation and Quality Assurance Commission

A. Obligatory Theoretical Fields

Field of Knowledge	Course Code	Course Name	Credits
Pure MATH.: Mathematics Foundation, Modern Algebra, Linear Algebra, Number Theory, Real Analysis, Complex Analysis, Geometry, Topology. **(At least 30 Credits)**	MATH 101	Calculus I	3
	MATH 102	Calculus II	3
	MATH 201	Intermediate Analysis I	3
	MATH 202	Intermediate Analysis II	3
	MATH 241	Linear Algebra I	3
	MATH 251	Set Theory	3
	MATH 261	Euclidean Geometry - A Modern Approach	3
	MATH 311	Real Analysis I	3
	MATH 312	Complex Analysis I	3
	MATH 342	Abstract Algebra I	3
	MATH 343	Number Theory	3
	MATH 362	Topology I	3
	Total Credits		**36**
Applied MATH.: Principles of Applied Mathematics, Ordinary Differential Equation, Partial Differential Equation, Numerical Analysis, Mathematics Modeling **(At least 21 Credits)**	MATH 203	Ordinary Differential Equations I	3
	MATH 204	Special Functions and Fourier Analysis	3
	MATH 281	Linear Programming and Game Theory	3
	MATH 301	Partial Differential Equations I	3
	MATH 321	Numerical Analysis I	3
	MATH 421	Numerical Analysis II	3
	MATH 483	Combinatorial Mathematics	3
	Total Credits		**21**
Statistics and Probability: Principles of Statistics, Mathematics Statistics, Applied Statistics, Theory of Probability. **(At least 12 Credits)**	STAT 101	Introduction to Statistics I	3
	STAT 111	Introduction to Probability I	3
	STAT 201	Introduction to Statistics II	3
	STAT 211	Introduction to Probability II	3
	Total Credits		**12**

B. Supporting Fields

Field of Knowledge	Course Code	Course Name	Credits
(At least **6** Credits in Computer Science and Physics)	PHYS 101	General Physics I	3
	CS 110	Programming in Selected Language	3
	Total Credits		**6**

C. Practical Courses

Field of Knowledge	Course Code	Course Name	Credits
(Not more than **3** Credits in the Specialty Field)	MATH 291	Mathematics Software Packages	1
	MATH 491	Programming in Selected Language	1
	Total Credits		**2**

Study Plan for the Bachelor Degree in Mathematics

The Department of Mathematics at Yarmouk University offers a Bachelor Degree upon the completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the Bachelor Degree at Yarmouk University *No.* (2) / year 1991 and its amendments issued in accordance with the bylaws of awarding academic degrees and diplomas at Yarmouk University *No.* 76 for the year 1976.
2. **University Requirements** stated under the above regulations (27 Credit Hrs.)

   a) **Obligatory Courses** (12 Credit Hrs.):

Table (1): Obligatory University Requirements

No.	Course Code	Course Name	Credit Hours
1.	P.S. 102	National Education	3
2.	MILT 100	Military Science	3
3.	AL 101	Arabic Language (1)	3
4.	EL 101	English Language	3
	EL 099	English Language Skills	Remedial course
	AL 099	Arabic Language	Remedial course
	COMP 099	Computer Skills	Remedial course
	Total		**12**

   b) **Elective Courses** (15 Credit Hrs.) to be chosen from the following courses.

Table (2): Elective University Requirements

Humanities Courses			
No.	**Course Code**	**Course Name**	**Credit Hours**
1.	HUM 101	Media Culture	3
2.	HUM102	Citizenship and Belonging	3
3.	HUM 103	Islam Thought and Civilization	3
4.	HUM 104	Art and Behavior	3
5.	HUM 105	Jordan\s Contribution to Human Civilization	3
6.	HUM 106	Introduction to the Study of Human Cultures	3
7.	HUM 107	Human Rights	3
8.	HUM 108	Thinking Skills	3

Scientific Courses			
1.	SCI 101	Environment and Public Health	3
2.	SCI 102	Information Technology and Society	3
3.	SCI 103	Physical Fitness for All	3
4.	SCI 104	Communication Skills	3
5.	SCI 105	Renewable Energy	3
6.	SCI 106	Administration and Society Development	3
7.	SCI 107	Scientific Research	3

3. **Faculty of Science Obligatory Requirements** (21 Credit Hrs.):

Table (3) Faculty of Science Requirements

No.	Course Code	Course Name	Credit Hours
1.	MATH 101	Calculus I	3
2.	PHYS 101	General Physics I	3
3.	CHEM 101	General Chemistry I	3
4.	BIO 101	General Biology I	3
5.	STAT 101	Introduction to Statistics I	3
6.	EES 101	General Geology I	3
7.	CS 110	Programming in Selected Language	3
	Total		**21**

4. **<u>Department Requirements</u>**

I. Single Major (86 Credit Hrs.):

Obligatory Courses (71 Credit Hrs.)	MATH 102, MATH 201, MATH 202, MATH 203, MATH 204, MATH 241, MATH 251, MATH 261, MATH 281, MATH 291, MATH 301, MATH 311, MATH 312, MATH 321, MATH 342, MATH 343, MATH 362, MATH 411, MATH 421, MATH 442, MATH 483, MATH 491. STAT 111, STAT 201, STAT 211.
Elective courses (15 Credit Hrs.): (At least 9 Credit Hrs. of 400 level) selected from the following courses.	MATH 341, MATH 351, MATH 352, MATH 361, MATH 381, MATH 382, MATH 401, MATH 403, MATH 412, MATH 413, MATH 445, MATH 451, MATH 462, MATH 463, MATH 492.

Table (4): Single Major Credit Hours

Requirements	Obligatory	Elective	Total
University	12	15	27
Faculty	21	-	21
Department	71	15	86
Total	104	30	**134**

II. Major / Minor (86 Credit Hrs.).

(1) Major in Mathematics (65 Credit Hrs.):

Obligatory Courses (65 Credit Hrs.)	MATH 102, MATH 201, MATH 202, MATH 203, MATH 204, MATH 241, MATH 251, MATH 261, MATH 281, MATH 291, MATH 301, MATH 311, MATH 312, MATH 321, MATH 342, MATH 343, MATH 362, MATH 421, MATH 483, MATH 491. STAT 111, STAT 201, STAT 211.
Elective courses No elective courses.	----

(2) Minor (21 Credit Hrs.) to be chosen from any department of the following Faculties: Science, Information Technology and Computer Sciences, Economics and Administrative Sciences and Education, according to the lists of minor course of the selected department.

Table (5): Major / Minor Credit Hour

Requirements	Obligatory	Elective	Total
University	12	15	27
Faculty	21	--	21
Department	65	--	65
Minor	--	--	21
Total	--	--	**134**

III. Minor in Mathematics (21 Credit Hrs.):

Obligatory Courses (15 Credit Hrs.)	MATH 102, MATH 201, MATH 203, MATH 241, MATH 251,
Elective courses (6 Credit Hrs.) selected from the following courses.	MATH 202, MATH 261, MATH 281, MATH 311, MATH 342, MATH 343.

