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# Course Description

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|---|
| **Course Code:** Math 2240 |
| **Course Title:** Algebra and Analytic Geometry |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Third |
| **Prerequisites:** Math 1060 |

**Course Objectives**

1- To understand the equations of the circle, the line, and conic sections.

2- To understand the logic, sets, relations, and functions.

3- To understand finite and infinite sets and countability.

**Course Contents**

Straight line and circle – Conic sections – General theory of second order curves – Simplifying the general second equation by translation and rotation – Systems of coordinates – Mathematical logic – Statement, Conjunction, Dis-conjunction, Conditional and bi-conditional statement – Existential and universal quantifiers – Negation – Converse, Inverse and contrapositive – Truth tables – Methods of proof – Sets theory – Relations, orderings – Mapping and functions – Countable set – Equivalents sets – Cardinal number – Finite and infinite sets.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Artin M. "Algebra", Englewood Cliffs – NJ: Prentice – Hall, ISBN: 01300476.
2- Strang Gilbert. "Introduction to Algebra", 3rd ed. Wellesley, MA: Wellesley – Cambridge Press, March. (2003), ISBN: 0961408898.
3- Algebraic and Analytic Geometry, Amnon Neeman.

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# Course Description

| |
|---|
| **Course Code:** Math 2250 |
| **Course Title:** Linear Algebra-I |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fourth |
| **Prerequisites:** Math 2240 |

**Course Objectives**

1- Present basic concepts of matrices and matrix algebra.
2- Present methods of solving systems of linear equations.
3- Present basic concepts of vector spaces.
4- Present concepts of linear transformations.
5- Present the concept of and methods of computing determinants.
6- Present methods of computing and using eigenvalues and eigenvectors.

**Course Contents**

Matrix Definition – Matrix Operations – Symmetric Matrices – Transpose and Inverse of a Matrix – Hermitian Matrices – Markov Matrices – Factorization – Positive definite Matrix – Row Operations – Row Reduced Echelon Form – Linear system of Equations – Solving $Ax = 0$ and $Ax = b$ – Vector Spaces and Subspaces – Basis & Dimension – Orthogonality – Similar Matrices – Singular Value Decomposition – Least Squares Approximations – Determinants – Properties of Determinants – Applications of Determinants – Cramer's Rule – Gauss elimination rule – Gauss Jordan Elimination – Eigenvalues and Eigenvectors – Diagonalization – Linear Transformation – Matrices with MATLAB.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Strang Gilbert. "Introduction to Linear Algebra", 3rd ed. Wellesley, MA: Wellesley – Cambridge Press, March (2003), ISBN: 0961408898.
2- Introduction to linear algebra by Gilbert and Howard Anton.
3- Linear Algebra: A Modern Introduction, David Poole.

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# Course Description

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|---|
| **Course Code:** Math 2290 |
| **Course Title:** Mechanics |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fourth |
| **Prerequisites:** Math 1060 |

**Course Objectives**

1- Understanding the physical meaning of many physical problems.
2- Understand the theories and principles of mechanics.
3- Understand in depth the theoretical basis of mechanics.

**Course Contents**

Static: Force as a vector – Vector Algebra – Free-body Diagrams – Coplanar Forces – Couples. Dynamics: Kinematics – Rectilinear Motion – Position Vector – Velocity and Acceleration – Graphical Methods – Relative Motion – Curvilinear Motion – Position Vector – Velocity and Acceleration in 2-D and 3-D – Relative Motion – Applications on Curvilinear Motion. Kinetics: Newton's 2nd Law – Principle of Work and Kinetic Energy – Principle of Impulse and Momentum – Central Force – Impact – Vibrations.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Hibbeler R. C., "Engineering Mechanics: Statics and Dynamics", Upper Saddle River, NJ: Prentice Hall, 2001, ISBN: 0130200069.
2- Introduction to Classical Mechanics: With Problems and Solutions, by David Morin , ISBN 978-0-521-87622-3 hardback. Printed in United Kingdom at the University Press, Cambridge, (2008).
3- Advanced Dynamics by Donald T. Greenwood ISBN10: 0511056214, ISBN13: 9780511056215, Edition/Copyright: 03, (2008).
4- Classical Dynamics of Particles and Systems by Stephen T. Thornton and Jerry B. Marion ISBN10: 0534408966, ISBN13: 9780534408961, Edition/Copyright: 5TH 04.

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# Course Description

| |
|---|
| **Course Code:** Math 2301 |
| **Course Title:** Visual Programming of Mathematical Problems |
| **Credit Hours:** 3(3,0,1) |
| **Level:** Third |
| **Prerequisites:** 1400 TC, Math 1060 |

**Course Objectives**

1- Understand the Basic concepts about the System Development Life Cycle.
2- Become aware about the History and development of Computer Languages.
3- Understand the advantages of GUI in developing applications
4- Develop simple applications using Visual Basic.

**Course Contents**

The course covers the basic programming principles focusing on graphical user interfaces and structured programming techniques. The topics include design interfaces for mathematical applications – Using variables and constants to store information – Input/output operations – Arithmetic Operations – Arithmetic Expressions – Sequential – Selection and repetition programming structure – Arrays Implementation – Function implementation and other related topics. Upon completion, Students should be able to design, code, test and debug Visual programs.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Visual basic2010 how to program, Deitel & Deitel.
2- Simply Visual Basic 2008 (3rd Edition), Paul Deitel.
3- Visual C# 2010 How to Program (4th Edition), Harvey Deitel.

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# Course Description

| |
|---|
| **Course Code:** Math 2311 |
| **Course Title:** Infinite Series and Calculus Applications |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Third |
| **Prerequisites:** Math 1060 |

## Course Objectives

1- Provide students with principles and theories of Infinite series.
2- Increase student ability and skills of problems solving of Infinite series.
3- Train students to practice intellectual skills.

## Course Contents

Sequences and Series – Sequence of real number – Bounded and monotonic sequences – Geometric Sequences – Infinite series – Convergence and Divergence of Infinite Series – Integral Test – Ratio Test – Root Test and Comparison Test. Conditional Convergence and Absolute Convergence – Alternating Series Test – Power Series – Differentiation and integration of power series – Taylor and Maclaurin series – The centroid of a plane region – Moments and center of mass – Work – Power – Energy – Fluid pressure and force – Newton's Method – Linearization and Differentials – Optimization.

**Exercises**: Include problems to cover the entire course contents.

## Suggested Text Books

1- Howard Anton, "Calculus with analytical geometry", John Wiley & Sons, Last Edition.
2- Calculus by Bruce H. Edwards and Ron Larson (Jan 16, 2009)
3- Calculus by Ron Larson (Jan 11, 2005).

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# Course Description

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|---|
| **Course Code:** Math 2321 |
| **Course Title:** Actuarial Mathematics-I |
| **Credit Hours:** 3(3,0,0) |
| **Level:** Fourth |
| **Prerequisites:** Math 1060 |

**Course Objectives**

1- This course aims to understand the basic concepts and principles in the calculation of simple interest.

