TECHNO INDIA UNIVERSITY
WESTBENGAL

EM 4, Sector V, Salt Lake, Kolkata-700091, West Bengal, India
Phone: +91 9836544416/17/18/19, Fax: +91 33 2357 1097

2-Year Master of Science (M.Sc.) Curriculum and Syllabus for Mathematics

First Semester

Course Code	Course Title	Contact Hrs/Week			Credit
		L	T	P	
Theory					
TIU-PMA-T101	REAL ANALYSIS AND MEASURE THEORY	3	1	0	4
TIU-PMA-T103	LINEAR ALGEBRA	3	1	0	4
TIU-PMA-T105	COMPLEX ANALYSIS	3	1	0	4
TIU-PMA-T117	ODE AND SPECIAL FUNCTIONS	3	0	0	4
TIU-PMA-T109	GENERAL MECHANICS	3	1	0	4
TIU-PMA-L197	CAREER ADVANCEMENT & SKILL DEVELOPMENT-I	3	0	0	3
	Sessional				
TIU-PES-S199	ENTREPRENEURSHIP SKILL DEVELOPMENT	0	0	0	2
	Total Credits				**25**

REAL ANALYSIS AND MEASURE THEORY

Functions of Bounded Variation and their properties, Differentiation of a function of bounded variation, Absolutely Continuous Function, Equicontinuity, Luzin (N) property of an absolutely continuous function; Riemann Steiltzes Integrals and fundamental properties.
Cardinal Number: Concepts of cardinal number of an infinite set, arithmetic of cardinal numbers, order relation of cardinal numbers.

Measure: Lebesgue Outer Measure and Measurable Sets, Borel sets, Non measurable set, Measurable functions, Approximation of Lebesgue measurable functions by continuous functions. Simple and Step Functions, Lebesgue integral of step functions, Upper Functions, Lebesgue integral of upper functions, Lebesgue Integrable functions, Fatou's Lemma,

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Dominated Convergence Theorem, Monotone Convergence Theorem, Riemann integral as a Lebesgue integral, Lebesgue-Vitali Theorem.

Books:

1. A. M. Bruckner, J. Bruckner & B. Thomson : Real Analysis
2. R. R. Goldberg : Methods of Real Analysis
3. G.De Barra: Measure Theory and Integration
4. H.L Royden: Real Analysis
5. I.P.Natanson: Theory of functions of a real variable vol-I,II

LINEAR ALGEBRA

Vector spaces over fields, subspaces, bases and dimension. Systems of linear equations, matrices, rank, Gaussian elimination. Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, linear functional, duality and transpose. Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule. Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonalization, Rational canonical form, Jordan canonical form. Inner product spaces, Gram-Schmidt ortho-normalization, orthogonal projections, linear operators and adjoints, Hermitian, self-adjoint, unitary and normal operators, Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.

Books:

1. Linear Algebra and Its Applications by Gilbert Strang
2. Linear Algebra by Stephen H Friedberg, Insel and Spence.

COMPLEX ANALYSIS

Complex Plane, Lines and Half Planes in the complex plane, extended plane and its Spherical Representation, Stereographic Projection.
Derivative of a complex function, Comparison between differentiability in the real and complex senses, Cauchy-Riemann Equations, Necessary and Sufficient Criterion for complex differentiability, Analytic functions, Entire functions, Harmonic functions and Harmonic conjugates.
Polynomial functions, Rational functions, Power series, Exponential, Logarithmic, Trigonometric and Hyperbolic functions, Branch of a logarithm, Analytic functions as mappings, Conformal maps, Möbius Transformations.

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The complex integral (over piecewise C1curves), Cauchy's Theorem and Integral Formula, Power series representation of analytic functions, Morera's Theorem, Goursat's Theorem, Liouville's Theorem, Fundamental Theorem of Algebra, Zeros of analytic functions, Identity Theorem, Weierstrass Convergence Theorem, Maximum Modulus Principle and its applications, Schwarz's Lemma, Index of a closed curve, Contour, Index of a contour, Simply connected domains, Cauchy's Theorem for simply connected domains.
Definitions and Classification of singularities of complex functions, Isolated singularities, Laurent series, Casorati-Weierstrass Theorem, Poles, Residues, Residue Theorem and its applications to contour integrals, Meromorphic functions, Argument Principle, Rouche's Theorem.