Table (6): The Significance of Second Digit

No.	Title	No.	Title
0	Calculus, Differential Equations	5	Logic, Foundation of Mathematics and History of Mathematics
1	Mathematics Analysis: Real, Complex Analysis, Functional Analysis	6	Geometry, Topology, Graph Theory
2	Numerical Analysis	7	Applied Mathematics
3	----------	8	Control Theory & Dynamical Systems
4	Algebra, Number Theory	9	Mathematics software packages, Research Projects, Seminar, Special Topics

Table (7): Courses offered by the Department of Mathematics for Mathematics Students

No.	Course Code	Course Name	Cr. Hr.	Prerequisites	Note
1.	MATH 101	Calculus I	3	----	old
2.	MATH 102	Calculus II	3	MATH 101	old
3.	MATH 201	Intermediate Analysis I	3	MATH 102	old
4.	MATH 202	Intermediate Analysis II	3	MATH 201	new
5.	MATH 203	Ordinary Differential Equations I	3	MATH 102	old
6.	MATH 204	Special Functions and Fourier Analysis	3	MATH 203	old
7.	MATH 241	Linear Algebra I	3	MATH 101	old

Table (7) To be Continued

8.	MATH 251	Set Theory	3	MATH 102	old
9.	MATH 261	Euclidean Geometry - A Modern Approach	3	MATH 251	old
10.	MATH 281	Linear Programming and Game Theory	3	MATH 241	old
11.	MATH 291	Mathematics Software Packages	1	MATH 102 + MATH 241	old
12.	MATH 301	Partial Differential Equations I	3	MATH 204	old
13.	MATH 311	Real Analysis I	3	MATH 251	old
14.	MATH 312	Complex Analysis I	3	MATH 201	old
15.	MATH 321	Numerical Analysis I	3	MATH 241 + MATH 291	old
16.	MATH 341	Linear Algebra II	3	MATH 241	old
17.	MATH 342	Abstract Algebra I	3	MATH 251	old
18.	MATH 343	Number Theory	3	MATH 251	old
19.	MATH 351	History of Mathematics I	3	MATH 251	old
20.	MATH 352	Fuzzy Sets and its Applications	3	MATH 152 or MATH 251	old
21.	MATH 361	Differential Geometry	3	MATH 201	New, Equivalent to MATH 465
22.	MATH 362	Topology I	3	MATH 251	old
23.	MATH 381	Nonlinear Programming	3	MATH 281	new
24.	MATH 382	Mathematics Modeling	3	MATH 203	old
25.	MATH 401	Partial Differential Equations II	3	MATH 301	old
26.	MATH 403	Ordinary Differential Equations II	3	MATH 203	old
27.	MATH 411	Real Analysis II	3	MATH 311	old
28.	MATH 412	Complex Analysis II	3	MATH 312	old
29.	MATH 413	Functional Analysis	3	MATH 311	old
30.	MATH 421	Numerical Analysis II	3	MATH 321	old
31.	MATH 442	Abstract Algebra II	3	MATH 342	old
32.	MATH 445	Applied Algebra	3	MATH 342	old
33.	MATH 451	History of Mathematics II	3	MATH 251	old
34.	MATH 462	Topology II	3	MATH 362	old
35.	MATH 463	Graph Theory	3	MATH 251	old
36.	MATH 483	Combinatorial Mathematics	3	MATH 251	old
37.	MATH 491	Seminar	1	Department Approval	old
38.	MATH 492	Selected Topics	3	MATH 251	old

Table (8): Courses offered by the Department of Mathematics for Non Mathematics Students

No.	Course Code	Course Name	Cr. Hr.	Prerequisites	Note
1.	MATH 103	Calculus I (for MIS Students)	3	----	old
2.	MATH 141	Applied Mathematics (for Information Technology Students)	3	MATH 101	old
3.	MATH 152	Discrete Mathematics (for Information Technology and Engineering Students)	3	MATH 101	old
4.	MATH 205	Ordinary Differential Equations (for Engineering Students)	3	MATH 102	old
5.	MATH 206	Mathematics for Chemistry Students		MATH 102	old
6.	MATH 212	Engineering Mathematics (for Engineering Students)	3	MATH 205	old
7.	MATH 322	Numerical Analysis (For IT Students)	3	MATH 241 + CS 110	old

Remarks:

- MATH 103 is not a substitute for MATH 101
- MATH 203 is not a substitute for MATH 205
- MATH 205 is not a substitute for MATH 203
- MATH 206 is not a substitute for MATH 201
- MATH 201 is not a substitute for MATH 206
- MATH 141 is not a substitute for MATH 241
- MATH 281 is not a substitute for Stat 278
- MATH 281 is not a substitute for MIS 241
- MATH 322 is not a substitute for MATH 321
- MATH 322 is not a substitute for MATH 421
- MATH 361 is equivalent to MATH 465
- MATH 383 is equivalent to MATH 483
- Stat 278 is not a substitute for MATH 281
- MIS 241 is not a substitute for MATH 281

Table (8): Table of Equivalent Courses

Course Code and No. in the New Plan	Equivalent Course Code and No. in the Old Plan
MATH 101	MATH 101
MATH 102	MATH 102
MATH 201	MATH 201
MATH 202	---
MATH 203	MATH 203
MATH 204	MATH 204
MATH 241	MATH 241
MATH 251	MATH 251
MATH 261	MATH 261
MATH 281	MATH 281
MATH 291	MATH 291
MATH 301	MATH 301
MATH 311	MATH 311
MATH 312	MATH 312
MATH 321	MATH 321
MATH 341	MATH 341
MATH 342	MATH 342
MATH 343	MATH 343
MATH 351	MATH 351
MATH 352	MATH 352
MATH 361	MATH 465
MATH 362	MATH 362
MATH 381	----
MATH 382	MATH 382
MATH 401	MATH 401
MATH 403	MATH 403
MATH 411	MATH 411
MATH 412	MATH 412
MATH 413	MATH 413
MATH 421	MATH 421
MATH 442	MATH 442
MATH 445	MATH 445
MATH 451	MATH 451
MATH 462	MATH 462
MATH 463	MATH 463
MATH 483	MATH 483
MATH 491	MATH 491
MATH 492	MATH 492 E

Table (8) To be Continued

Course Code and No. in the New Plan	Equivalent Course Code and No. in the Old Plan
MATH 103	MATH 101A
MATH 141	MATH 141
MATH 152	MATH 152
MATH 205	MATH 203E
MATH 206	MATH 206
MATH 212	MATH 212
MATH 322	MATH 322