2- This course aims to understand the basic concepts and principles in the calculation of compound interest.

3- This course aims to identification of investment alternatives and the selection of the best to streamline investment decisions.

**Course Contents**

Introduction and definitions – The general law of simple interest – True and commercial interest – Present value and discount – The sum of annuities – Certain using fixed and variable simple interest rates – Some practical applications on simple interest including methods of redemption of short term loans – Modification of loans and saving accounts. The general law of compound interest: The sum, present values and discount – The nominal rate of compound interest – The calculation of the sum and present value of annuities – Certain with fixed and variable compound rates of interest – Some practical applications on compound interest including methods of redemption of long term loans – Modification of loans and redeemable securities – Investment using software and spread sheets – Insurance – Investment using Excel.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- An Undergraduate Introduction to Financial Mathematics, J. Robert Buchanan, ISBN 981-256-637-6.
2- Robert Cissell and et al (2009), Mathematics of Finance, Houghton Mifflin Company.
3- C. Brown, Mathematics for Finance Second Edition, LEWIS PUBLISHERS.
4- T. T. Song (2005), Fundamentals of probability and Finance for engineering, John Wily and Sons, Ltd. Paul Mac Berthouex and Linfield.

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# Course Description

| | |
|---|---|
| **Course Code:** Math 2450 | |
| **Course Title:** Abstract Algebra -I | |
| **Credit Hours:** 3(3,1,0) | |
| **Level:** Fourth | |
| **Prerequisites:** Math 2240 | |

**Course Objectives**

1- To understand the binary operations and basic properties of groups.

2- To understand the cyclic and abelian groups and group of permutations.

3- To understand the subgroups and normal subgroups and simple groups.

**Course Contents**

Binary Operation – Associative – Commutative – Identity element v Inverse of an element – Fundamental Properties of Groups – Subgroups – Cyclic Groups – Permutation Groups – Symmetry Groups – Group Homeomorphisms and Cayley Theorem – Cosets and Lagrange's Theorem – Quotient Groups – Finite Groups – Normal subgroups and Factor Groups –Abelian Groups – The Isomorphism –Theorems of Groups – Simple Group.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Artin M., "Algebra", Englewood Cliffs, NJ: Prentice- Hall, ISBN: 013004763.
2- Introduction to Abstract Algebra, Jonathan D. H. Smith.
3- First Course in Abstract Algebra – J B Fraleigh – Wesley.
4- Contemporary Abstract Algebra, Gallian JA.

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# Course Description

| |
|---|
| **Course Code:** Math 3240 |
| **Course Title:** Actuarial Mathematics-II |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:**Math 2321 |

**Course Objectives**

1- This course aims to understand the basic financial models.

2- This course aims to understand the basic concepts of taxation and pricing.

3- This course aims solving partial differential equations in finance using Finite Difference methods

**Course Contents**

Review of financial models – Portfolio selection – Taxation – Monte-Carlo simulation and option pricing – Measurement and assessment of financial performance – Risk management – financial analysis and planning – Finite Difference methods for partial differential equations in finance – Time series analysis and parameter estimation – Applications.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- An Undergraduate Introduction to Financial Mathematics, J. Robert Buchanan, ISBN 981-256-637-6. Robert Cissell and et al (2009), Mathematics of Finance, Houghton Mifflin Company.
2- C. Brown, Mathematics for Finance Second Edition, LEWIS PUBLISHERS.
3- T. T. Song (2005), Fundamentals of probability and Finance for engineering, John Wily and Sons, Ltd. Paul Mac Berthouex and Linfield.

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# Course Description

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|---|
| **Course Code:** Math 3260 |
| **Course Title:** Mathematical Programming |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2250 |

**Course Objectives**

1- This course aims to familiarity with the concepts and principles of linear programming.

2- This course aims to Building and solving linear programming models.

3- This course aims to simulate the various administrative and different economic problems to assist in making decisions based on the basis of objective and accurate tools.

**Course Contents**

An introduction to operations research for solving managerial problems and the concept of model building – Polyhedra – Extreme Points – Optimality Conditions – The Simplex Method – The Two phase method – Dual simplex method – Sensitivity Analysis – Shortest Path Problem – Integer Programming Formulations.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Linear Programming and its Applications (2007), Prof. Dr. H. A. Eiselt, Prof. Dr. C.L. Sandblom. ISBN: 978-3-540-73670-7 (Print) 978-3-540-73671-4 (Online).

2- H.A.Taha: Introduction Operations Research 6th edition, London, Macmilla.

3- Shaum's outline series: Operation Research.

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# Course Description

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|---|
| **Course Code:** Math 3270 |
| **Course Title:** Number Theory |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2240 |

**Course Objectives**

1- To understand the number system and Euclid algorithm.

2- To understand the congruence and the theorems of Wilson and Euler.

3- To understand RSA cryptography.

**Course Contents**

Divisibility – Greatest Common Divisor – Division Algorithm – Prime Factorization and Binomial – Binomial Theorem and Congruencies – Congruencies – Residue Systems – Fermat's Little Theorem – Euler's Theorem – Wilson's Theorem – Diophantine Equations – Chinese Remainder Theorem – RSA Cryptography – Solving Equations Modulo Primes – Quadratic Residue Symbol – Quadratic Reciprocity – Continued Fractions – Introduction to Torsion points and Elliptic Curves.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Niven Ivan, Herbert S. Zuckerman and Hugh L. Montgomery, "An Introduction to the Theory of Numbers". New York: Wiley Text Books, ISBN: 0471625469.
2- Introduction to Modern Number Theory, Fundamental Problems, Ideas and Theories, Yuri Ivanovic Manin.
3- Number Theory for Mathematical Contests, David A. SANTOS.

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# Course Description

| |
|---|
| **Course Code:** Math 3280 |
| **Course Title:** Linear Algebra-II |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fifth |
| **Prerequisites:** Math 2250 |

**Course Objectives**

1- Knowing the concepts and Understand the scientific background of Linear Algebra and all operations concern with matrices.
2- Understand the theories and principles of Linear Algebra and solving linear system using matrices, and know the applications methods of Linear Algebra.
3- Understand in depth the theoretical basis of Linear Algebra-II.

**Course Contents**

Vector Spaces: Vector space axioms – Subspace and Span – Linear Combination – Linear independence – Generators – Basis and dimension – Coordinate and change of basis – Rank of a matrix – Linear transformations – Kernel and range – Isomorphism – Matrix of a linear transformation – Similarity and change of basis – Trace – Determinants and permutations – Odd and even permutations – Computation by row and column operations – Cofactor expansion – Eigenvalues and eigenvectors – Diagonalization – Characteristic polynomial – Cayley Hamilton theorem – Jordan canonical form I&II – Symmetric Matrices – Inner Product – Norm – Orthogonal transformations – Congruence – Orthogonal basis – Orthogonal Projections – Isometrics – Spectral theorem – Hermitian Products – Cauchy-Schwarz inequality – Angle between vectors – Gram – Schmidt Processes – Applications of Linear Algebra: Graph Theory – Cryptography – Finding The Equation of a Curve Passing through a Point – Computer Graphics.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Bretscher O., "Linear Algebra with Applications", 5th ed. Published by: Jose guiteerrz on Oct 11, 2013.
2- Strang Gilbert. "Introduction to Linear Algebra", 3rd ed. Wellesley, MA: Wellesley- Cambridge Press, March (2003), ISBN: 0961408898.

