GULBARGA UNIVERSITY
KALABURAGI

FACULTY OF SCIENCE & TECHNOLOGY

Syllabus for

MASTER OF SCIENCE
IN
MATHEMATICS
(CBCS SCHEME)

(With effect from Academic Year 2017-18 And Onwards)

DEPARTMENT OF POST-GRADUATE STUDIES & RESEARCH IN MATHEMATICS

FOURTH SEMESTER

Code	Paper Title	Marks			Lecture	Tutorial	Practical	Credit Value
		Sem. End	I. A.	Total	Hrs.	Hrs.	Hrs.	
Hard Core Papers								
HCT 4.1	Measure Theory	80	20	100	4	0	0	4
HCT 4.2	Graph Theory-II	80	20	100	4	0	0	4
HCT 4.3	Computational Numerical Methods-II	80	20	100	4	0	0	4
HCT 4.4	Differential Geometry	80	20	100	4	0	0	4
HCMP 4.5	Major Project	Report -60 Viva-Voce-20	20	100	4	0	0	4
Soft Core Course (Any One)								
SCT 4.1	Fluid Mechanics - II	80	20	100	4	0	0	4
SCT 4.2	Computational Fluid Dynamics	80	20	100	4	0	0	4

Total Number of Credits: 24

objects embedded in a three dimensional Euclidian space. In this course students will study the geometrical description of the motion. Some of the greatest minds of all times such as Sir Isaac Newton, Joseph Lagrange, Leonhard Euler, Sir William Hamilton laid the foundation and built the theoretical structure of the subject.

1. Analytical Dynamics: Generalized Co-ordinates, Holonomic and non- Holonomic systems. Seleronomic and rheonomic systems. D'Alembert's principle and Langrange's equation for Holonomic system. Langrange's equation for impulsive motion. Deduction of Lagrange's equation from D'Alembert's principle. Velocity dependent potentials and the dissipation function. (12 Hours)

2. Energy equation for conservative field; Generalized momenta and Hamilton's canonical equations. Rigid body and Eulerian angles, infinitesimal rotation. Coriolis theorem. Motion relative to rotating earth, Euler's dynamical equations of motion of a symmetrical top. (10 Hours)

3. Hamiltion's principle of least action. Deduction of Lagrange and Hamiltion equations from Hamiltion's principle. Hamilton's variational principle. Poincare integral invariants. Whitataker's equations, Jacobi's equations. Statement of Lee Hwa Chung's theorem, Hamilton-Jacobi's equation and its complete integral. Solution of Harmonic oscillator problem by Hamilton Jacobi method.

(22 Hours)

4. Cyclic co-ordinates, Rout's equation, Poisson's bracket, Poisson's identity, Lagrange's Bracket. Condition of canonical character of a transformation in terms of Lagrange's bracket, Poisson's bracket. Invariance of Lagrange's brackets and Poisson brackets under canonical transformations.

(20 Hours)

Reference Books:

1. A.S. Ramsey, Dynamics part I, the English Language book Society and Cambridge University Press, (1972)
2. F. Gantmacher, Lectures in Analytical Mechanics, MIR Publisher, Mascow, 1975.
3. H. Goldstein, Classical Mechanics(2nd Edition), Narosa Publishing House, New Delhi.
4. Narayan Chandra Rana and Sharad Chandra Jog, Classical Mechanics, TMH, 1991.
5. F. Choltron, Text book of Dynamics, (ELBS Edition), G. Van Nostrand and co.(1969).

M. Sc. Fourth Semester

Paper : HCT4.1 Measure Theory	
Teaching Hours: 4 Hrs/Week	Credits : 04
Maximum Marks: 100 (SEE-80 + IA-20)	

Preamble: The subject being very modern in nature, all needed definitions have been given at the beginning of the chapters, and though apparently the volume looks very thin but it covers the entire course as laid down in various Indian Universities. It is needless to emphasize that the style adopted in this syllabus is lucid, clear, easy, and clearly understandable to the students. A good many solved and unsolved examples have been given in every chapter so that students may have enough practice in the subject.

