NOIDA INTERNATIONAL UNIVERSITY

GREATER NOIDA

School of Sciences

Department of Mathematics

COURSE SYLLABUS

AS PER CBCS

M.Sc. (Mathematics)

(ALL SEMESTERS)

w.e.f., 2019-2020

NOIDA INTERNATIONAL UNIVERSITY
SCHOOL OF SCIENCES
Study & Evaluation Scheme for M.Sc. (Mathematics) 1st Year

SEMESTER-I

S. No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPGM-101	Algebra	4	1	0	20	20	40	60	100	5
2	STPGM-102	Real Analysis	4	1	0	20	20	40	60	100	5
3	STPGM-103	Ordinary Differential Equations	4	1	0	20	20	40	60	100	5
4	STPGM-104	Mechanics	4	1	0	20	20	40	60	100	5
TOTAL										400	20

SEMESTER-II

S. No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPGM-201	Complex Analysis	4	1	0	20	20	40	60	100	5
2	STPGM-202	Difference Equations	4	1	0	20	20	40	60	100	5
3	STPGM-203	Partial Differential Equations	4	1	0	20	20	40	60	100	5
4	STPGM-204	Optimization Techniques and Control Theory	4	1	0	20	20	40	60	100	5
5	STPGM-205	Seminar	2	0	0	15	10	25	75	100	2
TOTAL										500	22

NOIDA INTERNATIONAL UNIVERSITY

SCHOOL OF SCIENCES

Study & Evaluation Scheme for M.Sc.(Mathematics) 2nd Year

SEMESTER-III

S. No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
2	STPGM-301	Topology	4	1	0	20	20	40	60	100	5
3	STPGM-302	Probability Theory and Statistics	4	1	0	20	20	40	60	100	5
4	STPGM-303	Operation Research	4	1	0	20	20	40	60	100	5
5	STPGM-304	Computer Fundamentals &C Programming	4	0	0	20	20	40	60	100	4
PRACTICAL											
1	SPPGM-304	Computer Fundamentals &C Programming (Practical)	0	0	2			50	50	100	2
TOTAL										500	21

SEMESTER-IV

S. No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPGM-401	Integral Equations	4	1	0	20	20	40	60	100	5
2	STPGM-402	Functional Analysis	4	1	0	20	20	40	60	100	5
4	Specialization Paper I (Choose any one)		4	1	0	20	20	40	60	100	5
	STPGM 411	Fluid Dynamics									
	STPGM 412	Regression Analysis									
	STPGM 413	Algebraic Number Theory									
	STPGM 414	Discrete Mathematics									
5	Specialization Paper II (Choose any one)		4	1	0	20	20	40	60	100	5
	STPGM 421	Mathematical Modeling									
	STPGM 422	Calculus on $\mathfrak{R}^n$									
	STPGM 423	Differential Geometry									
PRACTICAL											
1	SPPGM 401	Dissertation	2	0	0			25	75	100	2
TOTAL										500	22

PAPERS OF SPECIALIZATION IN SEMESTER IV	
SPECIAL PAPER I **(Choose Any One Elective Paper)**	
STPGM 411	Fluid Dynamics
STPGM 412	Regression Analysis
STPGM 413	Algebraic Number Theory
STPGM 414	Discrete Mathematics
SPECIAL PAPER II **(Choose Any One Elective Paper)**	
STPGM 421	Mathematical Modeling
STPGM 422	Calculus on $\Re^n$
STPGM 423	Differential Geometry

OVERALLSCHEME

S. No.	Semester	TheoryTotal	Practical	SubjectTotal	TotalCredits
1.	I	400	-	400	20
2.	II	400	100	500	22
3.	III	400	100	500	21
4.	IV	400	100	500	22
GrandTotal				1900	85

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-101 **Course Name: ALGEBRA**
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

The main aim of this course is to understand finite groups, finite abelian groups , modules, finite fields and galois theory. The course gives the student a good mathematical maturity and enables to build mathematical thinking and skill.

Course Description:

This course includes Class equation for finite groups and its applications**,** Finite abelian groups. Solvable groups, types of Modules, Finite fields and Elements of Galois theory.

Course Contents :

Unit I - Class equation for finite groups and its applications, Cauchy`s theorem, Sylow p-subgroups, Sylow's theorems.

Unit II - Direct products, Finite abelian groups. Solvable groups, Insolvability of Sn for $n \geq 5$

Unit III - Modules, Submodules, Simple and Semi-simple modules, Quotient Modules, Cyclic modules, Free modules

Unit IV - Finite fields, Extension fields, Field automorphisms, Splitting fields, Roots of Polynomials, Wedderburn's theorem on finite division rings.

Unit V -Elements of Galois theory, Fundamental Theorem of Galois Theory.

Course Learning Outcomes(CLOs) :

CLO-1 :To understand different theorem like Cauchy`s theorem and Sylow's theorem.
CLO-2: To solve the problems on abelian groups.
CLO-3: To understand the Modules.
CLO-4 :Interpret basic concept of fields.
CLO-5 :To understand the Elements of Galois theory and Fundamental Theorem of Galois Theory.

Text books :

1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
2. I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference books :

1. P.M. Cohn, Classic Algebra, John Wiley & Sons Ltd., 2000.
2. P.M. Cohn, Basic Algebra: Groups, Rings and Fields, Springer, 2005.
3. N. Jacobson, Basic Algebra, Volumes I & II, Second Edition, Dover Publications, 2009.
4. T.W. Hungerford, Algebra, Springer-Verlag, 1981

Online links for study & reference materials :

https://youtu.be/yevjmxGQqgo
https://youtu.be/8Z4Cmhji_FQ

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-102
Course Credit Hour: 5hr

Course Name: Real Analysis
Total Contact Hour: 60hr

Course Objective:

The main aim of this course is to understand the convergence of the improper Integral, Riemann - Stieltjes integral, Necessary conditions for the existence of Riemann-Stieltjes integrals and Pointwise convergence of sequences of functions With Examples of sequences of real - valued functions.

Course Description:

Students will learn Convergence of Improper Integral, Comparison Test,Riemann's condition Comparison theorems, Mean value theorems for Riemann - Stieltjes integrals, The integrals as a function of the interval and Uniform convergence and Riemann - Stieltjes integration.

Course Contents:

Unit I - Improper Integral, Convergence of Improper Integral, Comparison Test, Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series, Differentiation under Integral Sign.

Unit II - Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral - Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition - Comparison theorems.

Unit III - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals, Necessary conditions for the existence of Riemann-Stieltjes integrals- Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus-Change of variable in a Riemann integral- Second Mean Value Theorem for Riemann integral, Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign - Lebesgue criterion for the existence of Riemann integrals.

Unit IV - Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.

Course Learning Outcomes(CLOs) :

CLO-1: Understand the concept Improper integrals and various comparison tests
CLO-2: Discuss the Riemann-Stieltjes integral and to solve its related problems.
CLO-3: Understand the Second fundamental theorem of integral calculus and Second Mean Value Theorem for Riemann-Stieltjes integrals.
CLO-4: Have knowledge of uniform convergence of sequence and series

Text books :

Rudin,W. Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.

Reference books :

Malik,S.C. and Savita Arora. Mathematical Anslysis, Wiley Eastern Limited.New Delhi, 1991.

Online links for study & reference materials :

https://youtu.be/WyoMpdh7f0c https://youtu.be/DO0Dzz07DNI

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-103 **Course Name:** Ordinary Differential Equations
Course Credit Hour: 5hr **Total Contact Hour :** 60hr

Course Objective: The main aim of this course is to understand various analytical methods to find exact solution of system of the second order linear equations and Boundary value problems and their implementation to solve real life problems.

Course Description:

Students will learn D' Alembert's principle, Two-body central force problem, Principle of least action, Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle, Generating functions, Poisson bracket and Small Oscillations.