Suggested Courses Registration for Mathematics Students

First Year

First Semester		**Second Semester**	
Course No.	Credit Hrs.	Course No.	Credit Hrs.
MATH 101	3	MATH 102	3
Obligatory Faculty Course	3	Obligatory Faculty Course	3
Obligatory Faculty Course	3	Obligatory Faculty Course	3
Obligatory University Course	3	Obligatory Faculty Course	3
Obligatory University Course	3	Elective University Course	3
Total	**15**	**Total**	**15**

Second Year

First Semester		**Second Semester**	
Course No.	Credit Hrs.	Course No.	Credit Hrs.
MATH 201	3	MATH 202	3
MATH 203	3	MATH 204	3
MATH 241	3	MATH 251	3
Obligatory University Course	3	MATH 281	3
Obligatory Faculty Course	3	STAT 111	3
Obligatory Faculty Course	3	Elective Department Course	3
Total	**18**	**Total**	**18**

Third Year

First Semester		**Second Semester**	
Course No.	Credit Hrs.	Course No.	Credit Hrs.
MATH 261	3	MATH 312	3
MATH 291	1	MATH 342	3
MATH 301	3	MATH 362	3
MATH 311	3	STAT 201	3
MATH 321	3	Obligatory University Course	3
Elective University Course	3	Elective Department Course	3
Total	**16**	**Total**	**18**

Fourth Year

First Semester		**Second Semester**	
Course No.	Credit Hrs.	Course No.	Credit Hrs.
MATH 343	3	MATH 411	3
MATH 442	3	MATH 421	3
MATH 483	3	MATH 491	1
STAT 211	3	Elective Department Course	3
Obligatory University Course	3	Elective Department Course	3
Obligatory University Course	3	Elective Department Course	3
Total	**18**	**Total**	**16**

Course Description for the Bachelor Degree in Mathematics

(a) Courses offered by the Mathematics Department for Mathematics Students

MATH 101 (Calculus I) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of calculus. The course includes:

Limits and continuity. Derivatives. Rules of differentiation. Tangent and normal lines. Related rates. The mean value theorem of differentiation and its applications, indeterminate forms (0/0,∞/ ∞), vertical and horizontal asymptotes local extrema, concavity, and curve sketching. The definite integral, the fundamental theorem of calculus, the indefinite integral. Applications of the definite integral: Area, solids of revolutions, and volumes using cylindrical shells. The transcendental functions: The general exponential and logarithmic functions.

Course Outcomes

- Be able to evaluate various limit problems both algebraically and graphically.
- Be able to check the continuity of various types of functions.
- Be able to differentiate various types of functions using the differentiation rules.
- Be able to sketch the graph of some functions using differentiation.
- Be able to apply differentiation to solve some optimization problems.
- Be able to find the area of a bounded region and the volume of a solid.

MATH 102 (Calculus II) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of calculus. The course includes:

Hyperbolic functions, inverse functions of trigonometric and hyperbolic functions. Techniques of integration: Integration by parts, trigonometric substitutions, partial fractions, quadratic expressions. Plane curves and polar coordinates, area in polar coordinates. Sequences and infinite series: convergence and divergence, positive term series, alternating series, absolute and conditional convergence, and improper integrals. Power series: Differentiation and integration of power series, Taylor series.

Course Outcomes

- Be able to compute integrals of certain types.
- Be able to evaluate improper integrals.
- Be able to sketch some curves and calculate the area and the length of some polar curves.
- Be able to determine the convergence/divergence of sequences and series.
- Be able to calculate Taylor and Maclaurin series for certain function.
- Be able to find power series representations of a given function and determine their intervals of convergence.

MATH 201 (Intermediate Analysis I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of analysis. The course includes:

Parametric equations, surface of revolution tangent lines. Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$: Lines and planes. Functions of several variables: Limits and continuity. Partial differentiation. Chain rule. Gradient and tangent planes. Extrema of functions of two variables. Lagrange multipliers. Vector-valued functions: The calculus of vector-valued functions. Space curves, curvature, tangential and normal components of acceleration. Quadratic surfaces. Double integrals with applications.

Course Outcomes

- Be able to understand the dot product of two vectors including the cross product of two vectors, surfaces.
- Be able to understand the concept of vector-valued function, differentiation and integration of vector-valued functions.
- Be able to understand limits, continuity, partial derivatives, gradients, tangent planes, normal lines and extrema of functions of several variables.
- Be able to calculate double integrals.

MATH 202 (Intermediate Analysis II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of analysis. The course includes:

Triple integrals in cylindrical and spherical coordinate systems with applications. Jacobian of transformations. Line integrals as integrals of vectors. Green's theorem. Independence of path. Simply connected domains. Parametrized surfaces, surface area, surface integrals, The divergence theorem. Stokes's Theorem, Conservative vector field. Taylor's and Maclaurin Theorems for a function of two variables. Integrals independent of path, Leibniz formula, Bessel function, Gamma and Beta functions. Implicit function theorem.

Course Outcomes

- Be able to evaluate a triple integral.
- Be able to represent rectangular coordinate by cylindrical, and spherical coordinate coordinates.
- Be able to calculate the volume of a given solid by cylindrical and/or spherical triple integral.
- Be able to evaluate line integrals of curves and vector fields.
- Be able to relate divergence and curl to the gradient function and Stokes 'Theorem to curl.

MATH 203 (Ordinary Differential Equations I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of ordinary differential equations. The course includes:

Introduction and classification, solutions of first order differential equations and their applications, (Growth and decay problems and linear motion problems), solutions of higher order linear differential equations and their applications (Spring problem and projectile problems), series solutions of differential equations near ordinary points. Laplace transforms.

Course Outcomes

- Be able to classify differential equations by order, linearity, and homogeneity.

- Be able to solve first order linear differential equations.
- Be able to solve linear equations with higher orders with constant coefficients.
- Be able to use power series to solve differential equations.
- Be able to use Laplace transforms and their inverses to solve differential equations.

MATH 204 (Special Functions and Fourier Analysis) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of special functions and Fourier analysis. The course includes:

Periodic functions, odd and even functions, orthogonal functions, Fourier series on $[-\pi,\pi]$, Fourier series on $[-l,l]$, Fourier sine and Fourier cosine series, convergence of Fourier series, Parseval's identity, Fourier integrals, Fourier transform, Gamma functions, Beta functions, Error Functions, Asymptotic Series of Error Functions, Stirling's Formula, Series solution of differential equations, Legendre polynomials, Leibniz's rule, Bessel functions, Other classes of orthogonal functions and their ODEs.

Course Outcomes

- Be able to demonstrate the principles of orthogonal functions and expansion functions in term of orthogonal functions.
- Be able to apply Fourier series, Fourier integrals, and Fourier transform.
- Be able to investigate the properties of Fourier series, Fourier integrals, and Fourier transforms.
- Be able to find the series solution of differential equations about ordinary and singular points.