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# Course Description

| |
|---|
| **Course Code:** Math 3320 |
| **Course Title:** Multivariable Calculus |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fifth |
| **Prerequisites:** Math 1060 |

**Course Objectives**

1- Effectively write mathematical solutions in a clear and concise manner.
2- Locate and use information to solve calculus problems in several variables.
3- Demonstrate ability to think critically effectively interpreting and using functions of several variables.
4- Demonstrate ability to think critically by recognizing patterns and determining and using appropriate techniques for solving a variety of integration and differentiation problems.
5- Work effectively with others to complete homework and class assignments.
6- Demonstrate the ability to learn a topic through independent study.

**Course Contents**

Coordinate Systems – Multivariable Functions – Partial derivatives – Critical Points of Multivariable Functions – Maxima and Minima of the Functions of Two Variables – SP – Lagrange Multipliers – Double Integrals in Rectangular Coordinates – Double Integrals in Polar Coordinates – Triple Integrals in Rectangular and Cylindrical Coordinates – Spherical Coordinates – Centre of Mass – Moment of Inertia.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- CALCULUS VOLUME II Multi–Variable Calculus and Linear Algebra, with Applications to Differential Equations and Probability SECOND EDITION, John Wiley & Sons New York London Sydney Toronto, C O N S U L T I N G E D I T, O R George Springer, Indiana University, COPYRIGHT 0 1969 BY XEROX CORPORATION.
2- Advanced Calculus and Analysis MA1002, Ian Craw, April 13, 2000, Version 1.3, Copyright 2000 by Ian Craw and the University of Aberdeen.
3- Thomas G., "Calculus", 11th edition, (2002).

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# Course Description

| |
|---|
| **Course Code:** Math 3330 |
| **Course Title:** Ordinary Differential Equations –I |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fifth |
| **Prerequisites:** Math 2250, Math 2311 |

**Course Objectives**

This course is intended to provide students with the knowledge and skills for

1- Understanding analytical methods for solving ODEs.

2- Selecting the suitable method for solving ODEs depending on the type of the equation.

3- Using Laplace transform in solving linear ODEs.

4- Understanding Basics of Fourier series.

**Course Contents**

First Order Equations: Non-Linear Separable – Homogeneous – Exact Equation – Linear Bernoulli's Equation – Direction Fields. Second Order Linear Equations with Constant Coefficients – Homogeneous case – Non-homogeneous Equations via Method of Undetermined Coefficients – Non-homogeneous Equations via Method of Variation of Parameters – Remarks on Higher Order Equations – Linear Independence and the Wronskian – Applications to Forced Oscillation Problems – Effect of Resonances – Application to Constant Coefficient Linear Equations: Laplace Transform – Fourier Series.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Edwards C., and Penney D., "Elementary Differential Equations with Boundary Value Problems", 6th ed. Pearson, 2007, (2007), ISBN 10: 0136006132 ISBN 13: 9780136006138.
2- William Boyce, and Richard C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 10 th ed, John Wiley and Sons, ISBN-13: 978-0470458334, ISBN-10: 047045833X.

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# Course Description

| |
|---|
| **Course Code:** Math 3340 |
| **Course Title:** Ordinary Differential Equations – II |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Sixth |
| **Prerequisites:** Math 3320, Math 3330 |

**Course Objectives**

This course is intended to provide students with the knowledge and skills for

1- Understanding mathematical methods for solving first order ODE system.
2- Understanding mathematical methods for second order ODE with variable coefficients.
3- Understanding mathematical methods for Boundary- Value Problems.
4- Using Frobenious series for solving ODEs about regular singular points.
5- Understanding Basics of Fourier series and using it to solve ODEs.

**Course Contents**

First Order Systems – Conversion of Second and Higher Order Equations to First Order Systems – Differentiation of Vector and Matrix Functions – Solution of Linear Constant Coefficient Systems – Two Dimensional Systems and Phase Plane – Classification of Equilibria for Linear Systems – Singular Points of Linear Second Order ODEs with Variable Coefficients – Frobenius Method – Differential Equations Satisfied by Bessel Functions – Introduction to Boundary – Value Problems – Eigenvalues – Eigen Functions – Orthogonality of Eigen Functions – Sturm-Liouville Problem – Fourier Series – Fourier Sine and Cosine Series – Complete Fourier Series.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Edwards C., and Penney D., "Elementary Differential Equations with Boundary Value Problems", 5th ed. Upper Saddle River, NJ: Prentice Hall, (2003), ISBN: 013145773X.
2- William Boyce, and Richard C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 7th ed, John Wiley and Sons.

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# Course Description

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|---|
| **Course Code:** Math 3350 |
| **Course Title:** Vector Analysis |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Sixth |
| **Prerequisites:** Math 3320 |

**Course Objectives**

1- Acquire knowledge about vectors and scalars
2- Acquire knowledge and skills about the basis and theories of curvature – torsion – Level Curves
3- Apply Green's Theorem, Stokes' Theorem and Divergence Theorem in real world application.
4- The students will acquire the importance of Heat/Diffusion Equation – Maxwell's Equations.

**Course Contents**

Vectors – Dot Product – Cross Product – Parametric Curves – Velocity – Acceleration – arc length – Curvature – Torsion – Level Curves – Partial Derivatives – Tangent Plane – Scalar Field and the Gradient – Directional Derivative – Lagrange Multipliers – Double and Iterated Integrals – Double Integrals in Polar Coordinates – Applications – Change of Variables – Triple Integrals in Rectangular and Cylindrical Coordinates – Spherical Coordinates – Gradient Fields and Path Independence – Conservative Fields and Potential Functions – Green's Theorem – two dimensional Curl (Vorticity) – Simply connected Regions – Flux Form of Green's Theorem – Vector Fields in 3-D-space – Surface Integrals and Flux – Divergence Theorem – Line Integrals in Space – Exactness – Potential – Stokes' Theorem – Conservation Laws – Heat/Diffusion Equation – Maxwell's Equations.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Thomas G., "Calculus", 11th edition, (2002).
2- "Vector Analysis", Wilson Gibbs. J. Willard (Edwin) – 1922.
3- "Multivariable and Vector Analysis", by W. L Chen, Publisher: Macquarie University 2008."Vector Analysis and an introduction to tensor analysis", Murray R. Spiegle – Schaum's Outline Series, McGraw Hill 1959-ISBN 07-060228-X.