Course Contents:

Unit I - The existence and uniqueness solution: The method of successive approximation, Picard's theorem, system of the second order linear equations, Linear systems, homogeneous linear system with constant coefficient, Nonlinear system.

Unit II - Qualitative properties of solution: Sturm separation theorem, Sturm comparison theorem, The Cauchy problem, Homogeneous wave equation, Non homogeneous wave equations, Fourier transform, Properties of Fourier transform.

Unit III - Sturm-Liouvill systems, eigen values and eigen functions, Greens function for ordinary differential equation, construction of green function, Autonomous system, types of critical points, stability critical points and stability for linear system, stability by Liapunovs direct method.

Unit IV - Boundary value problem, maximum and minimum principle, uniqueness and continuity theorem, Dirichlet problem for a circle, Neumann problem for a circle, Dirichlet problem involving the Poisson equation.

Unit V - Greens function and boundary value problem, the Dirac-Delta function Properties of Greens function, method of Greens function, Dirichlets problem for the Laplace operator, Method of eigen functions.

Course Learning Outcomes(CLOs) :

CLO-1 : knowledge of Picard's theorem.
CLO-2: Difference between Homogeneous wave equation and Non homogeneous wave equations
CLO-3: Understand Autonomous system and types of critical points,
CLO-4 : How to solve Dirichlet problem and Neumann problem for a circle
CLO-5 : Understands the Dirichlets problem for the Laplace operator

Text books :

S.L.Ross, Differential Equation, Wiley India, 2004.

Reference books :

E.A. Coddington, An Introduction to Ordinary Differential Equations, Dover, 1989.

Online links for study & reference materials :

https://youtu.be/gps3wHq87nw
https://youtu.be/t4poDybjZ-I

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-104 **Course Name:** Mechanics
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

The primary objectives of a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation. Indeed, the construction of a meaningful mathematical model is often a more important experience than its solution.

Course Description:

Students will learn D' Alembert's principle, Two-body central force problem, Principle of least action, Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle, Generating functions, Poisson bracket and Small Oscillations.

Course Contents:

Unit I - Newtonian mechanics and its limitations. Constrained motion. Constraints and their classification. Principle of virtual work. D' Alembert's principle. Generalised coordinates. Deduction of Lagrange's equations from D' Alembert's Principle. Generalised momenta and energy. Cyclic or ignorable coordinates. Rayleigh' s dissipation function. Integrals of motion. Symmetries of space and time with conservation laws.

Unit II - Central force, Definition and properties of central force. Two-body central force problem. Stability of orbits. Conditions for closure. General analysis of orbits. Kepler's laws. Kepler's equation. Artificial satellites. Rutherford scattering.

Unit III - Principle of least action. Hamilton's principle. The calculus of variations. Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle. Hamilton's principle and characteristic functions.

Unit IV - Canonical Transformations. Generating functions. Poisson bracket. Poisson's Theorem. Invariance of PB under canonical transformations. Angular momentum PBs. Hamilton-Jacobi equation. Connection with canonical transformation. Problems.

Unit V - Small Oscillations. Normal modes and coordinates. Problems.

Course Learning Outcomes(CLOs) :

CLO-1 : knowledge of Newtonian mechanics and its limitations.
CLO-2 : Understands the Kepler's laws. Kepler's equation.
CLO-3 : Knowledge of Principle of least action and Hamilton's principle.
CLO-4 : Knowledge of Generating functions and Poisson bracket.
CLO-5 : Problems based on the Small Oscillations.

Text books :

H. Goldstien (Addition Wesley, 1980) : Classical Mechanics

Reference books :

N.C. Rana and P.S. Joag, (Tata McGrae-Hill, 1991) : Classical Mechanics.

Online links for study & reference materials :

https://youtu.be/SZbNx4VfMzg
https://youtu.be/kx1Qau_hhnw

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-201 **Course Name:** COMPLEX ANALYSIS
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

Complex analysis is the study of complex numbers together with their derivatives, manipulation, and other properties. Complex analysis is an extremely powerful tool with an unexpectedly large number of practical applications to the solution of physical problems. The key result in complex analysis is the Cauchy integral theorem, which is the reason that single-variable complex analysis has so many nice results. A fundamental result of complex analysis is the Cauchy-Riemann equations, which give the conditions a function must satisfy in order for a complex generalization of the derivative, the so-called complex derivative, to exist. When the complex derivative is defined "everywhere," the function is said to be analytic.

Course Description:

Students will learn Cauchy's Integral Formula, The General Form Of Cauchy's Theorem, Evaluation Of Definite Integrals And Harmonic Functions, Harmonic Functions And Power Series Expansions, Partial Fractions And Entire Functions Partial fractions.

Course Contents:

Unit I - Cauchy's Integral Formula: The Index of a point with respect to a closed curve - The Integral formula - Higher derivatives. Local Properties of Analytic Functions: Removable Singularities - Taylors's Theorem - Zeros and poles – The local Mapping - The Maximum Principle.

Unit II - The General Form Of Cauchy's Theorem: Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multilply connected regions - Residue theorem – The argument principle.

Unit III - Evaluation Of Definite Integrals And Harmonic Functions: Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.

Unit IV - Harmonic Functions And Power SeriesExpansions: Schwarz theorem - The reflection principle - Weierstrass theorem - Taylor's Series - Laurent series.

Unit V - Partial Fractions And Entire Functions Partial fractions: Infinite products - Canonical products - Gamma Function - Jensen's formula - Hadamard's Theorem.

Course Learning Outcomes(CLOs):

CLO-1: knowledge of the Integral formula of Higher derivatives.
CLO-2: Understands the General statement of Cauchy's Theorem and its Proof.
CLO-3: Able to evaluate of definite integrals.
CLO-4: Knowledge of Schwarz theorem and Weierstrass theorem.
CLO-5: Able to solve infinite products, Canonical products and Gamma Function.

Text books:

1. L.V. Ahlfors, Complex Analysis, Mc Graw Hill Co., Indian Edition, 2017.
2. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa, New Delhi, 1996.

Reference books:

1. T.W. Gamelin, Complex Analysis, Springer, 2001.
2. L. Hahn, B. Epstein, Classical Complex Analysis, Jones and Bartlett, 1996.
3. D.C. Ullrich, Complex Made Simple, American Mathematical Society, 2008.

Online links for study & reference materials:

https://youtu.be/BsDGcJN_1TU
https://youtu.be/79-ESkh5_f0

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-202 **Course Name: DIFFERENCE** EQUATIONS
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

Difference equation, mathematical equality involving the differences between successive values of a function of a discrete variable.The student will able to solve linear homogenous equations with constant coefficients and the System of difference equations of autonomous system.

Course Description:

Students will learn Linear Difference Equations of Higher Order, System of Difference Equations Autonomous System, The Z-Transform Method, Asymptotic Behavior Of Difference Equation and Oscillation Theory.

Course Contents:

Unit I - Linear Difference Equations of Higher Order: Difference Calculus - General Theory of Linear Difference Equations - Linear Homogeneous Equations with Constant coefficients - Linear non-homogeneous equations - Method of Undetermined coefficients, the method of variation of constants - Limiting behavior of solutions.

Unit II - System of Difference Equations Autonomous System: The Basic Theory - The Jordan form - Linear periodic system.

Unit III - The Z-Transform Method: Definition, Example and properties of Z-transform - The Inverse Z-transform and solution of Difference Equations: Power series method, partial fraction method, the inverse integral method - Volterra Difference Equation of convolution types - Volterra systems.

Unit IV- Asymptotic BehaviourOf Difference Equation: Tools and Approximations - Poincare's Theorem - Second order difference equations - Asymptotic diagonal systems - Higher order Difference Equations.

Unit V - Oscillation Theory: Three-term difference Equation - Non-linear Difference Equations - Self-Adjoint second order equations.

