COMPLEMENTARY COURSES

FIRST SEMESTER

MTS1 C01:MATHEMATICS-1

4 hours/week **3 Credits** **75 Marks[Int.15 + Ext. 60]**

Text (1)	Calculus I (2/e) : Jerrold Marsden & Alan Weinstein *Springer-Verlag New York Inc(1985) ISBN 0-387-90974-5*
Text (2)	Calculus II (2/e) : Jerrold Marsden & Alan Weinstein *Springer-Verlag New York Inc(1985) ISBN 0-387-90975-3*

Module I **14 hrs**

1.1: Introduction to the derivative-instantaneous velocity, slope of tangent line, differentiating simplest functions

1.2: Limits- Notion of limit, basic properties, derived properties, continuity, continuity of rational functions, *one sided limit, limit involving* $\pm\infty$

1.3: The derivative as Limit- formal definition, *examples*, *differentiability and continuity*, Leibnitz notation,

1.4: Differentiating Polynomials-power rule, sum rule etc.,

1.5: Product and quotients- product, quotient, reciprocal & integral power rule

1.6: Linear Approximation and Tangent Lines- equation of tangent line and linear approximation, *illustrations*

Module II **13 hrs**

2.1: Rate of change and Second derivative- linear or proportional change, rates of change, second derivative,

2.2: The Chain Rule- power of a function rule, chain rule,

2.3: Fractional Power & Implicit Differentiation-rational power of a function rule, implicit differentiation

2.4: Related rates and parametric curves- Related rates, parametric curves, *word problems involving related rates*

2.5: Anti derivatives- anti differentiation and indefinite integrals, anti differentiation rules

Module III **18 hrs**

3.1: Continuity and Intermediate value theorem-IVT: first and second version

3.2: Increasing and decreasing function- Increasing and decreasing test, critical point test, first derivative test

3.3: Second derivative and concavity- second derivative test for local maxima , minima and concavity , inflection points

3.4: Drawing of Graphs- graphing procedure*, asymptotic behaviour*

3.5: Maximum- Minimum Problems- maximum and minimum values on intervals, extreme value theorem, closed interval test, *word problems*

3.6: The Mean Value Theorem- The MVT, consequences of MVT-*Rolles Theorem, horserace theorem*

11.2: L'Hospital rule- Preliminary version, strengthened version

Module IV **19 hrs**

4.1: Summation- summation, *distance and velocity*, properties of summation, telescoping sum (quick introduction- relevant ideas only)

4.2: Sums and Areas-step functions, area under graph *and its counterpart in distance-velocity problem*

4.3: The definition of Integral- signed area *(The counterpart of signed area for our distance-velocity problem),* The integral, Riemann sums

4.4: The Fundamental Theorem of Calculus-*Arriving at FTC intuitively using distance velocity problem,* Fundamental integration Method, *proof of FTC*, Area under graph, displacements and velocity

4.5: Definite and Indefinite integral-indefinite integral test, properties of definite integral, fundamental theorem of calculus: alternative version *(interpretation and explanation in terms of areas)*

4.6: Applications of the Integral- Area between graphs, area between intersecting graphs, total changes from rates of change,

9.1: Volume by slice method- the slice method, volume of solid of revolution by Disk method

9.3: Average Values and the Mean Value Theorem for Integrals- *motivation and definition of average value, illustration, geometric and physical interpretation,* the Mean Value Theorem for Integrals

References:

1	Soo T Tan: Calculus *Brooks/Cole, Cengage Learning(2010)ISBN 0-534-46579-X*
2	Gilbert Strang: Calculus *Wellesley Cambridge Press(1991)ISBN:0-9614088-2-0*
3	Ron Larson. Bruce Edwards: Calculus(11/e) *Cengage Learning(2018) ISBN: 978-1-337-27534-7*
4	Robert A Adams & Christopher Essex : Calculus *Single Variable (8/e) Pearson Education Canada (2013) ISBN:* 0321877403
5	Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus(14/e) *Pearson (2018) ISBN 0134438981*
6	Jon Rogawski & Colin Adams : Calculus *Early Transcendentals* (3/e) *W. H. Freeman and Company(2015) ISBN: 1319116450*