Books:

1. Functions of one Complex Variable by JB Conway
2. Foundations of Complex Analysis by S Ponnuswamy
3. Functions of complex variable- Brown and Churchill.

ODE AND SPECIAL FUNCTIONS

Existence-Uniqueness: Review of exact solutions of first order, The method of successive approximations, Lipschitz condition, Convergence of successive approximations, Existence and Uniqueness of solutions of initial value problem, Non local existence of solutions, Existence and uniqueness of solutions to systems, Existence and uniqueness of solutions to linear systems, Equations of order n.
Second Order Equations: General solution of homogeneous equations, Non-homogeneous equations, Wronskian, Method of variation of parameters, Sturm comparison theorem, Sturm separation theorem, Boundary value problems, Green's functions, Sturm-Liouville problems. Series Solution of Second Order Linear Equations: ordinary points, regular singular points, Legendre polynomials and properties, Bessel functions and properties.
Systems of Differential Equations: Algebraic properties of solutions of linear systems, The eigenvalue-eigenvector method of finding solutions.

Books:

1. Ordinary Differential Equations by EL Ince
2. Differential Equations by Shepley Ross
3. Theory of ordinary differential equation by JC Burkhill
4. E.A. Coddington, An Introduction to Ordinary Differential Equations, PHI Learning 1999.

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5. R.P. Agarwal and R.C.Gupta, Essentials of Ordinary Differential Equations, McGraw-Hill, 1993.
6. R.P. Agarwal and D. O'Regan, An Introduction to Ordinary Differential Equations, Springer- Verlag, 2008.

GENERAL MECHANICS

Generalized coordinates. Virtual work. D'Alemberts principle. Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Lagrange's equations of first and second kind. Uniqueness of solution. Energy equation for conservative fields. Euler's dynamical equations. Hamilton's variables. Hamilton canonical equation. Homogeneity of space and time conservation principles, Noethers theorem. Cyclic coordinates. Routh's equations. Hamilton's principle. Principle of least action. Poisson's Bracket. Poisson's identity. Jacobi-Poisson Theorem. Time dependent Hamilton-Jacobi equation and Jacobi's Theorem. Lagrange Brackets. Condition of canonical character of transformation in terms of Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations. Rotating coordinate system. Motion related to rotating earth. Foucalt's pendulum and torque free motion of a rigid body about a fixed point. Motion of a symmetrical top and theory of small vibrations.

Books:

1. Classical Mechanics by H Goldstein
2. Classical Mechanics by Rana and Joag

CASD-I (SCIENTIFIC COMPUTING WITH PYTHON)

1. **Tools for scientific computing in Python** – the SciPy stack: IPython, IPython notebook, NumPy, SciPy, Matplotlib and SymPy.

2. **Python essentials**: introduction, data types, numbers, strings, indexing and slicing, string formatting, lists, tuples, dictionaries, sets; python control flow, if-else, loops, list comprehension; functions, modules, exceptions and file I/O.

3. **Numerical computations with NumPy**: multi-dimensional arrays, fancy slicing, complex numbers, array constructors, typecasting, array sorting, array reshaping, grids, matrix objects, linear algebra, function vectorization, universal functions, array broadcasting, etc.

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4. **Plotting with Matplotlib**: 2D line plots, histograms, polar plots, contour plots, etc.; 3D line plots, surface plots etc.; different customizations and styling options.

5. **Scientific computations with SciPy**: root finding, interpolations, descriptive statistics, probability, curve fitting, hypothesis testing, optimization, integrations, ordinary differential equations and signal processing.

Special topics: (any one)

1. **Image processing in Python** with Scikit-image and OpenCV.

2. **Symbolic computations with SymPy**: symbolic calculus, integral transforms; symbolic solutions to algebraic equations, ordinary differential equations, etc.