Course Learning Outcomes(CLOs) :

CLO-1: Understand the concept of Theory of Linear Difference Equations.
CLO-2: Knowledge of the System of Difference Equations Autonomous System.
CLO-3: Problems based on the Z-Transform Method.
CLO-4: Knowledge of Second order difference equations.
CLO-5: Understand Three-term difference Equation and Non-linear Difference Equations

Text books :

R.P.Agarwal., Difference Equations and Inequalities, Marcel Dekker, 1999.

Reference books :

Saber N. Elaydi, An Introduction to Difference Equations, Springer Verlag, New York, 1996.
S. Goldberg, Introduction to Difference Equations, Dover Publications, 1986
V. Lakshmi kantham and Trigiante, Theory of Difference Equations, Academic Press, New York, 1988.

Online links for study & reference materials :

https://youtu.be/8nsoSdqmNpE
https://youtu.be/6o7b9yyhH7k

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-203 **Course Name:** PARTIAL DIFFERENTIAL EQUATIONS
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

The primary objectives of a Partial Differential Equations (PDEs) course are to learn the degree, order, classification, different types of PDEs, existence and uniqueness of solution and different analytical methods for solving PDEs.

Course Description:

Students will Partial Differential Equations of First Order, Elliptic Differential Equations, Parabolic Differential Equations, Hyperbolic Differential Equations, Green's Function.

Course Contents:

Unit I - Partial Differential Equations of First Order: Formation and solution of PDE- Integral surfaces - Cauchy Problem order eqn - Orthogonal surfaces - First order non-linear - Characteristics - Csmpatible system - Charpit method. Fundamentals: Classification and canonical forms of PDE.

Unit II - Elliptic Differential Equations: Derivation of Laplace and Poisson equation - BVP - Separation of Variables - Dirichlet's Problem and Newmann Problem for a rectangle - Interior and Exterior Dirichlets's problems for a circle - Interior Newmann problem for a circle - Solution of Laplace equation in Cylindrical and spherical coordinates - Examples.

Unit III - Parabolic Differential Equations: Formation and solution of Diffusion equation - Dirac-Delta function - Separation of variables method - Solution of Diffusion Equation in Cylindrical and spherical coordinates – Examples

Unit IV - Hyperbolic Differential Equations: Formation and solution of one-dimensional wave equation - canocical reduction - IVP- d'Alembert's solution - Vibrating string - Forced Vibration - IVP and BVP for two-dimensional wave equation - Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems - vibration of circular membrane - Uniqueness of the solution for the wave equation - Duhamel's Principle - Examples.

Unit V - Green's Function: Green's function for laplace Equation - methods of Images - Eigen function Method - Green's function for the wave and Diffusion equations. Laplace Transform method: Solution of Diffusion and Wave equation by Laplace Transform.

Course Learning Outcomes(CLOs):

CLO-1: Able to solve Partial Differential Equations of First Order.
CLO-2: Understands the Laplace and Poisson equation.
CLO-3: Knowledge of Diffusion equation and Dirac-Delta function
CLO-4: Understand the concept of Hyperbolic Differential Equations.
CLO-5: Knowledge of the Green's function for laplace Equation.

Text books :

S, Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi. 2005.
M.D.Raisinghania, Advanced Differential Equations, S.Chand& Company Ltd., New Delhi, 2001

Reference books :

R.C.McOwen, Partial Differential Equations, 2nd Edn. Pearson Eduction, New Delhi, 2005.
I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.
R. Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.

Online links for study & reference materials :

https://youtu.be/xNqLZnM-PPY
https://youtu.be/gps3wHq87nw

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-204 **Course Name:** OPTIMIZATION TECHNIQUES AND CONTROL THEORY
Course Credit Hour: 5hr **Total Contact Hour:** 60hr

Course Objective:

The primary objectives of a optimization techniques and control theory that it provides techniques for finding a control for a dynamical system over a period of time such that an objective function is optimized. The dynamical system could be a nation's economy, with the objective to minimize unemployment.

Course Description:

Students will learn extended real valued functions, Conjugate functions, Optimality conditions and Lagrange multipliers, Dynamic programming and optimal control problem and formulations

Course Contents:

Unit I - Extended real valued functions, Proper convex functions, Subgradients, Directional derivatives

Unit II - Conjugate functions, Dual convex programs, Optimality conditions and Lagrange multipliers, Duality and optimality for standard convex programs, Gradient descent method, Gradient projection method.

Unit III - Newton's method, Conjugate gradient method, Dynamic programming, Bellman's principle of optimality, Allocation problem, Stage coach problem.

Unit IV - Optimal control problem and formulations, Variational approach to the fixed-time free endpoint problem, Pontryagin's maximum principle, Dynamic programming and Hamilton-Jacobi-Bellman equation.

Course Learning Outcomes(CLOs):

CLO-1: knowledge of Extended real valued functions
CLO-2: Understands the Conjugate functions, Dual convex programs.
CLO-3: Able to solve problems based on Newton's method and Conjugate gradient Method.
CLO-4: Understand the Optimal control problem and formulations.

Text books:

1. F.S. Hillier, G.J. Lieberman, P. Nag and P. Basu, Introduction to Operations Research, Tata McGraw-Hill, 2012.

Reference books:

1.M. Avriel, Nonlinear Programming: Analysis & Methods, Dover Publications, New York, 2003.
2. O. Güler, Foundations of Optimization, Springer 2010.
3. Liberzon, Calculus of Variations and Optimal Control Theory: A Concise Introduction, Princeton University Press, 2012

Online links for study & reference materials:

https://youtu.be/Qneah_lyQ0o
https://youtu.be/LL20TZGXp3Q

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-4	- 05%
Assessment-5	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code : STPGM-301
Course Credit Hour: 5hr

Course Name : TOPOLOGY
Total Contact Hour: 75hr

Course Objective:

Objective 1: Students will learn the fundamentals of point-set topology.
Objective 2: Students will learn the fundamentals of algebraic topology. .
Objective 3: Students will be prepared to begin thesis research.

Course Description:

Solving equations is a crucial aspect of working in mathematics, physics, engineering, and many other fields. These equations might be straightforward algebraic statements, or complicated systems of differential equations, but there are some fundamental questions common to all of these settings: does a solution exist? If so, is it unique? And if we know of the existence of some specific solution, how do we determine it explicitly or as accurately as possible? This course develops the foundations required to rigorously establish the existence of solutions to various equations, thereby laying the basis for the study of such solutions. Through an understanding of the foundations of analysis, we obtain insight critical in numerous areas of application, such areas ranging across physics, engineering, economics and finance. Topics covered are: sets, functions, metric spaces and normed linear spaces, compactness, connectedness, and completeness. Banach fixed point theorem and applications, uniform continuity and convergence. General topological spaces, generating topologies, topological invariants, quotient spaces.Introduction to Hilbert spaces and bounded operators on Hilbert spaces.

Course Contents :

Unit1: Topological Spaces

Definition and examples of topological spaces, Closed sets, Closure, Dense sets. neighborhoods,interior,exterior,andboundary,Accumulationpointsandderivedsets,Basesandsub-bases,Subspaces and relative topology, Alternative methods of defining a topology in terms of Kuratowskiclosureoperator and neighborhoodsystems.

Unit2: Continuous Functions

Continuousfunctionsandhomeomorphism,Firstandsecondcountablespace,Lindelöfspaces,Separablespaces,Theseparationaxioms*T0*,*T1*,*T2*,*T3½*,*T4*,theircharacterizationsandbasicproperties,Urysohn's lemma, Tietzeex tension theorem.

Unit3: Connectedness
Connected spaces and their basic properties, Connectedness of the real line, Components, Locally

connected spaces.

Unit4: Compactness

Compactness,Basicpropertiesofcompactness,Compactnessandfiniteintersectionproperty,Sequential,countable,andB-Wcompactness,Localcompactness,One-point compactification.