MATH 241 (Linear Algebra I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of linear algebra. The course includes:

Systems of linear equations, Gaussian elimination, Matrices and matrix arithmetic. The inverse of a matrix. Determinants, evaluating determinants, properties of determinants, Cramer's rule. Vector spaces, subspaces, linear dependence, bases and dimension, row and column spaces, null space, rank and nullity. Eigenvalues and eigenvectors, diagonalization. Linear transformations, kernel and range.

Course Outcomes

- Be able to do matrix arithmetic.
- Be able to deal with vector spaces and subspaces.
- Be able to understand linear independence, span, and basis.
- Be able to determine eigenvalues and eigenvectors and solve eigenvalue problems.
- Be able to apply principles of matrix algebra to linear transformations.

MATH 251 (Set Theory) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of set theory. The course includes:

Mathematics Logic, methods of proof. The concept of sets, relations, equivalence relation, order relation, functions. Finite and infinite sets, denumerable and non-denumerable sets. Cardinal numbers and their arithmetic. The Schroeder-Bernstein theorem. The axiom of Choice and some of its equivalent forms (especially Zorn's lemma).

Course Outcomes

- Be able to perform basic logical operations and generalize the rules of logic to set theory, relations and functions.
- Be able to determine whether a relation is a function, and identify the function's properties.
- Be able to verify that a given relation is an equivalence relation, and find all equivalence classes.
- Be able to determine whether a given set is finite or infinite, countable or uncountable, denumerable or non-denumerable.
- Be able to perform basic arithmetic operations on cardinal numbers.

MATH 261 (Euclidean Geometry – A Modern Approach) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of Euclidean geometry. The course includes:

Axiomatic systems, consistency, independence, completeness, categoricalness, finite geometries, incidence geometry, neutral geometry, Euclidean geometry of the plane, parallel postulate, similarity, results concerning triangles, projective geometry, hyperbolic geometry, elliptic geometry, asymptotic triangles, amplitude of parallelism, Saccheri and Lambert quadrilaterals.

Course Outcomes

- Be able to understand some results in finite geometries like Veblen and Bussey and Bruck and Ryser and others.
- Be able to understand the concepts of the sum of measures and angles of triangle in the basic three geometries.
- Be able to understand Saccheri quadrilaterals.
- Be able to understand Lambert quadrilaterals.

MATH 281 (Linear Programming and Game Theory) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of linear programming. The course includes:

Introducing LPs and putting real life problems in LP form. Solving LPs: The corner method, Simplex method. Artificial variables: Big M method, the two Phase methods. Special cases and sensitivity analysis I. Matrix form of Simplex method. Dual LP: introduction and its solution via the original one, dual-simplex method. Sensitivity analysis II and integer LPs. Applications: Transportation problems: introduction and solving as an LP. The northwest corner rule, least cost method and Vogel's method. Assignment problems. Networks. Game theory: Introduction and examples, Principle of decision making, Saddle points and applications.

Course Outcomes

- Be able to formulate and solving LPs.
- Be able to use computer programs to solve LPs.
- Be able to deal with modifications of a given LP.
- Be able to understand transportation and assignment problems.
- Be able to understand the concepts of game theory.

MATH 291 (Mathematics Software Packages) (1 Credit Hours)

This course aims to familiarize students with the basic concepts of Mathematics Software Packages. The course includes:

Introduction to Mathematics Softwares: Matlab, Mathematics, and Maple, commands in Maple to solve elementary problems in Calculus and Linear Algebra that include vectors, matrices, basic functions, and basic operations. Programming in Maple including loops and conditions. Plotting in 2-D and 3-D, solving linear systems, commands in Maple to solve Mathematics symbolic Calculus and Linear Algebra problems. Building up symbolic manipulation and programming in Maple.

Course Outcomes

- To be familiar with some of Mathematics Softwares.
- Be able to apply the proper commands to solve problems in calculus and linear algebra by Maple Packages.
- Be able to use proper commands to solve some differential equations.
- Be able to use the plot commands and give some properties for the 2-D and 3-D plots.

MATH 301 (Partial Differential Equations I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of partial differential equations. The course includes:

Review to ordinary differential equations, Boundary value problems and Sturm-Liouville problem, Integral transforms (Laplace Transformation, Fourier sine transformation, Fourier cosine transformation, and Fourier transformation), The concept of partial differential equations (The classification of partial differential equations into linear and nonlinear PDEs), The classification of the PDEs based on their order), The classification of the second order linear PDEs into Hyperbolic, Elliptic, and Parabolic, The concept of the steady state solutions, The derivation of the heat equation, The heat problem on one dimension (on finite, semi-infinite, and infinite domains), The heat problem with advection, The heat problem on a plat (the heat problem on rectangular domains), The wave equation and its derivation, The wave equation on a finite domain (finite string), The wave equation on the space (D'Alembert solution), The Laplace equation on a rectangular domain, The Laplace equation on a disk (the Dirichlet Problem), An introduction of solving first order linear partial differential equations, Some selected topics.

Course Outcomes

- Be able to solve some different second order partial differential equations on different domains with different boundary conditions.
- Be able to solve some first order partial differential equations.
- Be able to understand some applications of partial differential equations

MATH 311 (Real Analysis I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of real analysis. The course includes:

Order properties of real numbers, the completeness properties of the real numbers, and main properties of Euclidean spaces; Metric spaces- Analysis point of view: definition of a metric, the concepts of neighborhood, limit points, interior points, open sets, closed sets, perfect sets,

closure of a set, compact sets and their elementary properties including Hine-Boreal theorem, finite intersection property, and the main characterization of compact sets in Euclidean spaces, connected sets with concentration on Euclidean spaces, Bair's category theorem; Sequences which includes Limit of sequences, subsequences and subsequential limits, Cauchy sequences, Monotone sequences (in $\Re$), upper and lower limits; Continuity: Limits of functions, continuous functions, continuity and compactness, uniform continuity, continuity and connectedness, monotonic functions, convex functions, and extension theorems; Differentiation on IR: Mean Value theorems on IR, continuity of derivatives, Taylor's theorem and real analytic functions, and differentiations of vector valued functions; Riemann Stieltjes Integral and its existence.

Course Outcomes

- Be able to identify the topological structure of the real line with the usual topology.
- Be able to use density property of rational numbers.
- Be able to identify Cauchy sequences.
- Be able to determine the limit of a given function at a certain point using sequences.
- Be able to understand the structure of functions on compact intervals of the real line.
- Be able to state and prove the max-min theorem.
- Be able to state and prove Cauchy mean value theorem.