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# Course Description

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|---|
| **Course Code:** Math 3370 |
| **Course Title:** Numerical Analysis |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Fifth |
| **Prerequisites:** Math 2250, Math 3330 |

**Course Objectives**

1- The introduction of the basic concepts of the numerical analysis.

2- To learn how to obtain the solution of non – linear algebraic and transcendental equations using numerical methods.

3- To be able to differentiate and integrate functions numerically.

4- To acquire shills to find the solutions of linear, non – linear and system of differential equations.

**Course Contents**

Types of Errors – Interpolation – Numerical Differentiation – Numerical Integration – Solving Algebraic Systems of Equations by Iterations – Root Finding – Solving System of Nonlinear Equations – Methods of Solving First Order Initial Value Ordinary Differential Equations – Converting Higher Order Ordinary Differential Equations to First Order Ones – Solving Systems of First Order Initial Value Ordinary Differential Equations – Finite Differences – Solving Two Point Boundary Value Problems by Finite Differences.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- C.F. Gerald and P.O. Wheatley, "Applied Numerical Analysis (7th Edition), Addison Wesley.
2- Burden, Richard L. and Douglas Faires J., "Numerical Analysis", 7th ed. Belmont, CA: Brooks Cole, (2000), ISBN: 0534382169.
3- Strang Gilbert. "Introduction to Numerical Analysis ", 2rd ed. Wellesley, MA: Wellesley- Cambridge Press, March (2004), ISBN: 0961408898.

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# Course Description

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|---|
| **Course Code:** Math 3460 |
| **Course Title:** Real Analysis-I |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Sixth |
| **Prerequisites:** Math 2240, Math 3320, Math 3330 |

**Course Objectives**

1- Understand the basic concepts of Mathematical Analysis, Sequences & Series and Power Series Representation involving its Derivatives.
2- Concept of Open and Closed Sets, Continuity and Differentiability.
3- Concept of Metric Spaces, Completeness, Compactness and Countability and Riemann Integral.
4- Understand some Standard Theorems like Mean Value Theorem, Taylor's Theorem and Fundamental Theorem of Algebra.

**Course Contents**

Sets and Fields – The Real Numbers – Countability – Metric Spaces – Closed Sets – Compact Spaces – Compact Subsets of Euclidean Space – Completeness – Sequences and Series – Continuity – Continuity and Compactness – Differentiability – Mean Value Theorem – Taylor Series – Riemann-Stieltjes Integral – Integrability – Fundamental Theorem of Calculus – Sequences of Functions – Uniform Convergence – Equicontinuity – Power Series – Fundamental Theorem of Algebra.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Rudin W., "Principles of Mathematical Analysis", 3rd ed. McGraw – Hill Science/Engineering/Math, New York, NY: McGraw – Hill, ISBN: 007054235X.

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# Course Description

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|---|
| **Course Code:** Math 3510 |
| **Course Title:** Mathematical Packages |
| **Credit Hours:** 3(2,1,0) |
| **Level:** Sixth |
| **Prerequisites:** Math 2301, Math 3330 |

**Course Objectives**

1- Acquire knowledge and skills about the basis of Algorithm Development.
2- Familiarity with programming in MATLAB.
3- Apply MATLAB®": in Numerical Calculations.
4- Apply MATLAB®": in symbolic Calculations.
5- Apply MATLAB®": in two and three dimensional plots.

**Course Contents**

Introduction to Mathematical packages – Basics of Matlab – Creating Arrays – and Mathematical Operations with Arrays – Logical Operations with Arrays – Using Script Files and Managing Data – Programming in MATLAB, User-Defined Functions and Function Files. Numerical Calculation: Zeros of Polynomials – Max and Min of a function – Solving systems of linear and nonlinear algebraic equations – Numerical Differentiation and Integration – Curve Fitting – and Interpolation – Solving systems of linear and nonlinear systems of ode's. Symbolic Calculations – Integration – Differentiation – solving systems of ode's – Laplace and Fourier Transforms. Graphics – 2-D and 3-D. Graphs.
Note: This description is based on the mathematical package (Matlab); similar packages such as (Mathematica and Maple) can be used.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- A Guide to MATLAB® for Beginners and Experienced Users, Brian R. Hunt Ronald L. Lipsman.
2- MATLAB® An Introduction with Applications, Amos Gilat.

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# Course Description

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|---|
| **Course Code:** Math 4350 |
| **Course Title:** Complex Analysis |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Eighth |
| **Prerequisites**: Math 3320, Math 3330 |

**Course Objectives**

1- Demonstrate and understanding of the fundamental concepts of complex analysis.
2- Demonstrate and understanding of the application of the theory both to other mathematical areas and to physics and engineering.
3- Prove the basic results relating to holomorphic functions.
4- Apply the theory learnt in the course to solve a variety of problems at an appropriate level of difficulty.
5- Demonstrate skills in communicating mathematics orally and in writing.

**Course Contents**

Complex Algebra and Functions – Algebra of Complex Numbers – Complex Plane – Polar Form – Geometric Series – Functions of Complex Variable – Analyticity – Cauchy – Riemann Conditions – Harmonic Functions – Complex Exponential – Complex trigonometric and hyperbolic functions – Complex Logarithm – Complex Powers – Inverse Trig. Functions – Complex Integration – Contour Integration – Path Independence – Cauchy's Integral Theorem – Cauchy's Integral Formula – Higher Derivatives – Bounds – Liouville's Theorem – Maximum Modulus Principle – Mean value Theorems – Fundamental Theorem of Algebra – Radius of Convergence of Taylor Series – Residue Calculus – Laurent Series – Poles – Essential Singularities – Point at Infinity – Residue Theorem – Integrals around Unit Circle – Real Integrals From $-\infty$ to $+\infty$.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- An introduction to complex for engineers, Michael D. Alder, June 3, 1997.
2- A first course in Complex analysis, version 1.24, Matthias Beck, Gerald Marchesi, and Dennis Pixton, Copyright 2002-2009.
3- Saff Edward B. and Arthur David Snider, "Fundamentals of Complex Analysis with Applications to Engineering Science and Mathematics", 3rd ed. Upper Saddle River - NJ: Prentice Hall, (2002), ISBN: 0139078746.

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# Course Description

**Course Code:** Math 4360
**Course Title:** Introduction to Partial Differential Equations
**Credit Hours:** 3(3,1,0)
**Level:** Seventh
**Prerequisites:** Math 3320, Math 3330

## Course Objectives

1- Study the basic facts and the types about partial differential equations using Euler equation.
2- Study of many physical applications on partial equations such as the heat equation and wave equation as well as the solution of boundary problems.

## Course Contents

Introduction and Basic Facts about PDE's – Types of PDE's – Derivation of the Heat and Wave Equations from physics – Solution of boundary problems (Dirichlet, Newmann, Robin) by Fourier series – Eigenvalues – Eigen Functions – Orthogonality of Eigen Functions – Sturm – Liouville Problem – Separation of Variables: The Heat Equation in 1D – The Wave Equation in 1D. Laplace's Equation in Rectangles, Circles – Inhomogeneous PDEs and the (Generalized) Fourier series – Fourier Transform – Solutions of PDE's by Fourier Transform – Heat and Wave Equations in Half Space – Solving Simple Equations by Characteristics.