Unit 5: ProductTopology

Tychonoff product topology in terms of standard sub-base and its characterizations, Product topologyand separation axioms, connected-ness and compactness (incl. the Tychonoff's theorem), productspaces.

Unit6: Nets and filters

Netsandfilters,theirconvergence,andinterrelation,Hausdorffnessandcompactnessintermsofnet/filterconvergence.

Course Learning Outcomes(CLOs) :

CLO1: Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics. Demonstrate familiarity with a range of examples of these structures.

CLO2: Prove basic results about completeness, compactness, connectedness and convergence within these structures. Use the Banach fixed point theorem to demonstrate the existence and uniqueness of solutions to differential equations.

CLO 3: Demonstrate an understanding of the concepts of Hilbert spaces and Banach spaces, and their role in mathematics. Demonstrate familiarity with a range of examples of these structures.

CLO4: Prove basic results about Hilbert spaces and Banach spaces and operators between such spaces.

CLO5: Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.

CLO6: Demonstrate skills in communicating mathematics orally and in writing.

Text books :

1. G.E.Bredon,TopologyandGeometry,Springer, 2014.
2. J.Dugundji,Topology,Allynand BaconInc.,Boston,1978.
3. J.L.Kelley,GeneralTopology,Dover Publications,2017.

Reference books :

1. J.R.Munkres,Topology,Second Edition,Pearson,2015.
2. T.B.Singh, ElementsofTopology,CRCPress,Taylor&Francis, 2013
3. S.Willard,GeneralTopology,Dover Publications,2004.

Online links for study & reference materials :

https://www.uio.no/studier/emner/matnat/math/MAT4500/h18/dokumenter/topology.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-302 **Course Name:** PROBABILITY THEORY &STATISTICS
Course Credit Hour : 5hr **Total Contact Hour :** 75hr

Course Objective:

This course is intended for students who have completed one semester of calculus and who wish to take an introductory course in probability and statistics. Statistics 50 concentrates on the fundamentals of probability, sample spaces, combinatorics, and random variables. Density and distribution functions, expectation, variance, and covariance, the binomial, uniform poisson, negative binomial, hypergeometric, exponential, and normal distributions, gamma beta, central limit theorem, confidence interval estimation, and hypothesis tests. Students will be given periodic writing assignments which encourage them to think through concepts of the course.

Course Description:

Sample spaces, combinatorics, and random variables.Density and distribution functions.Expectation, variance, and covariance.The binomial, uniform, poisson, negative binomial, hypergeometric, exponential, and normal distributions.Sampling distributions, estimation, and hypothesis tests.Graded: Graded Student.

Course Contents:

Unit 1: Probability Theory and Characteristic Function

Introduction to Probability Theory, Bayes' Theorem, Random Variables and Distribution Functions, Probability mass function, Probability density function Two Dimensional Random Variables-Joint,MarginalandConditionalDistributions,IndependenceofRandomVariables.MomentsofRandomVariables-Expectation,Variance,momentgeneratingfunction,cumulantsgeneratingfunction,characteristicgeneratingfunction.

Unit2: Distributions

Binomial,Poissondistributions,NegativeBinomialDistribution,Polynomialdistribution,Hypergeometricdistribution,Uniform(continuous),Normaldistribution,Beta-IandBeta-II,GammaDistribution, Laplace distributions, distribution of mean and variance, distribution of differences of means and variances, t distribution, F distribution, Chi-Square distribution.

Unit3: Survey Sampling

Probability sampling designs, sampling schemes, inclusion probabilities and estimation; Fixed (Design-based)andSuperpopulation(model-based)approaches;Reviewofimportantresultsinsimpleandstratified random sampling; Sampling with varying probabilities (unequal probability sampling) with orwithout replacement – ps sampling procedures and estimation based on them; Non-negative variance psand non-ps,estimation; Two-way stratification, post-stratification, controlled sampling; Estimationbased on

auxiliary data (involving one or more auxiliary variables) under design-based and model-basedapproaches;Double(two-phase)samplingwithspecialreferencetotheselectionwithunequalprobabilitiesinatleastoneofthephases;systematicsamplinganditsapplicationtostructuredpopulations; Cluster sampling (with varying sizes of clusters); Two-stage sampling (with varying sizes offirst-stageunits).

Unit4:Design of Experiments

Review of linear estimation and basic designs. ANOVA: Fixed effect models (2-way classification with unequal and proportional number of observations per cell), Random and Mixed effect models (2-wayclassification with m (>1) observations per cell), Incomplete Block Designs, Concepts of Connectedness, Orthogonally and Balance, Intra block analysis of General Incomplete Block design, B.I.B designs with and without recovery of inter block information.

Course Learning Outcomes (CLOs) :

At the end of the course students should be able to:

CLO1: Develop problem-solving techniques needed to accurately calculate probabilities.

CLO2: Apply problem-solving techniques to solving real-world events.

CLO3: Apply selected probability distributions to solve problems.

CLO4: Present the analysis of derived statistics to all audiences.

Text books:

1. MeyerP.L.,IntroductoryProbabilityandStatisticalApplications(AddisonWesley)
2. Goon,A.M.,Gupta,M.K.andDasgupta.B.(1985):AnOutlineofStatisticalTheory,Vol.I(WorldPress).

Reference books:

1. FreundJ.E. -MathematicalSatistics(PrenticeHall)
2. MukhopadhyayaP.(1996)Mathematical Statistics(NewCentralBookAgency)

Online links for study & reference materials :
http://www.utstat.toronto.edu/mikevans/jeffrosenthal/book.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-303 **Course Name:** OPERATION RESEARCH
Course Credit Hour: 5hr **Total Contact Hour:** 75hr

Course Objective:

Objective 1: Methodology of Operations Research. Linear programming: solving methods, duality, and sensitivity analysis.
Objective 2:Integer Programming. Network flows. Multi-criteria decision techniques.
Objective 3 Decision making under uncertainty and risk.Game theory. Dynamic programming

Course Description :

1 .To impart knowledge in concepts and tools of Operations Research
2. To understand mathematical models used in Operations Research
3. To apply these techniques constructively to make effective business decisions

Course Contents:

Unit 1:

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP.SimplexMethod,Artificialvariables,big-Mmethod,two-phasemethod,degeneracyandunboundsolutions.

Unit 2:

TransportationProblem.Formulation,solution,unbalancedTransportationproblem.Findingbasicfeasible solutions – Northwest corner rule, least cost method, Assignment model, Hungarian method foroptimalsolution.Solvingunbalancedproblem.Travelingsalesmanproblemandassignment problem.

Unit 3:

GamesTheory.Competitivegames,rectangulargame,saddlepoint,minimax(maximin)methodofoptimalstrategies,valueofthegame.Solutionofgameswithsaddlepoints,dominanceprinciple.Rectangulargameswithoutsaddlepoint–mixedstrategyfor2X2games.ReplacementModels.Replacement of Items that Deteriorate whose maintenance costs increase with time without change in themoney value. Inventory models. Inventory costs. Models with deterministic demand and probabilisticdemand

Unit 4:

Integer linear programming: Modeling using ,Branch and bound technique, Gomory's cutting plane algorithm, 0-1 programming problem, E-Bala's additive algorithm,Lineargoalprogramming:Modelingusinggoalprogramming,Archimedeangoalprogramming,Preemptivegoalprogramming,Graphicalmethod, Lexicographic simplex method.

Linear fractional programming:Generalizedconvexityverification,Simplexmethod,Charne'sandCooper method, Mathematical programming algorithms: Penalty functions method, Barrier functions method, Frankand Wolfe's method, Method ofreduced gradient, Convex simplex method.

Unit5:

Geometric Programming: Constrained and Unconstrained Minimization Problems.

Stochastic Programming: Stochastic Linear and Stochastic Nonlinear Programming, Netwok Schedulig by PERT/CPM.