MATH 312 (Complex Analysis I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of complex analysis. The course includes:

Complex Numbers-Sums and Products, Algebraic properties, Moduli and Conjugates, Triangle inequality, Polar coordinates and Euler's Formula, Product and quotients in exponential form, Roots of complex numbers, and Regions in the complex plane; Analytic Functions-Functions of a complex variables, Mappings, Limits, Theorems on limits, Limit at infinity, Continuity, Derivatives, Differentiation formulas, Cauchy-Riemann equations, Sufficient conditions for differentiability, Polar coordinates, Analytic functions, Reflection principle, Harmonic functions; Elementary Functions: The exponential function, Trigonometric functions, Hyperbolic functions, Logarithmic function and its branches, Some identities involving logarithms, Complex exponents, Inverse trigonometric and hyperbolic functions; Integrals-Complex valued functions, Contours, Contour integrals, Antiderivatives, Cauchy-Goursat Theorem, Simply and multiply connected domains, Cauchy Integral formula, Derivatives of analytic functions, Liouville's theorem and the fundamental theorem of algebra, Maximal moduli of functions; Series-Convergence of sequences and series, Taylor series, Laurent series, Absolute and uniform convergence of power series, Integration and differentiation of power series, Uniqueness of series representations, Multiplication and division of power series.

Course Outcomes

- Be able to manipulate and calculate with complex numbers, complex functions (polynomials, rational functions, exponential and trigonometric functions) and multi-valued functions (argument, logarithm and square root).
- Be able to compute the limit of a complex function at a point
- Be able to define and compute the derivative of a complex function.
- Be able to derive the Cauchy-Riemann equations for a complex differentiable.

- Be able to evaluate complex path integrals and state and prove properties of such integrals.
- Be able to determine if an infinite series of complex numbers is convergent.

MATH 321 (Numerical Analysis I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of numerical analysis. The course includes:

Round off errors, computer arithmetic, and convergence, Numerical solutions of equations in one variable, Interpolating and polynomial approximation, numerical differentiation and integration.

Course Outcomes

- Be able to work with computer algebra systems, particularly Maple, to solve problems numerically.
- Be able to developing an appreciation for the applicability of the Mathematics theorems and rules to the real world.
- Be able to use numerical analysis to solve problems from Physics and Chemistry.
- Be able to compare between numerical methods.
- Be able to develop an appreciation for numerical analysis.

MATH 341 (Linear Algebra II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of linear algebra. The course includes:

Inner product spaces, Orthogonality, Eigenvalues and eigenvectors and diagonalization, Hermitian, unitary, normal and positive definite matrices. Matrix representations of linear transformation. Change of basis, similarity, characteristic and minimal polynomials of a linear operator. Cayley-Hamilton theorem. Gram-Schmidt orthogonalization process. Normal, orthogonal and unitary operators. Jordan and rational canonical forms of matrices. Linear functionals and the dual spaces.

Course Outcomes

- Be able to do matrix arithmetic and analysis.
- Be able to deal with inner product spaces.
- Be able to determine eigenvalues and eigenvectors and solve eigenvalue problems.
- Be able to determine the Jordan and rational canonical form of a linear transformation.

MATH 342 (Abstract Algebra I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of abstract algebra. The course includes:

Binary operations. Groups, subgroups, cyclic subgroups and direct product of groups. Permutation groups. Cyclic groups. Group homomorphism and isomorphism. Classification of cyclic groups. Cosets and Lagrange's theorem. Normal subgroups and factor groups. The fundamental theorem of group homomorphism.

Course Outcomes

- Be able to understand basic concepts of groups, subgroups, and order of an element in finite groups.
- Be able to understand the concept of cosets of a subgroup of a group and normal subgroups.
- Be able to understand symmetric groups, cyclic groups and their properties.
- Be able to understand the concept of group homomorphism and isomorphism.
- Be able to understand how to construct proofs to groups theory related problems.

MATH 343 (Number Theory) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of number theory. The course includes:

Unique factorization in Z. Linear Diophantine equations. Congruences. Linear congruences. Fermat's, Euler's and Wilson's theorems. Euler's function. The divisors of an integer. Perfect numbers. Quadratic congruences. (Statement of) the quadratic reciprocity law. Pythagorean triplets. Infinite descent and the case n = 4 of Fermat's last theorem. Sums of two and of four squares. Pell's equation.

Course Outcomes

- Be able to compute the greatest common divisor and the least common multiple.
- Be able to solve linear Diophantine equations.
- Be able to apply Fermat, Euler and Wilson theorems.
- Be able to solve quadratic congruences.
- Be able to deal with Pell's equation.

MATH 351 (History of Mathematics I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of the history of Mathematics. The course includes:

A brief historical introduction of ancient Mathematics (Indian, Egyptian, Babylonian). Greek Mathematics: The school of Pythagoras, Euclid and his system of axioms. A brief biography of selected Greek Mathematics as Pythagoras, Euclid, Archimedes, Ptolemy, etc. Mathematics of the world of Islam, its main contributions and salient characteristics. A concise biography of selected Arab and Moslem Mathematics as Al-Khwarizmi, Thābit ibn Qurra, Omar Al-Khayyam, and Al-Biruni etc., along with selected topics from their writings, such as the Algebra of Al-Khwarizmi, the determination of Qibla of Al-Biruni, and Al-Khayyam's geometric method of solving cubic equations.

Course Outcomes

- Be able to describe the Mathematics of various different civilizations (Indian, Egyptian, Babylonian, Islamic era).
- Be able to recognize the use of Mathematics, and how the historical and environmental conditions of those civilizations affected and were affected by Mathematics.
- Be able to recognize the development of Mathematics from early civilizations era to the twelfth century.
- Be able to learn how to solve some of the Mathematics problems in the way they were solved by the ancients.
- Be able to understand some Mathematics of the Islamic era and concentrate on the contributions of the Arabs and Muslims Mathematics.

MATH 352 (Fuzzy Sets and Applications) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of fuzzy sets and applications. The course includes:

Fuzzy Sets, Operations of fuzzy sets, Fuzzy relations and compositions of fuzzy relations, Fuzzy graph and fuzzy relations, Fuzzy numbers and Operations on fuzzy numbers, Fuzzy functions, Fuzzy logic and some applications of fuzzy logic.

Course Outcomes

- Be able to learn the fundamental of fuzzy sets.
- Be able to deal with operations on fuzzy sets.
- Be able to deal with operations on fuzzy relations.
- Be able to deal with some fuzzy functions.
- Be able to deal with fuzzy logic and its applications.

MATH 361 (Differential Geometry) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of differential geometry. The course includes:

Curves, parameterized curves, torsion, Frenet formulas, Arc length, regular curves, Orientation, Regular surfaces, tangent plane, the differential of a map, diffeomorphism, normal vector, the first fundamental form, area, orientation of surfaces, Gauss map, Second fundamental form, Surfaces of revolution, Ruled surfaces.

Course Outcomes

- Be able to compute curvature, torsion, arc length of regular curves.
- Be able to find tangent normal, binormal vectors, osculating, rectifying and normal planes.
- Be able to introduce regular surfaces, tangent planes of regular surfaces.
- Be able to compute the area of a bounded regular surface.
- Be able to introduce the second fundamental form, Gauss map, ruled surfaces.