**Exercises**: Include problems to cover the entire course contents.

## Suggested Text Books

1- Elementary applied Partial Differential Equations, Richard Haberman, Pearson Prentice Hall (2004) – ISBN 0 – 13– 252875– 4.
2- Partial Differential Equations with Fourier series and Boundary value Problems, Nakhale Asmar – Pearson Prentice Hall, (2005).
3- An introduction to partial differential equations, Yehuda Pinchover and Jacob Rubinstein – Cambridge University Press (2005).

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# Course Description

**Course Code:** Math 4380
**Course Title:** Nonlinear Dynamics
**Credit Hours:** 3(3,1,0)
**Level:** Elective
**Prerequisites:** Math 2250, Math 3330

## Course Objectives

1- Present basic concepts in linear and nonlinear systems in dynamic.
2- Demonstrate the uses of mathematical models in science and engineering.
3- Present modern numerical and analytical methods to investigate dynamical systems.
4- Specific known and important examples of applications from physics, chemistry, medicine and mechanical.
5- Demonstrate that electrical engineering will serve as basis to explain the mathematical techniques.

## Course Contents

Pendulum – Free Oscillator – Energy in the Plane Pendulum – Stability of Solutions to ODEs – Linear Systems – Nonlinear Systems – Conservation of Volume in Phase Space – Damped Oscillators and Dissipative Systems – Phase Portrait of Damped Pendulum – Forced Oscillators and Limit Cycles – Van der Pol Equation – Parametric Oscillator – Mathieu's Equation – Elements of Floquet Theory – Stability of the Parametric Pendulum – Damping. Fourier Transforms: Continuous Fourier Transform – Discrete Fourier Transform – Inverse DFT – Autocorrelations – Power Spectra – Poincaré Sections – Periodic – Quasiperiodic Flows – Aperiodic Flows – 1– D Flows – Rössler Attractor – Fluid Dynamics and Rayleigh – Bénard Convection – The Concept of a Continuum – Mass Conservation – Momentum Conservation – Substantial Derivative – Forces on Fluid Particle – Nondimensionalization of Navier–Stokes Equations – Bifurcation Diagram – Pattern Formation – Convection in the Earth – Introduction to Strange Attractors – Dissipation and Attraction – Attractors with 2D – Aperiodic Attractors – Rössler Attractor – Lorenz Equations – Physical Problem and Parametrization – Equations of Motion – Momentum Equation – Temperature Equation – Dimensionless Equations – Stability – Diverging Trajectories – Lyaponov Exponents.

**Exercises**: Include problems to cover the entire course contents.

## Suggested Text Books

1- Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering (Studies in nonlinearity) by Steven H. Strogatz (29 Dec 2000).
2- Understanding Nonlinear Dynamics, by Daniel Kaplan and Leon Glass, Publisher: Springer; 1st ed.1995. Corr. 2nd printing edition (1 Nov 1997), ISBN-10: 0387944400, ISBN-13: 978-0387944401.

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# Course Description

| |
|---|
| **Course Code:** Math 4390 |
| **Course Title:** Differential Geometry |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 3320, Math 3330 |

**Course Objectives**

1- Knowing the concepts and Understand the scientific background of differential geometry.
2- Studying the curvature and torsion of the curves and its concerned planes.
3- Analysis and problem solving applied theories in Differential Geometry.
4- Apply essential scientific techniques and theories of Differential Geometry in studying the surfaces.

**Course Contents**

Geometry of Curves in the Plane – Arc Length – Tangential and Normal Vectors – (signed) Curvature – Reconstruction of a Curve with given Curvature and Arc Length – Evolutes and Involutes – The Isoperimetric Inequality and Hopf's Theorem on the Tangential Degree of an Embedded Closed Curve – Geometry of Curves in the Space – Arc length – Curvature – Torsion – The Frenet– Serret Equations – Reconstruction of a curve with given curvature and torsion – Generalized helices – Evolutes and involutes. Surfaces in Space: The first and second fundamental forms – Area and the Gauss and Codazzi Equations – Gaussian curvature – developable surfaces – principal curvature – Meunier's Theorem – Surfaces of constant Gaussian curvature – Mean curvature – Minimal surfaces – Intrinsic Geometry of Surfaces – Geodesic curvature of curves on surfaces – First variation of arc length – The Gauss –Bonnet Theorem and applications.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Elementary Differential Geometry, Revised Second Edition, Barrett O'Neill, 2006
2- Schaum's outlines. "Differential Geometry", Martin M. Lipschutz, Ph. D., 1969, McGraw-Hill.
3- Dirk Jan Struik, "Lectures on classical differential geometry", 2nd Edition,Dover Publications. 1961.

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# Course Description

| |
|---|
| **Course Code:** Math 4400 |
| **Course Title:** Fluid Dynamics |
| **Credit Hours:** 3(3,1,0) |
| **Level:** 8th |
| **Prerequisites:** 2290 Math, 4360 Math |

**Course Objectives**

1- To equip the students with the basic concepts of the subject of Fluid Dynamics.

2- To make the students to understand how to apply the conservation laws of classical mechanics to obtain the corresponding partial differential equations.

3- To teach the students, how to solve these partial differential equations.

4- The student shall learn to know about the action of fluid forces, like body, inertial and surface forces, on the bodies present in the fluid region.

**Course Contents**

Continuum concept in Fluids – Continuity Equation – Mass Conservation Law – Inviscid Flow – Euler's Equation of motion, Bernoulli's equation – Streamlines – Pathlines – Streaklines – Viscosity – Viscous Fluid – Navier – Stokes Equations – Boundary Layers theory – Separation of Boundary Layer theory – Drag – Lift and Thrust – Vorticity and Circulation – Surface Tension and its Effect on Flows.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

4- Fluid Mechanics by L.D. Landau and E.M.Lifshitz, Pergamon Press.
5- Boundary Layer Theory by Dr. Hermann Schlichting, McGraw Hill and Book Company.
6- Introduction to Fluid Mechanics (8th), Philip J. Pritchard, John C Leylegian, Robert W Fox, Alan T McDonald.

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# Course Description

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|---|
| **Course Code:** Math 4410 |
| **Course Title: A**nalytical Mechanics |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2290, Math 4360 |

**Course Objectives**

1- This course is intended to provide students with the knowledge and skills for understanding the basic principle of analytical mechanics.

2- To provide the students with a basics foundation of generalized the Newton's laws of motion through the mechanics of Lagrange and Hamilton and their applications.