Course Learning Outcomes (CLOs) : Students will be able to know :

CLO1: Identify and develop operational research models from the verbal description of the real system. CLO2: Understand the mathematical tools that are needed to solve optimization problems.

CLO3: Use mathematical software to solve the proposed models.

CLO4: Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

Text Books:

1. Gass,S.I.(1985).Linearprogramming-methodsandapplications(5thed.).New York:McGrawHill(Doveredition2003isalsoavailable).
2. Hadley,G.(2002).Linearprogramming.NewDelhi:NarosaPublishingHouse.
3. Hillier,F.S.,&Lieberman,G.J.(2010).Introductiontooperationsresearch-conceptsandcases(9thed.). New Delhi:TataMcGraw Hill (Indian print).

Reference books :

1. Ravindran,A.,Phillips,D.T.,&Solberg,J.J.(2005).Operationsresearch-principlesandpractice(2nd ed.). New Delhi:WileyIndia (P.) Ltd. (Indianprint).
2. Taha,H.A.(2007).Operationsresearch-anintroduction(8thed.).NewDelhi:PearsonPrenticeHall(Indian print).
3. Hadley,G.,&Whitin,T.M. (1963).Analysisofinventorysystems.Prentice-Hall.
4. Bazara,M.S.,Sherali,H.D.,&Shetty,C.M.(2006).Nonlinearprogramming-theoryandalgorithms(3rded.).New Delhi:John Wiley&Sons (Indian print).

Online links for study & reference materials :

https://web.itu.edu.tr/topcuil/ya/OR.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-304 **Course Name:** COMPUTER FUNDAMENTALS AND C PROGRAMING
Course Credit Hour: 4hr **Total Contact Hour :** 60hr

Course Objective:

Programming forms the core of Computer Science. Other aspects of the subject are either side-issues, or specializations from the basic programming core. Therefore Introduction to Programming is the core first-year course in all our Computer Science degrees, and is an essential prerequisite to almost all that follows in the second and third year.

Programming is about writing the instructions which a computer follows to enable it to store knowledge, process knowledge, and communicate knowledge with the outside world. Stemming from storing knowledge we can move into data structures and databases. Stemming from processing knowledge we can move into algorithms and computations. Stemming from communicating knowledge we can move into human-computer interaction and network issues. We can look in more detail at what is actually happening when a computer runs programs, considering how the instructions we write are translated to real changes in the electronic mechanisms of computer machinery. We can step back and consider more generally how we can organize the process of writing computer programs. We can develop mathematics to help us describe and analyze the behavior of computer programs. We can look at some of the common applications of computers, and methods of programming those applications. We can think of new things we would like computers to do for us, and try and work out how we can write programs to make them do those things.

Course Description:

In a Computer Science degree we aim to teach you skills that will be relevant many years in the future. That is not always easy because we know computers and computing are changing rapidly. The machines, computer applications and even the role of computers in society today are very different from what they were ten, twenty or thirty years ago, and we can be sure that they will be different again ten, twenty or thirty years into the future. That is why we don't see our job as giving detailed training in whatever are the current leading systems on the market. Instead we are concerned with teaching more general principles. However, programming is a practical subject: you will be taught enough to be able to write real working programs, albeit ones on a much smaller scale than those used in industry or sold as commercial software applications.

Course Contents:

Unit-I

Fundamental: H/W and S/W part of computer system, Computer Block Diagram, online processing,time sharing system, real time system, batch system, multiprogramming, multiprocessing, SPOOLING,distributed data processing. Element of computer file, types of files, file processing activities, file designfactors,access methods, prosandcons offile organization

Unit-II

MS office: Introduction to MS Office; Introduction to MSWord; Features & area of use. Working withMS Word.; Menus & Commands; Toolbars & Buttons; Shortcut Menus, Wizards & Templates; Creatinga New Document; Different Page Views and layouts; Applying various Text Enhancements; Workingwith – Styles, Text Attributes; Paragraph and Page Formatting; Text Editing using various features ;Bullets,Numbering, Auto formatting,Printing&various printoptions

Unit-III

MSExcel: Introductionandareaofuse;WorkingwithMSExcel.;conceptsofWorkbook&Worksheets; Using Wizards; Various Data Types; Using different features with Data, Cell and Texts;Inserting, Removing & Resizing of Columns & Rows; Working with Data & Ranges; Column Freezing,Labels,Hiding,Splittingetc.;UsingdifferentfeatureswithDataandText;UseofFormulas,Calculations & Functions; Cell Formatting including Borders & Shading; Working with Different ChartTypes;Printingof Workbook.

Unit-IV

Elements ofC: Ccharacterset, identifiers andkeywords,Data types:declaration anddefinition,storageclassesin C,Type conversion, Typesoferror,'C' macro, macrovs function.
Operators: Arithmetic,relational,logical,bitwise,unary,assignmentandconditionaloperatorsandtheirhierarchy&associativity. Datainput/output.
Controlstatements: Sequencing,Selection:ifandswitchstatement;alternation,Repetition:for,while,anddo-whileloop;break, continue, goto.

Unit-V

Functions: Definition,prototypes,passingparameters,recursion.
DataStructures: arrays,structure,union,string.
Pointers: Declaration,operationsonpointers,arrayofpointers,pointerstoarrays.
String&filehandling,Streams,StringI/O,FileOperations,FormattedI/O,CharacterI/O,**LineI/O,BlockI/O,File positioning, File handling.**

Course Learning Outcomes(CLOs) : This course will enable the students to:

CLO1: Understandandapplytheprogrammingconceptsof C++forsolvingmathematicalproblems.

CLO2: Apply to find greatest common divisors, generator and numbers, understand Cartesian geometry and algebraic concepts through programming.

CLO3: Representtheoutputsofprogramsvisuallyintermsofwellformattedtextandplots.

Text Books:

1. JoeHabraken,Microsoft Office2000,8in1by,PrenticeHallofIndia
2. Deitel&Deitel:CHowtoProgram(PrenticeHall),1996.
3. YashwantKanetker,LetusC,BPBPublications.

Reference books :

1. R.B.Patel,FundamentalofComputersandProgramminginC,KhannaBookPublishingCompanyPVT. LTD.Delhi,India,1stedition,2008,ISBN: 13: 978-81-906988-7-0, pp.1-962.
2. Gottfried,ProgrammingwithC,TataMcGrawHill.
3. BrianW.Kernighan,DennisM.Ritchie,TheCProgrammingLanguage,2ndEd.,PrenticeHallofIndia

Online links for study & reference materials :

https://vardhaman.org/wp-content/uploads/2018/12/Computer%20Programming.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-401
Course Credit Hour : 5hr
Course Name: Integral Equations
Total Contact Hour : 75hr

Course Objective :

The integral equation, its classification, different types of kernals.and the relationship between the integral equations and ordinary differential equations and how to solve the linear and non linear integral equations by different methods with some problems which give rise to integral equations.

Course Description:

This course emphasizes concepts and techniques for solving integral equations from an applied mathematics perspective. Material is selected from the following topics: Volterra and Fredholm equations, Fredholm theory, the Hilbert-Schmidt theorem; Wiener-Hopf Method; Wiener-Hopf Method and partial differential equations; the Hilbert Problem and singular integral equations of Cauchy type; inverse scattering transform; and group theory. Examples are taken from fluid and solid mechanics, acoustics, quantum mechanics, and other applications.

Course Contents:

Unit1:

Preliminaryconceptsofintegralequations,Someproblemswhichgiverisetointegralequations,Conversion of ordinary differential equations into integral equations, Classification of linear integralequations.

Unit2:

Fredholm integral equations of second kind with separable kernels, Eigen Values and Eigen functions,Reductiontoasystemofalgebraicequations,AnapproximateMethod,Methodofsuccessiveapproximations, Iterative scheme, Condition of convergence and uniqueness of series solution, Resolventkernel and itsresults, Fredholmtheorems.