MATH 362 (Topology I) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of topology. The course includes:

Topology and topological Concepts: Interior, exterior, boundary, cluster point, isolated point, dense, nowhere dense, perfect, Sets: open, closed, clopen, Some topologies on arbitrary set: the discrete and indiscrete, the cofinite and cocountable, the included set (point) and the excluded set (point) topologies, More topologies on the Reals: the left ray, the right ray, the usual (standard, Euclidean) and the Sorgenfrey topologies. Base and subbase. Topologies induced by functions, Product topology (Finite Product), Local base, First and second countable spaces, 0-dimensional spaces, Continuous functions, open and closed function, homeomorphism; Separation axioms: T_i–spaces for i = 0,1, 2, 3, 4 and for i = 1.5, 2.5, 3.5, Regular, completely regular and normal spaces, Sequences in topological spaces: their convergence and accumulation points, sequentially continuous functions.

Course Outcomes

- Be able to understand topological concepts.

- Be able to find all nowhere dense sets in a topological space.
- Be able to find all perfect sets in a topological space.

MATH 381 (Nonlinear Programming) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of nonlinear programming. The course includes:

Review of calculus, gradient, Hessian, Taylor expansion, necessary and sufficient conditions, linear approximation, quadratic approximation, local minimum. Unconstrained optimization, Fibonacci and golden section search, The Hooke and Jeeves search algorithm, the gradient projection, Newton's method. Constrained optimization, equality constraints: Lagrangian optimization (Everett's method), constrained derivatives, and projected gradient methods. Inequality constraints: KKT conditions, quadratic programming, complementary pivot algorithms, separable programming. The general nonlinear programming problem, the cutting plane (Kelly) Algorithm. Geometric programming. Selected application, network programming, introduction to networks, modeling strategies and assumptions for network programs, total unimodularity, matching and assignment problems, shortest paths modeling, Dijkstra's algorithm, maximum flow modeling, Ford-Fulkerson algorithm, max-flow-min-cut Theorem.

Course Outcomes

- Be able to understand the basics of intermediate and advanced calculus.
- Be able to understand different methods of solving unconstrained optimization problems.
- Be able to understand different methods of solving constrained optimization problems.
- Be able to characterize an optimization problem and determine appropriate methods for solving them.
- Be able to solve different types of applied nature form.

MATH 382 (Mathematics Modeling) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of Mathematics modeling. The course includes:

Introduction, Mathematics classification of Models, constraints and terminology on Models, modeling process, population dynamics models for single species, stability analysis of growth models, Fishing management models, scaling variables, bifurcation analysis of the ODE y' = f(y, c); saddle-node, trans critical and Pitchfork bifurcations, models from science and finance, Newton's law of cooling or heating, Chemical Kinetic reactions, modeling by systems of equations, modeling interacting species; model building, different types of interactions models.

Course Outcomes

- Be able to model situations from a variety of settings in differential equations forms ;
- Be able to express and manipulate Mathematics information, concepts, and thoughts using differential equations.
- Be able to solve multiple-step problems using differential equations.
- Be able to extract quantitative data from a given situation, translate the data into differential equations.

MATH 401 (Partial Differential Equations II) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of partial differential equations. The course includes:

Review in MATH 301 (partial differential equations I), The classification of second order linear partial equations and the canonical forms, The Fourier transformation on two and three dimensions, The heat equation in two and three dimensions, First order quasi linear partial differential equations, nonlinear first order partial differential equations, Applications on the first order partial differential equations, Nonlinear reaction-diffusion phenomena with applications, Existence and uniqueness theorem of reaction diffusion equations, The weak and strong maximum principle, The comparison theorem.

Course Outcomes

- Be able to understand how to solve first order partial differential equations.
- Be able to understand some application of the partial differential equations.
- Be able to understand the reaction diffusion models and their applications
- Be able to understand the traveling wave solution of the reaction diffusion model (examples of that are the Fisher's and Burger's Equations).
- Be able to understand the existence theorem, maximum principles and comparison theorem.

MATH 403 (Ordinary Differential Equations II) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of ordinary differential equations. The course includes:

Series solutions of second order ordinary linear differential equations: Review of series solutions near ordinary and singular points, series solution near regular singular points, Bessel's equations,

systems of first order linear order ordinary differential equations: Introduction, review on matrix functions, uncoupled systems, diagonal systems, using diagonalization to solve systems of first order ordinary differential equations, exponential of matrices, the fundamental theorem of linear systems, linear systems in the plane (phase plane portraits), complex eigenvalues, multiple eigenvalues, nonhomogeneous linear systems,

Nonlinear differential equations and stability: Autonomous systems and stability, almost linear systems, the fundamental theorem of nonlinear systems, competing species, Predator-Prey equations, Liapunov's theory for stability, periodic solutions and limit cycles.

Course Outcomes

- Be able to use different approaches to investigate differential equations which are not easily solvable.
- Be able to understand the notions of linearization, equilibrium, stability and having the ability to use the eigenvalue method for autonomous systems on the plane.
- Be able to demonstrate the idea of using Power series solutions of ODE's, the existence of analytic solutions, and Frobenius method.

MATH 411 (Real Analysis II) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of real analysis. The course includes:

Sequences of functions: Convergence and uniform convergence; Approximation theorems (Stone, Weierstrass theorems). Series of functions: Absolute and uniform convergence, Cauchy criterion, Weierstrass M-test, Dirichlet test and Abel test. Differentiation in IR^p: Chain Rule and Mean-Value theorem, inverse and implicit function theorems.

Course Outcomes

- Be able to understand the definition of point-wise convergent, uniform convergent of a sequence of functions.
- Be able to understand the definition of point-wise convergent, uniform convergent of a series of functions.
- Be able to understand some consequences and relation between uniform convergence of a sequence and series of functions continuity, differentiation and Integration.
- Be able to understand the proof and applications of three famous theorems, Weierstrass approximation theorem, Picard's existence theorem, and the Arzela theorem on equicontinuous families of functions.
- Be able to understand the structure of vector fields concerning the differentiability, and how to find the derivative of a given vector field as a matrix.
- Be able to understand the Hessian matrix associated with a vector field.

MATH 412 (Complex Analysis II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of complex analysis. The course includes:

Residues and Poles: Residues, Residue theorems, The three types of isolated singular points, Residues at poles, Zeros and poles of order m, Conditions under which f(z) = 0, Behavior of f(z) near removable and essential singular points. Applications of Residues: Evaluation of improper integrals, improper and definite integrals involving sines and cosines, Indented paths, Integration along a branch cut, Argument principle and Rouche's Theorem. Mapping by Elementary Functions: Linear transformations, the transformation w = 1/z, Linear fractional transformations and an implicit form, Mappings of the upper half plane, Exponential and logarithmic transformations, the transformation w = *sin* z, Square roots of polynomials. Conformal Mapping: Preservation of angles and some properties, Harmonic conjugates.