**Course Contents**

Principle of Stationary Action – Lagrange Equations – Hamilton's Principle – Coordinate Transformations and Rigid Constraints – Total time Derivatives and the Euler – Lagrange Operator – State and Evolution – Chaos – Conserved Quantities – Euler's Equations – Hamilton's Equations – Legendre Transformation – Hamiltonian Action and Poisson Brackets – Phase Space Reduction – Phase Space Evolution – Surfaces of Section – Autonomous Systems: Henon – Heiles – Exponential Divergence – Solar System – Liouville Theorem – Phase Space Structure – Linear Stability – Homoclinic Tangle – Integrable Systems – Poincare – Birkhoff Theorem – Invariant Curves – KAM Theorem – Canonical Transformations – Integral Invariants – Extended Phase Space – Generating Functions – Time Evolution in Canonical Hamilton –Jacobi Equation – Lie Transforms – Perturbation Theory – Perturbation Theory with Lie Series.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Sussman Gerald Jay and Jack Wisdom, "Structure and Interpretation of Classical Mechanics", Cambridge, MA: MIT Press March 19, (2001), ISBN: 9780262194556.
2- Herbert Goldstein, Classical Mechanics, Third Edition.
3- R. DOUGLAS GREGORY, CLASSICAL MECHANICS AN UNDERGRADUATE TEXT Cambridge University Press (2006), www.cambridge.org/9780521826785.
4- J. Michael Finn, CLASSICAL MECHANICS, Infinity Science Press LLC (2008). ISBN: 978-0-7637-8290-0 (e).

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# Course Description

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|---|
| **Course Code:** Math 4420 |
| **Course Title:** Introduction to Functional Analysis |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 3280, Math 3460 |

**Course Objectives**

1- To study the basic concepts of normed spaces and Banach spaces.
2- To study Hahn–Banach Theorem and its applications.
3- Understanding the fundamentals results in functional analysis.
4- To demonstrate understanding basic concepts of inner product spaces.
5- To understand the basic concepts of the theory of operators on Hilbert spaces.

**Course Contents**

Normed Vector Spaces – Completeness – Functionals – Hilbert spaces – Isomorphism – Cardinality – Aleph Null – Invariant Subspace – Basic theory of Banach Spaces – Lebesgue Measure – Measurable Functions – Completeness of L– p spaces – Dual Space " The space of all Continuous Linear Functionals – Frechet spaces – Frechet Urysohn Space as a type of Sequential Space – Major and Foundational results – The Uniform Boundedness Principle or (Banach–Steinhous Theorem) – Spectral Theorems – Integral Formula for the Normal Operators on a Hilbert Space – Hahn–Banach Theorem – extends Functionals from a subspace to the full space – Open Mapping Theorem – Closed Graph Theorem – Theory of Compact Operators – Hilbert – Schmidt and Trace Class Operators.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Giles J. R., "Introduction to the Analysis of Normed Linear Spaces", Cambridge University, Press (2000).
2- E. kreyzig, introductory functional analysis with application, John Inc. Wiley & Son. 1978.

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# Course Description

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|---|
| **Course Code:** Math 4430 |
| **Course Title:** Introduction to Topology |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Seventh |
| **Prerequisites:** Math 3460 |

**Course Objectives**

1- To understand topological spaces.

2- To understand bases, countability and continuous functions.

3- To understand separation axioms and metric spaces.

**Course Contents**

Logic and Foundations – Relations – Cardinality – Axiom of Choice – Topologies – Open and Closed Sets – Bases and Countabilty – Continuous Functions – Urysohn Lemma – Tietze Extension Theorem – Separation Axioms – Metric Topologies – Connected Spaces – Compact Spaces – Metrization.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Munkres James, "Topology", 2nd ed. Upper Saddle River – NJ: Prentice Hall, ISBN: 0131816292.
2- Introduction to General Topology, by George L. Cain, ISBN10: 0201756110, ISBN13: 978-0201756111.
3- Topology: Introduction to Point-Set and Algebraic, by Donald W. Kahn, ISBN10: 0486686094 ISBN13: 978-0486686097.
4- Topology by K P Gupta, Pragati Prakashan Publishers, Meerut, India.

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# Course Description

| |
|---|
| **Course Code:** Math 4450 |
| **Course Title:** Abstract Algebra-II |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Seventh |
| **Prerequisites:** Math 2440 |

**Course Objectives**

1- To understand the rings and fields and subrings.
2- To understand ideals (prime and maximal) and ring homomorphism.
3- To understand polynomial rings and field extensions.

**Course Contents**

Rings: Definitions – Basic Properties of Rings – Subring – Fields – Division Ring – Integral Domain – Characteristic of the Rings – Right and Left Ideal of the Ring – Quotient Rings – Principal Ideal Domains – Unique Factorization – Maximal Ideals – Polynomial Rings – Euclidean Rings – Ring Homomorphism – Ring Endomorphism – Fields: Algebraic Elements.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Artin M., "Algebra", Englewood Cliffs, NJ: Prentice – Hall, ISBN: 0130047635.
2- Gallian J.A, Contemporary Abstract Algebra 3rd edition D.C. Heath Company, 1994.
3- J.B.fraleigh, a first course in abstract algebra, 4thedition, adddison Wesley, 1989.
4- Herstein I.N, Abstract Algebra, macmillamInc, 1986.

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# Course Description

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|---|
| **Course Code:** Math 4480 |
| **Course Title:** Principles of Automatic Control |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2250, Math 3320, Math 3330 |

**Course Objectives**

1- To understand Open and Closed– loop control systems for Dynamic Systems.

2- To understand Frequency and perturbation response in Transient and State Space.

3- To understand Root Locus and Liapunov Stability Analysis.

**Course Contents**

Closed-loop control systems – Open-loop control systems – The Laplace Transform – Mathematical Modeling of Dynamic Systems – Transient Response Analysis – Basic Control Actions and Response of Control Systems – Root Locus Analysis – Frequency Response Analysis – Analysis of Control System in State Space – Liapunov Stability Analysis and Quadratic Optimal.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Ogata K., "Modern Control Engineering", Pearson; 5 edition (September 4, 2009), ISBN-13: 978-0136156734.

2- Ogata K., "Solving Control Engineering Problems with MATLAB®", Prentice Hall (September 1993), ISBN-13: 978-0130459077.

3- Kuo Benjamin, "Automatic Control Systems" Wiley; 9th edition (July 7, 2009), ISBN-13: 978-0470048962.

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# Course Description

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|---|
| **Course Code:** Math 4490 |
| **Course Title:** Mechanics of Continuous Media |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 3350, Math 4360 |

**Course Objectives**

1- To understand how to deal with tensor analysis.

2- To understand to express the stress or the strain tensor in different system of coordinates.

3- To know the difference between Lagranian point of view and Euler point of view to describe the tensors.

4- To understand the fundamental of elasticity theory.

5- To understand the fundamental concepts of dislocation.

6- To understand Navier Stock equation.

7- To understand the foundations of porous Media.