Unit3:

Solution of Volterra's integral equations by iterative scheme, Successive approximation, Resolvent kernel,Integral transform methods: Fourier transform, Laplace transform, Convolution integral, Application toVolterraintegralequationswith Convolution typekernels.

Unit4:

Symmetric kernel, Complex Hilbert space, Orthonormal system of functions, Fundamental properties ofeigen values and eigen functions for symmetric kernels. Expansion in eigen function and bilinear form,HilbertSchmidttheorem,SolutionofintegralequationswithsymmetrickernelsSingularIntegralEquations

- Inversion formula for singular integral equation with kernel of type (h(s) - h(t) - a, 0< a <1).DiracDelta Function.

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: recognize difference between Volterra and Fredholm Integral Equations, First kind and Second kind, homogeneous and inhomogeneous etc.

CLO2: They apply different methods to solve Integral Equations.

CLO3: Students will have much better and deeper understanding of the fundamental concepts of the space of admissible variations and concepts of a weak and a strong relative minimum of an integral.

CLO4: demonstrate a depth of understanding in advanced mathematical topics in relation to geometry of curves and surfaces

Text books :

1. R.P.Kanwal,Linear Integral Equation.TheoryandTechniques, AcademicPress, NewYork,1971.
2. S.G.Mikhlin,LinearIntegral Equations(translatedfromRussian),HindustanBookAgency,1960.
3. AbdulJ.Jerri,IntroductiontoIntegralEquationswithApplications.

Reference books :

1. Hildebrand.F.B-MethodofAppliedMathematics.
2. L.G.Chambers,IntegralEquations: AshortCourse,Int. Text BookCompanyLtd. 1976.
3. HarryHochsdedt,*IntegralEquations*.

Online links for study & reference materials :

https://services.math.duke.edu/~jtwong/math551-2019/lectures/Integrals1_Fredholm_IEs.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM-402 **Course Name:** FUNCTIONAL ANALYSIS
Course Credit Hour: 5hr **Total Contact Hour:** 75hr

Course Objective:
This course provides students with results and methods that are applicable to other areas of mathematics, and are the foundations for more advanced topics in functional analysis.

The Hahn-Banach theorem, the open mapping and closed graph theorems, the Banach-Steinhaus theorem, dual spaces, weak convergence, the Banach-Alaoglu theorem, and the spectral theorem for compact operators.

Course Description:

1. The student has knowledge of central concepts from functional analysis, including the Hahn-Banach theorem, the open mapping and closed graph theorems, the Banach-Steinhaus theorem, dual spaces, weak convergence, the Banach-Alaoglu theorem, and
   The spectral theorem for compact self-adjoint operators.
2. The student is able to apply his or her knowledge of functional analysis to solve mathematical problems.

Course Contents :

Unit 1:Banach Spaces

Definition-Someexamples-ContinuousLinearTransformations-TheHahn-BanachTheorem-Thenatural embeddingofNin N**

Unit2:BanachSpacesAndHilbertSpaces

Openmappingtheorem-conjugateofanoperator-Definitionandsomesimpleproperties-Orthogonalcomplements-Orthonormalsets

Unit3:Hilbert Space

ConjugatespaceH*- Adjointofanoperator- Self-adjointoperator- NormalandUnitaryOperators-Projections

Unit4: Preliminaries On Banach Algebras

Definitionandsomeexamples-Regularandsingleelements-Topologicaldivisorsofzero-spectrum-the formula forthe spectralradius-the radicaland semi-simplicity.

Unit5:StructureOfCommutativeBanachAlgebras

Gelfandmapping-Applicationsoftheformular(x)=lim7x^n7$^{1/n}$-InvolutionsinBanachAlgebras-Gelfand-NeumarkTheorem.

Course Learning Outcomes(CLOs) :

Students will able to know as

CLO1: work comfortably with Banach spaces.

CLO2: Exposure embedded of a normed linear spaces and their compatibilities.

CLO3: Enhance the knowledge regarding L p spaces and its application.

CLO4: Able to understand Hilbert space and its applications.

CLO5: Ability to acquire knowledge of orthogonal sets and operators.

Text books :

1. G.F.Simmons, *IntroductiontoTopologyandModernAnalysis*,McGraw-Hill,1963.
2. G.BachmanandL.Narici,*Functional Analysis*,AcademicPress,1966.
3. A.E.Taylor,*IntroductiontoFunctional Analysis*,JohnWiley,1958.
4. B.V.Limaye,*Functional Analysis*,WileyEastern.

Reference books :

1. N.DunfordandJ.T.Schwartz, *LinearOperators*, Part-I,Interscience,1958.
2. R.E.Edwards,*FunctionalAnalysis*,Holt RinehartandWinston, 1965.
3. C.GoffmanandG.Pedrick,*FirstCourseinFunctionalAnalysis*,Prentice-HallofIndia,1987.
4. K.K.Jha,*FunctionalAnalysisandItsApplications*,Students' Friend,1986

Online links for study & reference materials :

https://www.mimuw.edu.pl/~aswiercz/AnalizaF/lecture.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 411 **Course Name:** FLUID DYNAMICS
Course Credit Hour: 5hr **Total Contact Hour:** 75hr

Course Objective:

To give the student 1) a foundation in the fundamentals of fluid mechanics; 2) practice in the analytical formulation of fluid mechanics problems using Newton's Laws of motion and thermodynamics; 3) an introduction to experimental methods; and 4) an exposure to practical applications, work on a small design project, and the writing of a technical report related to the design project.

Course Description:

Covers properties of fluids, laws of fluid mechanics and energy relationships for incompressible fluids. Studies flow in closed conduits, including pressure loss, flow measurement, pipe sizing and pump selection.

Course Contents:

Unit1:
Kinematics of fluid-Lagrangian and Eulerian methods, Stream lines, Path lines, Streak lines, Velocitypotential,Irrotational and rotational motions.Vortexlines,Equation ofContinuity.

Unit2:
Lagrangian and Eulerian approach, Euler's equation of motion, Bernoulli's theorem, Kelvin circulationtheorem,Vorticityequation, Energyequation for an incompressibleflow.

Unit3:
Boundary conditions, Kinetic energy of liquid, Axially symmetric flows, Motion of a sphere through aliquid at rest at infinity, Liquid streaming past a fixed sphere, Equation of motion of a sphere, Sources,Sinksanddoublets,Imagesinarigidimpermeableinfiniteplaneandinimpermeablesphericalsurfaces.

Unit4:
Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in aninfinitemassof liquid,Streamfunctions,Stokesstreamfunctions,Complex velocitypotential.

Unit5:

Conformal mapping, Milne-Thomson Circle theorem, Blasius theorem, Vortex Motion and its elementary properties, Kelvin's proof of permanence, Motion due to rectilinear vortices.

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: Identify how properties of fluids change with temperature and their effect on pressure and fluid flow.
CLO2: Describe fluid pressure and its measurement.
CLO3: Define the relationship between pressure and elevation as it relates to manometers, barometers and other pressure measuring devices.
CLO4: Calculate forces on a plane submerged in static fluid. Calculate buoyancy on a body submerged in a static fluid.
CLO5: Use the general energy equation to calculate changes in fluid flow for circular and non-circular pipes for in-compressible fluids. Select a pump type and pump size to meet capacity and other pumping requirements.

Text books:

1. F.Chorlton,TextBookofFluidDynamics,CBSPublisher,2005.
2. R.W.Fox,P.J.PritchardandA.T.McDonald,IntroductiontoFluidMechanics,SeventhEdition,John Wiley&Sons, 2009.