1. Measure and Outer Measure: Ring of a set, σ-ring of sets, algebra of sets, σ- algebra of sets, measure space, Caratheodory's postulates of outer measure, measurable set, problems related to measure function, ring of sets, σ-algebra of sets and Lebesgue measure of a set, Exterior and interior measure, Vitali's covering theorem, Borel measurable set. (20 Hours)

2. Measurable Functions: Measurable function, Almost everywhere, equivalent function characteristic function, Borel measurability of functions, Little wood's three principles, Lebesgue integral of a function, first mean value theorem. (14 Hours)

3. Convergence in measure, Reisz's theorem, D.F. Egoroff's theorem, Lebesgue, bounded convergence theorem, Fatou's lemma, absolute continuous function, indefinite integration and differentiation. (15 Hours)

3. Signed Measure: Signed measure, positive and negative sets, Hahn decomposition theorem, singular measure, Jordon decomposition, absolutely continuous measure function. (15 Hours)

References:

1. Paul R. Halmos: Measure Theory, D. Van. Nostrand Co. Inc., New York and Affiliated East - West Press Pvt. Ltd., Delhi, (1966).
2. I. K. Rana: An Introduction to Measure and Integration, Narosa Publishing House, (1997).
3. K. P. Gupta: Measure Theory, Krishna Prakashan Media (P) Ltd, II, Shivaji Road, Meerut (U. P.), India.
4. Harold Wodom: Lectures on Measure and Integration, Van Nostrand Reinhold Company, New - York.
5. J. F. C. Kingmam and S. J. Taylor: Introduction to Measure and Probability, Cambridge University Press.

Paper : HCT 4.2 Graph Theory - II	
Teaching Hours: 4 Hrs/Week	Credits : 04
Maximum Marks: 100 (SEE-80 + IA-20)	

Preamble: It can also be used as a supplemental text of courses in graph theory, cambinatorics and related areas. It will be a valuable tool to researchers and advanced post graduate students. They can use to familiarize themselves with the subject, the research techniques and major research accomplishments in the field. The students will find many topics that can be developed into masters theses and Ph.D dissertation.

1. Domination in Graphs: Dominating sets, Bounds on dominating sets in terms of order, degree; Bounds in terms of order and size; Bounds in terms of degree and diameter, Bounds in terms of independent number and covering number. (20 Hours)

2. Independent sets. Irredundant sets, Total dominating sets, Connected dominating sets, Weak dominating sets, Weakly connected dominating sets, Strong dominating sets, Restrained dominating sets, Roman dominating sets. Independent, total, connected, weakly, strong, restrained roman domination numbers. (22 Hours)

3. Graph Valued Functions: Line graph, characterization, outer planarity, minimally non-outer planarity of line graphs and second line graphs. Blok-vertex tree of a graph, semi-total block graph and total block graph of a graph, square graph, lict graph, litact graph, total graph , middle graph and their planarity properties. (15 Hours)

4. Crossing Numbers: Line graph, Semitotal block graph, Total-block graph, Total graph,Lict graph and Litact graph. (07 Hours)

References:

1. F. Harary: Graph Theory, Addison-Wesley, Reading Mass, (1988).
2. T. W. Haynes, S. T. Hedetniemi and P. J. Slater: Fundamentals of Domination in Graphs, Marcel Dekker Inc. 270 Madison Avenue, New York , (1998).
3. V. R. Kulli : Theory of Domination in Graphs, Vishwa International Publications, Gulbarga (2010).
4. M. H. Muddebihal: Thory of Graph Valued Functions in Graphs, Vishwa International Publications (in press).

Paper : HCT 4.3 Computational Numerical Methods - II	
Teaching Hours: 4 Hrs/Week	**Credits :** 04
Maximum Marks: 100 (SEE-80 + IA-20)	

Preamble: The purpose of this course is to study various numerical methods for the solution of ordinary and partial differential equations. The single step methods like Runge-Kutta method for solving simultaneous and higher order ordinary differential equations, shooting method are useful for solving several problems arising in the study of real life problems. Similarly, the finite difference techniques for the solution of parabolic, hyperbolic and elliptic partial differential equations to be studied in this paper are very useful for the students in solving some of the problems arising in fluid mechanics.