Course Outcomes

- Be able to classify the type of singularities.
- Be able to determine the order of a given pole.
- Be able to find the residue of a function at certain isolated singularity.
- Be able to use residue theorem to evaluate complex integrals and series that could not be evaluated with the methods of calculus (2).
- Be able to analyze mappings, such as conformal mappings and complex-valued functions of a complex variables.
- Be able to apply the theory of analytic functions to problems in science and engineering.

MATH 413 (Functional Analysis) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of functional analysis. The course includes:

Normed and Banach spaces (Completion, Product and Quotients of normed spaces), Finite dimensional normed spaces and subspaces, Boundedness and continuity of linear functional, The Dual spaces, Inner Product spaces, Hilbert space (orthonormal sets, representation of functional in Hilbert spaces, Hilbert adjoint operator, self-adjoint, Unitary and normal operators).

Course Outcomes

- Be able to understand the definition normed and Banach spaces and some of their properties (Completion, Product and Quotients of normed spaces).
- Be able to differentiate between finite and infinite dimensional normed spaces.
- Be able to understand the definition of linear operators and linear functions on normed spaces and some of their properties, Boundedness and continuity, dual space reflexive space etc.
- Be able to understand the definition of inner product spaces and differentiate between different kinds of bounded linear operators on Hilbert spaces, (Hilbert adjoint operator, self-adjoint, Unitary and normal operators).
- Be able to understand the idea of normal and orthonormal sets in Hilbert spaces and representation of functional.

MATH 421 (Numerical Analysis II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of numerical analysis. The course includes:

Numerical solutions of initial-value problems for ordinary differential equations, iterative techniques in matrix algebra, approximation theory, approximating eigenvalues.

Course Outcomes

- Be able to work with computer algebra systems, particularly Maple, to solve problems numerically.
- Be able to develop an appreciation for the applicability of the Mathematics theorems and rules to the real world.
- Be able to use numerical analysis to solve problems from Physics and Chemistry.
- Be able to compare between numerical methods.
- Be able to derive numerical methods for various Mathematics operations and tasks, such the solution of linear system, least square approximation and the solution of differential equations.

MATH 442 (Abstract Algebra II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of abstract algebra. The course includes:

Rings, integral domains and fields. Some non-commutative examples. The field of quotients of an integral domain. Ideals and quotient rings. Prime and maximal ideals. Homomorphisms of rings. The fundamental theorem of ring homomorphism. Rings of polynomials. Division algorithm, ideal structure and unique factorization in the ring of polynomials over a field. Principal ideal domain and unique factorization domains. Euclidean domains and the ring of Gaussian integers. Field extensions. Algebraic elements and their irreducible polynomials.

Course Outcomes

- Be able to understand the definition of a ring, integral domains and fields.

- Be able to understand the ideals and the quotient rings. Prime and maximal ideals.
- Be able to understand polynomials, the division algorithm, principal ideal domains.
- Be able to understand ring homomorphisms.
- Be able to apply theorems from abstract systems to particular cases.

MATH 445 (Applied Algebra) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of applied algebra. The course includes:

Boolean Algebras: Propositional Logic, Switching Circuits, Posets and Lattices, Transistor Gates.

Groups: Symmetries, Dihedral Groups, Action of a group on a set. Symmetry groups in three Dimensions, Translations and the Euclidean Group. Polya–Burnside Method of Enumeration: Burnside's Theorem, Necklace Problems. Geometrical Constructions: Duplicating a Cube, Trisecting an Angle, Squaring the Circle, Constructing Regular polygons. Error-Correcting Codes: The Coding Problem, Error Correcting and Decoding.

Course Outcomes

- Be able to do arithmetic in Boolean arithmetic.
- Be able to apply Boolean algebra in solving some circuit problems.
- Be able to use the basics of Number Theory, Abstract Algebra, and counting.
- Be able to demonstrate understanding of Geometrical Constructions.
- Be able to demonstrate some problems in cryptography.

MATH 451 (History of Mathematics II) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of history of Mathematics. The course includes:

Mathematics in the medieval and in the renaissance eras with emphases on the effect of Arab and Muslim Mathematics on Europe in a precise and well documented historical context. Mathematics of the 16th to the 19th centuries through the study of selected Mathematics.

Selected topics from well-known master pieces of the Mathematics literature such as Newton's principia, Laplace's celestial Mechanics etc. A detailed history of selected topics like: Calculus, Number Theory, Group Theory, Ring theory, Field theory, Set theory, Fourier series etc.

Course Outcomes

- Be able to describe the Mathematics of various different civilizations (Islamic era, Indian, European)
- Be able to understand some historical Mathematics of the Islamic era trying to concentrate on the contributions of the Arabs and Muslims.
- Be able to understand the usual subjects of high school Mathematics.
- Be able to learn how the concepts and methods of Calculus and Algebra were invented or discovered.
- Be able to identify some of the important people, events and topics in the history of Mathematics.

MATH 462 (Topology II) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of topology. The course includes:

Connected Spaces: Components and path components, Types of connectedness and their relations : path connected, locally connected, connected ,quasi connected spaces and quasi components, Compactness: Types of compactness: Compact, Countably compact, Lindelof spaces, Bolzano Weirstrass property, The Daraboux property, Compactifications especially the one-point compactification, Metric Spaces: metric topologies, equivalent metrics, Continuity and Uniform continuity, Sequences in metric spaces, Contraction mappings and Fixed Point theorems such as Brouwer Fixed point Theorem, A glimpse of function spaces.

Course Outcomes

- Be able to understand the covering concepts.
- Be able to find some metrics inducing a topological space.
- Be able to find all compactification of a topological space.

MATH 463 (Graph Theory) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of graph theory. The course includes:

Introducing graphs: Basic definitions and examples, isomorphism, degree sequence. Eulerian and Hamiltonian graphs, Diagraphs. Matrix representations. Tree structures. Counting trees. Greedy algorithms, Path algorithms. Paths and connectivity. Planarity. Vertex colourings. Decompositions. Edge colourings. Decompositions.

Course Outcomes

- Be able to understand graph's basics.
- Be able to learning how to use graphs to solve real life problems.
- Be able to deal with algorithms.
- Be able to demonstrate understanding of Vertex colourings. Decompositions. Edge colourings. Decompositions.

MATH 483 (Combinatorial Mathematics) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of combinatorial Mathematics. The course includes:

Permutations and Combinations (deep study), Selections and the binomial coefficients, the pigeonhole principle. The inclusion-exclusion principle, more on counting techniques, Recursions (homogenous and inhomogeneous). Generating functions. Graphs: definition of graphs and subgraphs, Handshaking lemma, examples in graphs, properties of trees, Ramsey numbers, chromatic number, chromatic polynomial, Tutte polynomial.