Reference books :

1. P.K.Kundu,I.M.Cohen,D.R.Dowling,FluidMechanics,SixthEdition,AcademicPress,2016.

Online links for study & reference materials :

https://www.meteo.physik.uni-muenchen.de/lehre/roger/manuskripte/Fluid_Dynamics.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	-

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 412
Course Credit Hour: 5hr

Course Name: DIFFERENTIAL GEOMETRY
Total Contact Hour: 75hr

Course Objective:

The course introduces the fundamentals of differential geometry primarily by focussing on the theory of curves and surfaces in three space. The theory of curves studies global properties of curves such as the four vertex theorem. The theory of surfaces introduces the fundamental quadratic forms of a surface, intrinsic and extrinsic geometry of surfaces, and the Gauss-Bonnet theorem.

Course Description:

Students should acquire knowledge about the application of methods of differential and integral calculus to the study of geometry with emphasis on the differential geometry of surfaces. They should be able to apply this knowledge independently to analyze and solve mathematical problems in contexts where methods of differential geometry are relevant.

Course Contents:

Unit 1: Curves with torsion: Tangent, Principal Normal, Curvature, Binomial, Torsion, Serret Frenet formulae, Locus of center of spherical Curvature.

Unit2: Envelopes: Surfaces,Tangent plane, Envelope, Characteristics, Edge of regression

Unit3: Curvilinear Co-ordinates : First order magnitude, Directions on a surface, Second order magnitudes, Derivative of unit normal, Principal directions and curvatures.

Unit4: Geodesics: Geodesic property, Equations of geodesics, Torsion of a geodesic

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: Calculate the curvature and torsion of a curve.

CLO2: Find the moving trihedron of a curve and write its intrinsic and canonical equations.

CLO3: Find the osculating surface and the osculating curve at any point of a given curve.

CLO4: Calculate the first and the second fundamental forms of a surface.

Text books:

1. C.E.,Weatherburn,Differential GeometryofThreeDimensions.
2. J. A. Thorpe, Elementary Topics in Differential Geometry, Springer-Verlag, New York, 1979.
3. B. O'Neill, Elementary Differential Geometry. (Revised Second Edition), Elsevier/Academic Press, San Diego CA, 2006

Reference books :

1. R. S. Millman and G. D. Parker, Elements of Differential Geometry, Prentice-Hall, Englewood Cliffs, NJ, 1977.
2. M. P. doCarmo, Differential Geometry of Curves and Surfaces, Prentice-Hall, Saddle River NJ, 1976.

Online links for study & reference materials :

http://www.wisdom.weizmann.ac.il/~yakov/scanlib/hicks.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 413
Course Credit Hour: 5hr

Course Name: ALGEBRIC NUMBER THEORY
Total Contact Hour: 75hr

Course Objective:

Object 1: The concept (definition and significance) of algebraic numbers and algebraic integers.

Object 2: How to factories an algebraic integer into irreducible.

Object 3: How to find the ideals of an algebraic number ring. The definition of the Class Group.

Course Description:

Algebraic Numbers, including bases, norm, trace, and the ring of integers. Modules, Integral Dependence and Noetherian Domains.

Factorisation in rings of integers, discriminant, examples of uniqueness and non-uniqueness of factorisation.Factorisation of ideals, the Class Group and the Class Number.

Course Contents:

Unit1: Primesincertainarithmeticalprogressions.FermatnumbersandMersennenumbers.Approximation of irrational numbers by rationals. Hurwitz's theorem, irrationality of e and π. System oflinearcongruencesChineseRemainderTheorem.Quadraticresiduesandnonresidues.Legendre'sSymbol.Gauss Lemmaand itsapplications.QuadraticLawofReciprocityjacobi'sSymbol.

Unit 2: Riemann Zeta Function ξ(s) and its convergence. Application in prime numbers. ξ(s) as Euler'sproduct. Evaluation of ξ(2) and ξ(2k). Dirichlet series with simple properties. Dirichlet series as analyticfunctionandits derivative.Eulers products.Introduction to modularforms.

Unit3: Euler'ssummationformulaandsomeelementaryasymptoticformula.Averageorderofthearithmeticalfunctionsd(n),σa(n),φ(n),μ(n)andΛ(n).PartialsumsofaDirichletproductandtheir applicationtoμ(n)andΛ(n).

Unit4: Chebyshev'sfunctionsΨ(x)andν(x)andrelationbetweenν(x)andπ(x).Shapiro'sTauberiantheoremanditsapplications.Partialsumsof theMobiusfunction.Selberg'sasymptoticformula.

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: define the key notions of algebraic number theory and outline their interrelation;

CLO2: calculate the most important number theoretical quantities introduced during the course;

CLO3: give an account of the fundamental theorems of the course and apply them in specific cases;

CLO4: outline important parts of the theory presented during the course, such as the deduction of the four-squares theorem from Minkowski's theorem and Kummer's proof of Fermat's great theorem for regular prime exponents;

Text books:

1. T.M.Apostol.IntroductiontoAnalyticnumbertheory(NarosaPublishingHouse1980).
2. T.M.Apostol.ModularfunctionsandDirichletseriesin NumberTheory(Springer-Verlag1976).

Reference books :

1. J.P.Serre. ACourse inArithmetic G.T.M.Vol.7(SpringerVerlag1973).

Online links for study & reference materials :

http://people.math.gatech.edu/~mbaker/pdf/ANTBook.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 414
Course Name: DISCRETE MATHEMATICS
Course Credit Hour: 5hr
Total Contact Hour: 75hr

Course Objective :

To develop logical thinking and its application to computer science (to emphasize the importance of proving statements correctly and de-emphasize the hand-waving approach towards correctness of an argument). The subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument. About 40% of the course time will be spent on logic and proofs and remaining 60% of the course time will be devoted to functions, relations, etc.

Course Description:
Basic set theory and symbolic logic.Methods of proofs, including mathematical induction.Relations, functions, and partitions; modular arithmetic.

Course Contents :

Unit1: Lattices

1. PropertiesandexamplesofLattices
2. Distributivelattices
3. Booleanalgebras
4. Booleanpolynomials
5. MinimalFormsof BooleanPolynomials.

Unit2: Applicationsoflattices

6. SwitchingCircuits
7. ApplicationsofSwitchingCircuits

Unit3: Finite fields and polynomials

8. Finitefields

Unit4:Finite fields and polynomials

9. IrreduciblePolynomialsoverFinitefields
10. FactorizationofPolynomialsoverFinitefields

Unit 5:Coding theory

11. LinearCodes
12. CyclicCodes

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: Learn about partially ordered sets, lattices and their types.

CLO2: Understand Boolean algebra and Boolean functions logic gates, switching circuits and their applications.

CLO3: Solve real-life problems using finite-state and Turing machines.

CLO4: Assimilatevariousgraphtheoreticconceptsandfamiliarizewiththeirapplications.

Text books:

1. Rudolf Lidl & Gunter Pilz. Applied Abstract Algebra, Second Indian Reprint2006,SpringerVerlag, NewYork.
2. A.Gill,AppliedAlgebraforComputerScience,PrenticeHallInc.,NewJersey.

Reference books:

1. J.L.Gersting,MathematicalStructuresforComputerScience(3rdEdn.),ComputerSciencePress,NewYork.
2. S.Wiitala,DiscreteMathematics-AUnifiedApproach,McGrawHillBookCo.

Online links for study & reference materials:

https://home.iitk.ac.in/~arlal/book/mth202.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 421 **Course Name:** MATHEMATICAL MODELLING
Course Credit Hour: 5hr **Total Contact Hour:** 75hr

Course Objective:

The objectives of this course are to:
1. Enable students understand how mathematical models are formulated, solved, and interpreted.
2. Make students appreciate the power and limitations of mathematics in solving practical real-life problems.
3. Equip students with the basic mathematical modeling skills.

Course Description:

This course is an introductory course on Mathematical Modeling. It is designed for students studying mathematical sciences (i.e. Mathematics and Statistics). It may, however, be useful to students in sciences, engineering and other related fields. It introduces students to basic concepts in mathematical modeling. It also equips the students with mathematical modeling skills with emphasis on using mathematical models to solve real-life problems. Topics to be covered in this course includes: methodology of model building, problem identification and definition, model formulation and solution, consideration of varieties of models involving equations like algebraic, ordinary differential equation, partial differential equation, difference equation, integral and functional equations, consideration of some specific applications of mathematical models to biological, social, and behavioral sciences.