1. Numerical Solution of Ordinary Differential Equations: *Initial Value Problems- Taylor's series method, Picard's method (Recapitulation).* Euler's method, Runge-Kutta 4^{th} order method, stability of 1^{st}

order and 2nd order methods, Runge-Kutta method for simultaneous and higher order differential equations. (12 Hours)

2. Predictor-Corrector Methods: Adam-Bashforth's method, Mine's Method. *Boundary Value Problems* - Finite difference method, shooting method. (13 Hours)

3. Numerical Solution of Partial Differential Equations: Classification of Partial Differential Equation, finite difference approximations to derivatives, *Parabolic Partial Differential Equations*- Non-dimensional form, explicit finite difference scheme, Crank-Nicholson method, Gauss-Seidal iterative scheme for Crank-Nicholson method, Successive Over Relaxation(SOR), parabolic equation with derivative boundary condition, ADI method; *Elliptic Partial Differential Equations*- Laplace equation, Poisson equation, explicit finite difference method, implicit method, iterative methods. (25.Hours)

4. Hyperbolic Partial Differential Equations - Explicit finite difference method, implicit method. *Finite Element Method*- Introduction, Functionals, base functions, *Methods of Approximation* -Rayleigh-Ritz method, Galerkin method, applications to two-dimensional problems, Finite Element Method for one-dimensional problems. (14 Hours)

References:

1. Jain M. K., Iyengar S. R. K., and Jain R. K.: Numerical Methods for Scientific and Engineering Computation, *New Age International(P) Ltd.*, 5th Ed., (2007).
2. Mitchell A. R. and Griffiths D. J.: The Finite Difference Method in Partial Differential Equations, Wiley Interscience Publication, *John Wiley & Sons, New York*, (1980).
3. Richeard L. Busden and J. Douglas Faires: Numerical Analysis, *Thomson Brooks/Cole*, 7th Ed., (2005).
4. Hildebrand F. B.: Introduction to Numerical Analysis, *Dover Publications, Inc.* , 2 nd Ed., (1987).
5. Sastry S. S.: Introductory Methods of Numerical Analysis, *PHI*, 4th Ed., (2006).

Paper : HCT 4.4 Differential Geometry	
Teaching Hours: 4 Hrs/Week	**Credits : 04**
Maximum Marks: 100 (SEE-80 + IA-20)	

Preamble: This syllabus is an elementary account of the geometry of curves and surfaces. It is written for students who have completed standard first course in calculus and linear algebra, and its aim is to introduce some of the main ideas of differential geometry. The traditional undergraduate course in differential geometry has changed very little in the last few decades. By contrast, geometry has been advancing very rapidly at the research level, and there is general agreement that the undergraduate course needs to be brought up to date. However, the syllabus is framed with new idea only if it really pays its way by simplifying and clarifying the exposition.

1. Directional Derivatives: Definition of Directional derivatives curves in E^3, reparametrization of a curve, 1-Forms, differential Forms, mappings, derivative map. (14 Hours)

2. Frame Fields: Frame at a point, Dot and cross product of the vector fields, geometric study of curves, the Frenet formulas, arbitrary – speed curves, covariant derivatives, Frame fields, connection forms. (20 Hours)

3. Euclidean Geometry: Isometric of E^3, the derivative map of an isometry, orientation, Euclidean geometry, convergence of curves. (15 Hours)

4. Calculus on a Surface: Surface in E^3, patch computations differentiable functions and tangent vectors. Differential Forms on a surface, Mapping of surfaces, Topological properties of surfaces. (15 Hours)

References:

1. Barrett O'Neil: Elementary Differential Geometry, Academic Press, New York, (1966).
2. T. J. Wilmore: Introduction to Differential Geometry, Oxford Clarendon Press, (1959).
3. Langwitz D. : Differential and Riemann Geometry, Academic Press, New York, (1965).
4. W. K. Hugenberg: A Course in Differential Geometry, Springer, (1978).
5. Elementary Topics in Differential Geometry, Springer Verlag , New York, (1979).