**Course Contents**

Tractions – Stress Tensor – Stress Tensor in Different Coordinate Systems – Pore Fluid Pressure – Newton's Second Law – Stress in the Earth – Stress Rotation – Sandbox Tectonics – Displacement Gradients – Measurement of Displacement Gradient Tensor – Finite Strain – Elasticity – Dislocation in Elastic Half space Model of the Earthquake Cycle – Stress and Strain from a Screw Dislocation Plates – Navier Stokes Equation – Flow in Porous Media.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- "Mechanics of Generalized Continua", Altenbach, Holm; Maugin, Gerard A; Erofeev, Vladimir, 2011, Advanced Structured Materials, 7, ISBN 3642192181.
2- "Continuum Mechanics Through the Twentieth Century", G.A. Maugin, ISBN: 978-94-007-6352-4 (Print) 978-94-007-6353-1 (Online).
3- "Mechanics of Continuous Deformable Media" , Chaichian, Masud; Merches, Ioan; Tureanu, Anca Mechanics, 2012, 2012, ISBN 3642163904.

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# Course Description

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|---|
| **Course Code:** Math 4500 |
| **Course Title:** Numerical Methods for Partial Differential Equations |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 337, Math 4360 |

**Course Objectives**

1- Study the formulations of Finite-Difference method (FDM).
2- Apply (FDM) to parabolic, elliptic and hyperbolic partial differential equations.
3- Study the iterative methods for nonlinear algebraic equations.
4- Study the Finite-Volume method.
5- Study the Finite-element method.
6- Collocation and Galerkin Methods.
7- Advanced topics: Structured Grid generation and Multigrid Methods.

**Course Contents**

Finite Differences: Elliptic Problems – Parabolic Problems – 2D Problems – Solution Methods – Iterative Methods – Hyperbolic Problems – Finite Elements: Variational Formulation – General Elliptic Problems – Overview – Parabolic Problems – Eigenvalue Problems. Integral Equations: Collocation and Galerkin Methods.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Smith G.D. "Numerical Solution of Partial Differential Equations: Finite Difference Methods", 3rd Edition, Oxford University Press, New York.
2- Trefethen L. N. and Bau D., "Numerical Linear Algebra", Philadelphia, PA: SIAM, (1997). ISBN: 9780898713619.
3- Quarteroni A. and Valli A., "Numerical Approximation of Partial Differential Equations", Berlin; New York, NY: Springer – Verlag, (1997), ISBN: 9783540571117.
4- Atkinson K. E., "The Numerical Solution of Integral Equations of the Second Kind", Cambridge, UK: Cambridge University Press (1997), ISBN: 9780521583916.

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# Course Description

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|---|
| **Course Code:** Math 4520 |
| **Course Title:** Calculus of Variations |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 3320, Math 3330 |

**Course Objectives**

1- Study the functional and how to set the maximum values using Euler – Lagrange equations, as well as designate the type described these extreme values through Legendre condition and Weierstrass condition.

2- Study the many applications of Euler – Lagrange equations notably the issue of the shortest path – the smallest surface of revolution area and the Brachistochrone Problems.

**Course Contents**

Review of Vector Spaces – Functional – The Geodesics Problems – Brachistochrone – Linear Functional – Properties of Functional – Local Maximum – Local Minimum – Extremum Value – Extremal with Corners – Euler's Necessary Condition – Constant End Points Problems – Minimal Time Curve Problem – Functional of Several Variables – Canonical Euler – Lagrange Equations – Hamilton's Principle – Functional of Higher Derivatives – Euler – Poisson Differential Equation – Functional with Multiple integrals – Minimal Surface Plateau's Problem and Applications – Schrödinger's Equations – Inverse Problem – Moving End Points Problems – Transversality Conditions – Hamilton– Jacobi Equation – Extremals With Corners – Reflection of Extremals – Refraction of Extremals – Corners Conditions – Necessary and Sufficient Conditions of Extremals – Legendre Condition – Jacobi Conditions – Weierstrass Condition – Optimal Control – Optimality Principle – Bellman's Equation – Maximum Principle and Its Applications.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Giaquinta M. and Hilderbrandt S., "Calculus of Variations I", New York – NY: Springer (2003), ISBN: 9780387506258.
2- Troutman J. L., "Variational Calculus with Elementary Convexity", New York – NY: Springer – Verlag (1995), ISBN: 9780387907710.
3- Bruce van Brunt the Calculus of Variations (2004) Springer-Verlag New York, Inc. ISBN 0-387-40247-0.
4- Luigi Ambrosio, Luis Caffarelli, and Nicola Fusco, Calculus of Variations and Nonlinear Partial Differential Equations (2008) Springer-Verlag Berlin Heidelberg.

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# Course Description

**Course Code**: Math 4530
**Course Title**: Optimization
**Credit Hours**: 3(3,1,0)
**Level**: Elective
**Prerequisites**: Math 3260, Math 3320

**Course Objectives**

1- Develop models of linear programs for practical problems, i.e.; learning the art of Problem Formulation. i.e. and acquire knowledge about converting a Physical Model to Mathematical Model.
2- Solving some practical problems of large scale linear Programs Models with software.
3- Studying the classical optimization methods for Unconstrained and constrained nonlinear Optimization problems.
4- Develop Algorithms for nonlinear constrained and unconstrained Problems using both direct and indirect search methods.
5- Introduction to the Optimal Control theory and applying it to some Practical Problems.

**Course Contents**

Linear Optimization – Modeling with linear Programming – Large Scale Optimization using software – Practical applications in linear programming using software. Nonlinear Optimization – Unconstrained Optimization and Lagrange multipliers – Constrained optimization and Kuhn –Tucker conditions. Nonlinear Optimization Techniques: Classical Methods, Unconstrained Optimization Techniques, Direct search Methods, Pattern Directions Methods: (Powell's Method). Indirect search methods, (Gradient methods): Steepest Descent (Cauchy) Method, Conjugate Gradient (Fletcher – Reeves) Methods, Marquardt method and Newton's Method. Nonlinear Optimization: Classical Methods Unconstrained Optimization Techniques Rank 1, 2 Updates, Davidon – Fletcher – Powell Method, Broyden – Fletcher – Goldfarb – Shanno Method. Introduction to Optimal Control Theory with some Applications.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Operations Research an Introduction, by H. Taha.
2- Engineering Optimization: Theory and Practice by S. S. Rao (Jul 20, 2009).

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# Course Description

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|---|
| **Course Code:** Math 4540 |
| **Course Title:** Computational Geometry |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2250, Math 3330, Math 3370 |

**Course Objectives**

1- To understand the engineering models of curves and surfaces, especially Bezier curves and generalized cylinders.

2- Understanding and study of nonlinear systems software, as well as drawing using a computer.

3- Study advanced topics in differential geometry.

**Course Contents**

Classification of Geometric Modeling Forms – Differential Geometry of Curves – Differential Geometry of Surfaces – Introduction to Spline Curves – B– splines (Uniform and Non– uniform) – Spline Surfaces – Physically– Based Deformable Surfaces – Fairing – Generalized Cylinders – Blending Surfaces – Surface Intersections – Nonlinear Solvers – Interval Methods – Robustness – Offset Curves and Surfaces – Advanced Topics in Differential Geometry (Geodesics – Developable Surfaces – Umbilics – Parabolic Line – Ridge Line – Sub – Parabolic Line) – Localization – Discrete Differential Geometry.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Patrikalakis N. M. and Maekawa T., "Shape Interrogation for Computer Aided Design and Manufacturing", New York – NY: Springer Verlag, February (2002), ISBN: 9783540424543.
2- Computational Geometry: Algorithms and Applications by Mark H. Overmars (Nov 19, 2010)
3- Computational Geometry, CRC Press.

