Syllabus for M.Phil in Applied Mathematics Program

M.Phil Applied Mathematics Programs:

S.No	Subject	Code	Credit Hours	Semester	Approved / To be Approved
1	ADVANCED LINEAR ALGEBRA	MTH 635	3	First	Approved
2	ADVANCED DIFFERENTIAL EQUATIONS	MTH 625	3	First	Approved
3	SCIENTIFIC COMPUTING	MTH 605	3	First	Approved
4	APPLIED STATISTICS	MTH 665	3	Second	Approved
5	OPERATIONS RESEARCH AND OPTIMIZATION	MTH 655	3	Second	Approved
6	COMPUTATIONAL FLUID DYNAMICS	MTH 615	3	Second	Approved
7	FINITE ELEMENT ANALYSIS	MTH 745	3	Third	Approved
8	MODELING AND SIMULATION	MTH 705	3	Third	Approved

MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO
DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject	**: Advanced Differential Equations**	**Marks:100**
Discipline	**: M.Phil in Applied Mathematics**	
Code	**: MTH 625**	
Pre-requisites	**: Differential Equations**	
Assessment	**: 10% Sessional work, 30% mid semester, 60% final examination**	
Credit Hours	**: 03**	**Minimum Contact Hours : 42**

Aims **:** To give the idea of differential equations and its applications in the engineering.

Object **:** After completion of this course the student should be able to:

: Know the solution techniques of Ordinary and Partial differential equations

Contents: Ordinary Differential Equations:

Bessel's equation, Legendre's equation, Hermite equation, Laguerr's equation, Strum – Liouville problem, Eigen Functions and Eigen values, Significant use of phase – plane diagrams and associated concepts, equilibrium points, Orbits, Limit cycles and domain of attractions.

Partial Differential Equations:

PDE and its types, Classification of PDE, Method of separation of variables, D'Alembert's method, PDE with constant and variable coefficients, Solution of Laplace, Heat and Wave equations.

Books Recommended:

- D. Murray, Differential Equations
- H.K.Dass, Advance Engineering Mathematics,S. Chand and Company, 12 th Edition, 2003.
- B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 1988
- J.L.V Iwaarden, Ordinary Differential Equation with Numerical Techniques
- Erwin Kreyzig, Advance Engineering Mathematics, sixth edition, John Wiley & sons, 1991

Approval:	Board of Studies:	2013(1)	Dated: 05 – 06 – 2013
	Advanced Studies and Research Board:	128.03	Dated: 29-04-2014
	Academic Council	83.39	Dated: 30-06-2014

MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Scientific Computing

Marks:100

Discipline : M.Phil in Applied Mathematics

Code : MTH 605

Pre-requisites : Numerical Methods

Assessment : 10% Sessional work, 30% mid semester, 60% final examination

Credit Hours : 03 **Minimum Contact Hours : 42**

Aims : Introduce the concept about numerical computation.

Objects : After completion of this course, the student should be familiar with:

- Root of a non-linear equation f (x) =0 and its computation
- Iterative methods for the solution of simultaneous linear algebraic equations.
- Interpolation, extrapolation and curve fitting.
- Numerical differentiation and integration.
- Numerical solution of ordinary and partial differential equation.

Contents:

Non-Linear Equations: Bisection method, Regula-Falsi method, Newton-Raphson method, Secant method, Multiple roots.

Linear Algebraic Equations: Matrix spliting methods, Jaccobi's method, Guass-Seidal method, Conjugate Gradient method, Over relaxation method .

Curve Fitting: Method of least squares, Splines.

Numerical Differentiation: Newton's forward and backward differentiation formulae.

Numerical Quadrature: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Romberg integration, Gaussian quadrature.

Numerical Solution of Ordinary Differential Equations: Taylor series method, Euler's and its modified methods, Runge-Kutta methods, Miline's method, Adam-Molton method (Predictor corrector).