Course Outcomes

- Be able to do computations in Permutations and Combinations and counting techniques.
- Be able to understand and solve recurrence relations.
- Be able to learn generating functions and how to use them to solve recurrence relations.
- Be able to demonstrate understanding of graphs and the basic ideas.
- Be able to demonstrate understanding chromatic number, chromatic polynomial, Tutte polynomial and Ramsey numbers.

MATH 491 (Seminar) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of Seminar. The course includes:

A certain Mathematics subject chosen by the instructor and not to be part of the courses offered by the Department. The student presents his research in a seminar for discussion and evaluation.

Course Outcomes

MATH 492 (Selected Topics) **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of Selected Topics. The course includes:

Certain Mathematics subjects chosen by the instructor and not to be part of the courses offered by the Department.

(b) Courses offered by the Mathematics Department for other Departments' students in the University

MATH 103 (Calculus I) (for MIS Students**))** **(3 Credit Hours)**

This course aims to familiarize students with the basic concepts of calculus (for MIS Students). The course includes:

Elementary functions. Limits and continuity. Derivatives. Rules of differentiation. Tangent and normal lines. Applications of differentiation: increasing and decreasing functions, extreme values, concavity, and curve sketching. The definite integral, the fundamental theorem of calculus, the indefinite integral. Applications of the definite integral: Area, and volumes. The transcendental functions: The general exponential and logarithmic functions.

Course Outcomes

- Be able to calculate limits for many different functions.
- Be able to use the derivative definition to calculate derivative of some functions.
- Be able to apply the derivative Theorems to find the extreme values for functions of one variable.
- Be able to understand the definition of definite integral.
- Be able to calculate the definite and indefinite integrals of several known functions.
- Be able to use integration by substitution to evaluate integrals, to find the area under a curve and the volume of a solid of revolution.

MATH 141 (Applied Mathematics (for Information Technology Students))

(3 Credit Hours)

This course aims to familiarize students with the basic concepts of applied Mathematics (for Information Technology Students). The course includes:

Logic and Boolean algebra: (Truth tables), Arithmetic progressions, compounding, compound interest, applications, Linear functions (Slope, intercept, application), Linear

systems and their application, Matrix (basics, matrix operation), Applications and case studies in information systems. Linear programming: Formulation of LP. The corners method. The simplex method. Applications.

Course Outcomes

- Be able to do arithmetic in logic.
- Be able to learn how to solve linear systems and know some of their application.
- Be able to deal with Matrices (basics, matrix operations), Applications and case studies in information systems.
- Be able to demonstrate understanding of how to formulate LPs and how to solve them.

MATH 152 (Discrete Mathematics (for Information Technology and Engineering College Students)) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of discrete Mathematics (for Information Technology and Engineering College Students) The course includes:
Logic, Methods of proof, Boolean algebra, Sets, Relations, Functions, ordered relations, Counting principles, Mathematics induction, Recursive relations, Permutations, Graphs and trees.

Course Outcomes

- Be able to implement various methods of proof including direct and indirect proofs, and proofs by induction, in proving a large selection of Mathematics statements.
- Be able to determine whether a relation is a function, and identify the function's properties.
- Be able to verify that a given relation is an equivalence relation, and find all equivalence classes.
- Be able to determine whether a function is one-to-one or onto.
- Be able to understand basic concepts of graph theory.

MATH 205 (Ordinary Differential Equation (for Engineering Students)) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of ordinary differential Equation (for Engineering Students). The course includes:
Introduction and classification, solutions of first order differential equations and their applications, (Growth and decay problems RL-electric circuits and RC-electric circuits), solutions of higher order linear differential equations and their applications (Spring problem, RLC-electric circuits and LC-electric circuits), series solutions of differential equations near ordinary points. Laplace transforms; solving linear differential equations and system of linear differential equations using Laplace transform.

Course Outcomes

- Be able to classify the differential equations.
- Be able to apply the techniques of solving first order differential equations.
- Be able to generate the solution of higher order differential equations with constant coefficients.
- Be able to solve differential equations by using power series.
- Be able to apply principles Laplace transform to find the solution of linear system of differential equations.

MATH 206 (Mathematics for Chemistry Students) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of Mathematics for chemistry students. The course includes:

Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$: Vector algebra, dot product, cross product. Vector calculus. Applications. Functions of several variables: partial differentiation, gradient, extreme-value problems. Applications. Evaluations of double and triple integrals: area, volume, the mass of a plate,…etc. First ordinary differential equations: Linear separable, homogeneous, exact equations. Applications. Second order differential equations: power series method and some other methods. Bessel function. Partial differential equations: separation of variables and some applications. Matrices and linear transformations: matrix algebra, determinants, the eigen-value problem.

Course Outcomes

- Be able to demonstrate the ideas of vectors and matrices. Also, be able to perform the corresponding operations.
- Be able to understand the ideas and the rules corresponding to several variables functions and use them to optimize quantities subject to additional conditions and constraints.
- Be able to solve certain types of ordinary and partial differential equations and use them to express and manipulate life situations.
- Be able to solve ordinary differential equations by using series methods.
- Be able to find matrices determinants and be familiar with matrices properties.

MATH 212 (Engineering Mathematics (for Engineering Students)) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of engineering Mathematics (for Engineering Students). The course includes:

Vector algebra, Dot and cross products, Lines and planes, Vector-valued functions, Curves and arc length, Functions of two and three variables, Partial derivatives, Chain rule, Gradients, Directional derivatives, Tangent lines and tangent planes, Double integrals, Polar coordinates, Area using double integrals, Volumes using double integrals, Triple integrals, Volumes using triple integrals, Cylindrical coordinates and Spherical Coordinates, Line integral, Independence of path, Green's theorem, Surface area, Surface integrals, Divergence theorem and Stoke's theorem, Periodic functions, Fourier series, Even and odd functions, Complex Fourier series, Fourier cosine and Fourier sine transforms, Fourier transform and it's inverse.

Course Outcomes

- Be able to calculate the double and triple integrations.
- Be able to deal with vectors and planes.
- Be able to apply Green’s, divergence, and Stokes Theorems, in solving problems.
- Be able to apply Fourier integrals and Fourier series.

MATH 322 (Numerical Analysis (For IT Students)) (3 Credit Hours)

This course aims to familiarize students with the basic concepts of numerical analysis (For IT Students). The course includes:

Round off errors, computer arithmetic, and convergence, numerical solutions of equations in one variable, Interpolating and polynomial approximation, numerical differentiation and integration, iterative techniques in matrix algebra, approximation theory.

Course Outcomes

- Be able to work with computer algebra systems, particularly Maple, to solve problems numerically.
- Be able to develop an appreciation for the applicability of the Mathematics theorems and rules to the real world.
- Be able to use numerical analysis to solve problems from Physics and Chemistry.
- Be able to compare between numerical methods.
- Be able to write efficient, well-documented Matlab code and present numerical results in an informative way.