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# Course Description

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|---|
| **Course Code**: Math 4550 |
| **Course Title**: Wavelets and Modern Signal Processing |
| **Credit Hours**: 3(3,1,0) |
| **Level**: Elective |
| **Prerequisites**: Math 4470 |

**Course Objectives**

1- Study the different types of wavelet transform

2- Acquire knowledge about Denoising by Linear Filtering.

studying the Approximation Theory (Linear/Nonlinear).

Applications of Fast Wavelet Transforms to Data Compression.

**Course Contents**

The Continuous Fourier Transform – The Discrete Fourier Transform – FFT – Time Frequency Analysis – Short time Fourier transform – The Wavelet Transform – The Continuous Wavelet Transform – Discrete Wavelet Transforms – Orthogonal Basis of Wavelets – Statistical Estimation – Denoising by Linear Filtering – Inverse Problems – Approximation Theory: Linear/Nonlinear Approximation and Applications to Data Compression – Wavelets and Algorithms – Fast Wavelet Transforms – Avelet Packets – Cosine Packets – Basis Pursuit – Data Compression – Nonlinear Estimation – Topics in Stochastic Processes – Topics in Numerical Analysis – Multigrids and Fast Solvers.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Wavelets and Filter Banks", Wellesley, Cambridge Press.

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# Course Description

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|---|
| **Course Code:** Math 4560 |
| **Course Title:** Rigid Body Dynamics |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 2290, Math 3330 |

**Course Objectives**

1- This course is intended to provide students with knowledge and skills for understanding the basic principle of motion rotating and translating axes and some applications.

2- Study of many applications on 3D rigid body dynamics such as gyroscopic motion, rocket equation, central force motion and Keppler's Laws.

**Course Contents**

CurviLinear Motion – Cartesian Coordinates – Equations of Motion in Cartesian Coordinates – Intrinsic Coordinates – Other Coordinate Systems – Application Examples – Work and Energy – Conservative Forces – Potential Energy – Linear Impulse and Momentum – Angular Impulse and Momentum – Relative Motion – Translating Axes – Relative Motion Rotating/Translating Axes – Newton's Second Law for Non– Inertial Observers – Inertial Forces – Newtonian Relativity – Gravitational Attraction – The Earth as a Non– Inertial – Reference Frame – 2D Rigid Body Kinematics – Conservation Laws for Systems of Particles. 2D Rigid Body Dynamics: Equations of Motion – Work and Energy – Impulse and Momentum – Pendulums. 3D Rigid Body Kinematics. 3D Rigid Body Dynamics: Inertia Tensor – Equations of Motion – Gyroscopic Motion – Torque– Free Motion – Spin Stabilization. Variable Mass Systems: The Rocket Equation – Central Force Motion – Keppler's Laws – Orbits – Orbit Transfer.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Meriam J. L. and Kraige L. G., "Engineering Mechanics: Dynamics", 5th ed. New York: Wiley – December 28, (2001), ISBN: 0471406457.
2- Harrison H. R. and Nettleton T., "Advanced Engineering Dynamics", London: Arnold, ISBN: 0340645717.
3- Hibbeler R. C., "Engineering Mechanics: Statics And Dynamics", 9th ed. Upper Saddle River – N. J.: Prentice Hall, December 15, (2001), ISBN: 0130200069.

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# Course Description

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|---|
| **Course Code:** Math 4570 |
| **Course Title:** Quantum Mechanics |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 4410 |

**Course Objectives**

1- Study the time - dependent and time - independent Schrodinger equations and it is applications.

2- Study and determined the energy and wave function of the hydrogen and helium atom.

**Course Contents**

Foundations of Quantum Mechanics and its mathematical tools. Energy Spectra for some molecules. Wave Mechanics – The Schrödinger equation and its applications – The particle in a box – The harmonic Oscillator – Heisenberg uncertainty principle – Vector Spaces – Angular Momentum – Hydrogen Atom – Helium Atom.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Ballentine.L.E", Quantum mechanics, NJ: Prentice – Hall (1990).
2- Dirac.P.A.M "The principle of Quantum mechanics", 4rd ed. Oxford university, Press New York (1958).
3- Dicke.R.H and Wittke .J.P, Introduction to Quantum mechanics, Addison – Wesley, Reading, Mass (1960).

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# Course Description

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|---|
| **Course Code:** Math 4580 |
| **Course Title:** Special Functions |
| **Credit Hours:** 3(3,1,0) |
| **Level:** Elective |
| **Prerequisites:** Math 3340 |

**Course Objectives**

1- This course is intended to provide students with knowledge and skills for understanding the basic principle of Special Functions.
2- Study recurrence relations and generating function of the different Special Functions and their physical applications.

**Course Contents**

Gamma Function – Beta Function – Legendre functions – Generating function – Recurrence relations – Associated Legendre function – Spherical Harmonics – Legendre function of the second kind – Bessel Functions – Properties of Bessel Functions – Modified Bessel Functions – Hermit Functions – Generating function– Recurrence relations – Laguerre Functions – Generating function – Recurrence Relations – Chebyshev Polynomials – Hyper Geometric Functions – Some applications in quantum mechanics.
Tutorial Section: Different problems of every topics includes in the Course Description.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Arfken.G.B and Weber.H.J, Mathematical methods for physicists, sixth Edition, Elsevier AP (2005).
2- H.S.Jeffreys and B.S. Jeffreys, Methods of Mathematical Physics, 3 rd ed.Cambridge, UK: Cambridge University Press (1972).
3- Amold.F.N,Yasilii.B.U ,Special Functions of Mathematical Physics, (1988) ISBN: 978-1-4757-1597-2 (Print) 978-1-4757-1595-8 (Online).

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# Course Description

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|---|
| **Course Code**: Math 4620 |
| **Course Title**: Ethics of Mathematicians |
| **Credit Hours**: 1(1,0,0) |
| **Level**: Elective |
| **Prerequisites**: Math 3460 |

**Course Objectives**

1- Concept of Ethics.
2- Manners of Mathematicians.
3- The role of teacher in the society.

**Course Contents**

Concept of Ethics– Manners of Mathematicians – Difference between Mathematical Ethics and Manners – Ethics and General Welfare – Ethics in General jobs – Duties in General job – Manners of the Mathematical Employee – Illegal Manners of the Mathematical Employee – Deviation of Authority or job – Bribery – Gifts and Tips – Favoritism – Embezzlement – Forgery – Using the Authority or job – Teacher and society.

**Exercises**: Include problems to cover the entire course contents.

**Suggested Text Books**

1- Class Notes.