Numerical Solution of Partial Differential Equations: Finite difference method to solve elliptic, parabolic and hyperbolic Partial Differential Equations.

Books Recommended:

- Canal & Chapra, Numerical methods for Engineers
- Curits F. Gerald, Applied Numerical Analysis
- Evvien Cryzigg, Advance Engineering Mathematics
- Chung Yau lam, Applied numerical methods for the solution of partial differential equations.
- Dr. Saeed Akhter Bhatti, A first course in numerical analysis.
- John L. Van Iwaarden, Ordinary differential equations with numerical techniques.
- Robert J.S and SandraL.H, Applied Numerical Methods for engineers, Using MATLAB, Thomson Books, 2006.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Computational Fluid Dynamics **Marks:100**
Discipline : M.Phil in Applied Mathematics
Code : MTH 615
Pre-requisites : Differential Equations and Matrices
Assessment : 10% Sessional work, 30% mid semester, 60% final examination
Credit Hours : 03 **Minimum Contact Hours : 42**

Aims : To give the idea of fluid dynamics and its applications in the engineering Field.

Object : After completion of this course the student should be able to know:

- the idea about the fluids with their mechanics and dynamics.
- Basic schemes of Discretisation of PDE's.
- Numerical solutions of the PDE's

Contents:

Introduction and Governing Equations:Differential and integral forms of governing equations in fluid dynamics (Momentum equation, Navier Stoke's equation), fixed and moving control volume, physical interpretation of governing equations, Mathematical behavior of PDE and its suitability for the different types of flows.

Discretisation:Basic schemes of discretisation, Finite difference method, Finite element method, Finite volume method, Boundary element method, meriots and demerits of each method.

Initial and Boundary Conditions:Initial and boundary conditions (symmetry, inlet, outlet, open, wall and cyclic boundary conditions), Mathematical description for steady and unsteady flows, incompressible flows, compressible flows, subsonic and supersonic flows.

Numerical Solutions:Segregated versus coupled solver methods, residual and imbalances, accuracy of numerical schemes, Types of errors, False diffusion, Stability criteria, Relaxation method, Grid independent study.

Introduction to Turbulence:Turbulanbce transport equations, Turbulence models based on Reynolds Average Navier – Stokes equations (RANS), Application of different turbulence models, Hands on experience with commercial CFD packages.

Books Recommended:

- Went J.F, Computational Fluid Dynamics, 3 rd Edition, Springer, 2009.
- Versteeq H and Malasekra W, An Introduction to Computational Fluid Dynamics, Dorling Kindersley, 2008.
- Hirsch C, Numerical and Computation of Internal and External Flows, Butterworth Heinemann, 2007.
- Pozrikidis C, Introduction to Theoritical and Computational Fluid Dynamics, Oxford University Press, 1997.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Advanced Linear Algebra Marks:100
Discipline : M.Phil in Applied Mathematics
Code : MTH 635
Pre-requisites : Elementary Linear Algebra
Assessment : 10% Sessional work, 30% mid semester, 60% final examination
Credit Hours : 03 Minimum Contact Hours : 42

Aims : To give the idea of algebra of different types of spaces and their applications in the different fields of engineering.

Object : After completion of this course the student should be able to:

- Know the idea about different types of spaces.
- Eigen values and Eigen vectors with their applications to differential equations and approximations.

Content:

Vector Space:

Euclidean *n* – spaces, general vector spaces, Subspaces, Linear independences, Basis and dimensions, Row and column spaces, Rank.

Inner Product Spaces:

Length and angle in inner spaces, Orthonormal basis, Gram – Schmidt process, Change of basis.

Eigen Values and Eigen Vectors:

Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalisation, Applications to differential equations, Applications to approximations, Applications to conics, Quadric form, Applications to quadric surfaces, Electrical networks, Geometric linear programming, Graph theory, Computer graphics.