Paper : SCT 4.1 Fluid Mechanics – II	
Teaching Hours: 4 Hrs/Week	**Credits :** 04
Maximum Marks: 100 (SEE-80 + IA-20)	

1. Fluid Equations for Newtonian Fluids: Momentum equation, general stress state of deformable bodies, relation between stresses and rate of deformation, Stokes hypothesis, Navier-Stokes equations, energy equation. (16 Hours)

2. Dimensional Analysis: Reynolds number, Buckingham's theorem, physical significance of non dimensional numbers (12 Hours)

3. Exact Solutions of Navier - Stokes Equations: Couette Poiseuille flows, Hagen-Poiseuille flow through a circular pipe, steady flow between co-axial circular pipes, steady flow in pipes of elliptic cross-

section, steady flow in pipes of equilateral triangular section, Steady flow in pipes of rectangular sections, unsteady motion of a flat plate, flow due to an oscillating flat plate, pulsatile flow between parallel surfaces, unsteady flow of viscous incompressible, incompressible fluid between two parallel plates.
(16 Hours)

4. Laminar Boundary Layer Flow: Two dimensional boundary layer equations for flow over a plane wall, boundary layer flow along a flat plate, boundary layer thickness, energy thickness, displacement thickness, momentum thickness, friction drag, momentum integral equation for the boundary layer, Van Karmans Pohlhausen method. (20 hours)

References:

1. W. H. Besaint and A. S. Ramsey: A Treatise of Hydrodynamics, Part II, CBS Publishers, Delhi, (1958).
2. G. K. Batchelor: A Introduction to Fluid Mechanics, Foundation Books, New Delhi, (1994).
3. F. Chorlton: Text Book of Fluid Dynamics, CBS Publishers, Delhi, (1985).
4. H. Schlichting: Boundary Layer Theory, McGraw Hill Book Company, New York, (1979).
5. R. K. Rathy: An Introduction to Fluid Dynamics, Oxford and IBM Publishing Company, New Delhi, (1976).
6. A. D. Young: Boundary Layers AJAA Education Series, Washington DC, (1989).
7. S. W. Yuan: Foundations of Fluid Mechanics, Prentice Hall of India (P) Ltd., New Delhi, (1976).
8. S. I. Pai: Viscous Flow Theory, Vol.1; Laminar Flow, D Von Moptrand Comp.

Paper : SCT4.2 Computational Fluid Dynamics	
Teaching Hours: 4 Hrs/Week	**Credits : 04**
Maximum Marks: 100 (SEE-80 + IA-20)	

1. Fundamentals: Finite Difference Method, Programming languages such as FORTRAN and C++, Conservation Equations, Reynold's-Averaged Navier-Stokes Equations, Stokes's Flow, Boundary layers, Stability Equations, Classification of Conservation Equations, Boundary Conditions.
(12 Hours)

2. Numerical Methods for Modeling Parabolic and Elliptical Equations: Model Equations, discritization of derivatives with Finite Differences, Explicit methods, Implicit methods for Parabolic Equations, Finite Difference Methods for Elliptic Equations using Direct Method, Iterative Method and Multigrid Method. (20 Hours)

3. Numerical Methods for Modeling Hyperbolic Equations: Explicit Methods using Two-Step Lax-Wendroff Method, MacCormack Method, Implicit Methods, Upwind Methods, Numerical Dissipation and Dispersion: Artificial Viscosity. (20 Hours)

Inviscid Flow Equations for Incompressible Fluids: Laplace Equation and its Fundamental Solutions, Finite Difference Method, A Panel Program for Airfoils:- 1. Main Program, 2. Subroutine COEF, 3. Subroutine GAUSS, 4. Subroutine VPDIS, 5. Subroutine CLCM.

(12 Hours)

References:

1. J.E. Wendt, J.D. Anderson, G. Degrez and E Dick: Computational Fluid Dynamics: An Introduction, Springer-Verlog, (1996).
2. J.D. Anderson: Computational Fluid Dynamics: Basic with applications, McGraw Hill, (1986).
3. M.T. Somashekar: Programming in C, PHI, New Delhi, (2006).
4. Ian Sneddon: Elements of Partial Differential Equations, International Student Editions.

Paper : HCMP 4.5 Minor Project	
Teaching Hours: 4 Hrs/Week	**Credits :** 04
Maximum Marks: 100 SEE: Project Report – 60 + Viva – Voce - 20 + **IA: 20**	

SEE- Semester End Examination

IA – Internal Assessment