Course Contents:

Unit1:

Introduction, basic steps of Mathematical Modeling, its needs, types of models, limitations. Elementary ideas of dynamical systems, autonomous dynamical systems in the plane-linear theory. Equilibrium point, node,saddle point, focus,centre and limit-cycleide as with simple illustrations and figures.

Unit2:

Linearizationofnon-linearplaneautonomoussystems.MathematicalModelinginthebiologicalenvironment.Bloodflowandoxygentransfer.Modelingbloodflow,viscousity,Poiseuillelaw,mathematicalformulationoftheproblem,solutionandinterpretation.Oxygentransferinredcells,diffusion,mathematicalformulation,solution,interpretation,andlimitations.

Unit3:

Single species population models.Basic concepts. Exponential growth model, formulation, solution,interpretation,andlimitations.Compensationanddepensation.Logisticgrowthmodel,formulation,solution,interpretation, andlimitations.

Unit4:

Gompertz growth model, formulation, solution, interpretation, and limitations.Two species populationmodels.Types of interaction between two species.Lotka-VolteiTa prey-predator model, formulation,solution, interpretation, arid limitations.Lotka-Volterra model of two competing species, formulation,solution,interpretation, andlimitations.

Unit5:

Mathematical modeling of epidemics.Basic concepts.Simple epidemic model, formulation, solution,interpretation,andlimitations.Generalepidemicmodel,formulation,solution,interpretation,andlimitations.

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CLO1: understand what a mathematical model is and explain the series of steps involved in a mathematical modeling process. state and explain the different classifications of mathematical models stating examples in each classes

CLO2: explain the essential features of a good model and discuss the benefits of using a mathematical model.

CLO3: Identify some simple real-life problems that can be solved using mathematical models, model the problem(s), solve the resulting problem, and interpret the solution.

CLO4: Mention and discuss some applications of mathematical modeling in solving problems in engineering, physical, biological, social and behavioral sciences

CLO5: Acquire basic mathematical modeling skills that will enable them carry out simple modeling tasks individually or as a group.

Text books:

1. RutherfordAris,MathematicalModellingTechniques,DoverPublicationsInc.;1994.
2. Berry J. And Houston K. (1995). Mathematical Modelling. Edward Arnord , London, United Kingdom. 142p.

Reference books:

1. Finkelstein, L and Carson E.R. (1985). Mathematical Modelling of Dynamic Biological Systems (2nd Edition). Research Studies Press, Herfordshire, England. 355p

Online links for study & reference materials:

https://core.ac.uk/download/pdf/12518237.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 422 **Course Name:** CALCULUS ON R^n
Course Credit Hour: 5hr **Total Contact Hour:** 75hr

Course Objective :

This course desined in the form of a knowledge which gives homotopy, BrouwerFixedPointTheorem and gives a brief intro about Van Kampen's Theorem and gives the application of homology.

Course Description:

Be able to analyze, test, interpret and form independent judgments in both academic and non-academic contexts and Recognize and appreciate the connections between theory and applications Have an appropriate set of professional skills to ensure a productive career.

Course Contents:

Unit1:

Pathsandhomotopy,homotopyequivalence,contractibility,deformationretracts,Basicconstructions:cones, mappingcones, mappingcylinders,suspension.

Unit2:

Cellcomplexes,subcomplexes, CWpairs.
Fundamentalgroups.Examplesandapplications,BrouwerFixedPointTheoremandBorsuk-UlamTheorem.

Unit3:

Van Kampen's Theorem, Covering spaces, lifting properties, deck transformations.universal coverings.Simplicialcomplexes,barycentricsubdivision,starsandlinks,simplicialapproximation.SimplicialHomology.

Unit4:

Singular Homology.Mayer-Vietoris Sequences.Long exact sequence of pairs and triples.Homotopyinvarianceand excision,Degree.Cellular Homology.

Unit5:

Applicationsofhomology:Jordan-Brouwerseparationtheorem,Invarianceofdimension,Hopf'sTheorem for commutative division algebras with identity, Borsuk-Ulam Theorem, Lefschetz Fixed PointTheorem.

Course Learning Outcomes (CLOs) :

On successful completion of the course students will be able to

CO1: Apply the logic theory to practical situations for drawing conclusions

CO2: Analyze statements of Simplicial complexes.

CO3: Write and interpret mathematical notation and mathematical definitions
CO4: Construct and restate various theorems using logical arguments of Cellular Homology.
CO5: Unravel abstract definitions, create intuition-forming examples or Borsuk-Ulam Theorem examples, and prove Lefschetz Fixed PointTheorem.

Text books:

1. EdwinH.Spanier,AlgebraicTopology,SpringerVerlag,1966.

Reference books:

1. **B**ittinger,Surgent, Addison-Wesley "Calculus and its Applications"10ed ,2012

Online links for study & reference materials:

http://people.math.harvard.edu/~shlomo/docs/Advanced_Calculus.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Structure Template

L	T	P
4	1	0

Course Code: STPGM- 423
Course Name: REGRESSION ANALYSIS
Course Credit Hour: 5hr
Total Contact Hour: 75hr

Course Objective:

Regression is perhaps the most widely used statistical technique. It estimates relationships between independent variables and dependent variables. Regression models can be used to help understand and explain relationships among variables; they can also be used to predict actual outcomes.

In this course you will learn how to derive multiple linear regression models, how to use software to implement them, and what assumptions underlie the models. You will also learn how to test whether your data meets those assumptions, what can be done when those assumptions are not met, and strategies to build and understand useful models.

Course Description:

A conceptual and practical introduction to the basic concepts and techniques of regression analysis:
1. Learn how to apply linear regression models in practice: identify situation where linear regression is appropriate; build and fit linear regression models with software; interpret estimates and diagnostic statistics; produce exploratory graphs.
2. Learn about the theory underlying point estimation, hypothesis and confidence intervals for linear regression models.

Course Contents:

Unit 1

Simple and multiple linear regression models %G—%@ estimation, tests and confidence regions. Checkfornormalityassumption.
Likelihoodratiotest,confidenceintervalsandhypothesestests;testsfordistributional assumptions.

Unit 2

Collinearity,outliers;analysisofresiduals,Selectingthe$(B!H(BBest$(B!I(Bregressionequation,transformationofresponsevariables.Ridge's regression.

Unit 3

Natureofeconometrics.Thegeneral linear model(GLM)anditsextension.Ordinaryleast squares (OLS)estimationandprediction.Generalizedleastsquares(GLS)estimationandprediction.Heteroscedasticdisturbances.

Course Learning Outcomes(CLOs) :

On successful completion of the course students will be able to

CLO1: Interpretation of linear regression models

CLO2: Relationship between correlation and linear regression and Regression coefficients

CLO3: Interpretation of interaction termsInterpretation of linear regression models

Text books :

1. B.L.BowermanandR.T.O'Connell,LinearStatisticalModels:AnAppliedApproach,PWS-KENTPub.,Boston, 1990
2. N.RDraper.AndH.Smith.,AppliedRegressionAnalysis,JohnWileyandSons(Asia)Pvt.Ltd.,Seriesin Probabilityand Statistics,2003.

Reference books :

1. D.C.Montgomery,E.A.Peck,G.G.Vining,IntroductiontoLinearRegressionAnalysis,JohnWiley NY, 2003
2. A.A.SenandM.Srivastava,RegressionAnalysis%G–%@Theory,Methods&Applications,
3. Springer-Verlag,Berlin,1990.

Online links for study & reference materials:

http://spartan.ac.brocku.ca/~jvrbik/MATH3P82/notes.pdf

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**