Books Recommended:

- Daniat S.A. and Sober E.; "Advanced Linear Algebra for Engineers with Matlab." Taylor and Frances, 2009.
- David C. L. "Linear Algebra and Its Applications", 3rd ed, Addison Waseley, 2002.
- Cooperstsien B. "Advanced Linear Algebra", Taylor and Frances, 2010.
- Lawrence, Jonson W., Riess R.D. and Arnold J.T, "Introduction to Linear Algebra', Addison Waseley, 2001.
- Stever R., "Advanced Linear Algebra", 3rd ed., Springer, 2008.
- Kreyszig E, Introductory Functional Analysis with Applications, John Wieley and Sons, 2003.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Applied Statistics Marks:100
Discipline : M.Phil in Applied Mathematics
Code : MTH 665
Pre-requisites : Elementary Statistics
Assessment : 10% Sessional work, 30% mid semester, 60% final examination
Credit Hours : 03 Minimum Contact Hours : 42

Aims : Introduce the concept of descriptive & inferential statistics and probability

Objects : After completing this course, the student should be familiar with:

- Different statistical methods to obtain the measure of central values of a data and their interpretation.
- Probability and its rules. Different probability distributions and their uses.
- Estimations and hypothesis.

Content:

Probability Distribution:

Uniform, Binomial, Hyper – geometric, Poisson, Normal, Exponential, Chi – square, F and T distributions.

Sampling Distribution:

Sampling distribution of means with replacement and without replacement, Central limit theorem.

Testing of Hypothesis:

Testing a statistical hypothesis, Type I & II error, one tailed and two tailed tests, test concerning means and variances, testing the difference between two means, Goodness of fit test, test of independence. Confidence interval of one population mean, estimation a population mean, estimating the difference between two population mean, estimating a population standard deviation, estimating the ratio of two variances.

Regression and Correlation:

Regression analysis by least squares method, testing the significance of the slope, simple correlation analysis, coefficient of correlation and coefficient of determination, testing the significance of r. Rank correlation. Multiple Regression. Multiple and partial correlation. Choice of regression modle.

Books Recommended:

- Walpole, Ronald E and Mayers Raymond H, Probability and Statistics for Engineers and Scientists, 8th Edition, Person Prentice Hall, 2007.
- Freund and John E, Mathematical Statistics, Prentice Hall International Inc. New Jarsey, 1999.
- Hogg R. V and Tanis E.A, Probability and Statistical Inference, 4th Edition, Macmillan Publishing Company, New York, 1993.
- Mood A.M, Graybill F.A and Boes D.C, Introduction to Theory of Statistics, 3rd Edition, Mcgraw-Hill Book Company, New York, 1974.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Finite Element Analysis **Marks:100**

Discipline : M.Phil in Applied Mathematics

Code : MTH 745

Pre-requisites : Numerical Analysis

Assessment : 10% Sessional work, 30% mid semester, 60% final examination

Credit Hours : 03 **Minimum Contact Hours : 42**

Aims : To give the idea of Finite Elements and its applications in the engineering field

Object : After completion of this course the student should be able to:

- Know the descretisation techniques of PDE's into finite elements.
- GalArkin approach to solve the PDE's.

Content:

Introduction:

Historical background, Matrix approach, Discretisation, Matrix algebra, Gaussian elimination, Governing equations, Classical techniques in FEM, Weighted residual method, Ritz method.

One Dimensional Problem:

FE modelling coordinates and shape functions, Interpolation function, Potential energy approach, Galarkin approach, Assembly of stiffness function and load vector, Finite element equations, Quadratic shape functions, Application to plane trusses.

Two Dimensional Problem:

Introduction, finite element modelling, Scalar valued problem, Laplace equation, Poisson equation, Triangular elements, Element stiffness matrix, Force vector, Galarkin approach, Stress calculation, Temperature effects.

Axisymmetric:

Axisymmetric formulation, Element stiffness matrix and force vector, Galarkin approach, body force and temperature effects, Stress calculations, Boundary conditions, Applications to cylinders under internal or external pressures, Rotating discs.

Books Recommended:

- Moaveni S, finite Element Analysis Theory and Applications with ANSYS, International Edition, Pearson Education, 2008.
- Chandrupatla T.R and Belegundu A.D, Introduction to Finite Elements in Engineering, 3 rd Edition, Pearson Education, 2002.
- Zienkiewicz O.C and Taylor R.L, The Finite Element Methods: The Basic Formulation and linear Problems, 5 th Edition, Butterworth Heineman, 2000.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Operations Research and Optimization Marks:100
Discipline : M.Phil in Applied Mathematics
Code : MTH 655
Pre-requisites : Linear Algebra
Assessment : 10% Sessional work, 30% mid semester, 60% final examination
Credit Hours : 03 Minimum Contact Hours : 42

Aims : To give the idea of operation research techniques and optimization and its applications in the engineering field

Object : After completion of this course the student should be able to:

- Know the concept of linear programming.
- Know the concept of special types of linear programming problems.
- Know the idea about Queuing theory, Games theory and Inventory Control theory.

Content:

Linear Programming:

Concept of linear programming model, Graphical methods, Simplex method, Dual simplex method, Duality theory, primal and dual problems.

Special Types of Linear Programming Problems:

Mathematical model for transportation problem, Types of transportation problem, Russell's method, Transshipment problem, Assignment problem, Goal programming, Sensitivity analysis, Parametric programming, Integer programming, Dynamic programming.

Queuing Theory:

Basic queuing process, Birth and death process, Basic model with infinite and finite queue, Limited input source, Priority queuing model.

Game Theory:

Introduction to game theory, game with pure and mixed strategies, dominance property, Graphical and linear programming for game theory.

Inventory Control Theory:

Deterministic model, Continuous review – uniform demand, Shortage permitted, Quantity discount – shortages not permitted.

Books Recommended:

- Hillier S.F and Lieberman G,J, Introduction to Operations Research, 7th Edition, Mecgraw Hill Education, 2007.
- Hamdy A.T, Operation Research, 8th Edition, Prentice Hall, 2006.
- Wiston W.L, Operation Research Applications and Algorithms, 4th Edition, Duxbury Resource Centre, 2008.

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MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO

DEPARTMENT OF BASIC SCIENCE AND RELATED STUDIES

Title of Subject : Modelling and Simulation **Marks:100**

Discipline : M.Phil in Applied Mathematics

Code : MTH 705

Pre-requisites : Numerical and Statistical methods

Assessment : 10% Sessional work, 30% mid semester, 60% final examination

Credit Hours : 03 **Minimum Contact Hours : 42**

Aims : To give the idea of converting the physical problems in mathematical models and their simulations and its applications in the engineering field

Object : After completion of this course the student should be able to know the :

- Concept of Modelling, types and nature of models.
- Random variables and their generation techniques.
- Queuing system and Markov chains.

Content:

Introduction to Modelling and Simulation:

System concepts, System modelling, Mathematical models, Nature and assumptions, Continous and descrete systems, Steps in model development.

Generation of Random Variables:

Uniform random generators, Testing of uniform random generator, Methods of generating non-uniform generators, Inversion, Rejection, Composition, Special cases.

Generation of Multivariate:

Autoregressive models for stationary processes, Autoregressive models for seasonal data, Autoregressive moving average models.

Queuing Systems and Markov Chains:

Poisson process, FIFO system, Priority queuing systems, Chapman – Kolmogorov equations, Regular Markov chains, Applications.

Analysis of Simulation Output and Simulation Languages:

Estimation methods, Simulation statistics, Replication of runs, Elimination of initial bias, Basic concept of simulation languages, Discrete modelling and simulation with GPSS, Continuous simulation languages.

Books Recommended:

- Misra J.C, computational Mathematics, Modelling and Algorithm, Narosa, 2003.
- Lawand A.M and Kelton W.D, Simulation Modelling and Analysis, 3 rd Edition, MGraw _Hill Companies, 2000.

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