SECOND SEMESTER

MTS2 C02:MATHEMATICS-2

4 hours/week **3 Credits** **75 Marks[Int.15 + Ext. 60]**

Text (1)	Calculus I (2/e) : Jerrold Marsden & Alan Weinstein *Springer-Verlag New York Inc(1985) ISBN 0-387-90974-5*
Text (2)	Calculus II (2/e) : Jerrold Marsden & Alan Weinstein *Springer-Verlag New York Inc(1985) ISBN 0-387-90975-3*
Text(3)	Advanced Engineering Mathematics(6/e) : Dennis G Zill *Jones & Bartlett Learning, LLC(2018)ISBN: 978-1-284-10590-2*

Module I Text (1) & (2) 18 hrs

5.1: Polar coordinates and Trigonometry – Cartesian and polar coordinates (*Only representation of points in polar coordinates, relationship between Cartesian and polar coordinates, converting from one system to another and regions represented by inequalities in polar system are required*)

5.3 : Inverse functions-inverse function test, inverse function rule

5.6: Graphing in polar coordinates- *Checking symmetry of graphs given in polar equation, drawings,* tangents to graph in polar coordinates

8.3: Hyperbolic functions- hyperbolic sine, cosine, tan etc., derivatives, anti differentiation formulas

8.4: Inverse hyperbolic functions- inverse hyperbolic functions *(their derivatives and anti derivatives)*

10.3: Arc length and surface area- Length of curves, Area of surface of revolution about x *and* y axes

10.4: Parametric curves- parametric equations of lines and circles, tangents to parametric curves, length of a parametric curve, speed

10.5: Length and area in polar coordinates- arc length and area in polar coordinates , *Area between two curves in polar coordinates*

Module II Text (2) 20 hrs

11.3: Improper integrals- integrals over unbounded intervals, comparison test, integrals of unbounded functions

11.4: Limit of sequences and Newton's method- $\varepsilon - N$ definition, limit of powers, comparison test, Newton's method

11.5: Numerical Integration- Riemann Sum, Trapezoidal Rule, Simpson's Rule

12.1: The sum of an infinite series- convergence of series, properties of limit of sequences (*statements only*), geometric series, algebraic rules for series, the i^{th} term test

12.2: The comparison test and alternating series- comparison test, ratio comparison test, alternating series, alternating series test, absolute and conditional convergence

12.3: The integral and ratio test-integral test, p-series, ratio test, root test

12.4: Power series – ratio test for power series, root test, differentiation and integration of power series, algebraic operation on power series

12.5: Taylor's formula- Taylor and Maclaurian series, *Taylor's formula with remainder in integral form, Taylor's formula with remainder in derivative form,* convergence of Taylor series, Taylor series test, some important Taylor and Maclaurian series

Module III Text(3) 12 hrs

7.6: Vector spaces – *definition, examples , subspaces, basis, dimension, span*

7.7: Gram-Schmidt Orthogonalization Process- *orthonormal bases for* $\mathbb{R}^n$, construction of orthonomal basis of $\mathbb{R}^n$

8.2: Systems of Linear Algebraic Equations- General form, solving systems, augmented matrix, Elementary row operations, Elimination Methods- *Gaussian elimination, Gauss–Jordan elimination, row echelon form, reduced row echelon form*, *inconsistent system* , networks, homogeneous system, *over and underdetermined system*

8.3: Rank of a Matrix- *definition*, row space, rank by row reduction, rank and linear system*, consistency of linear system*

8.4: Determinants- *definition*, *cofactor (quick introduction)*

8.5: Properties of determinant- properties, *evaluation of determinant by* row reducing to triangular form

Module IV Text(3) 14 hrs

8.6: Inverse of a Matrix – finding inverse, properties *of inverse*, adjoint method, row operations method, using inverse to solve a linear system

8.8: The eigenvalue problem- Definition, *finding eigenvalues and eigenvectors*, complex eigenvalues, eigenvalues and singular matrices, eigenvalues of inverse

8.9: Powers of Matrices- *Cayley Hamilton theorem*, finding the inverse

8.10: Orthogonal Matrices- symmetric matrices and eigenvalues, inner product, *criterion for* orthogonal matrix, construction of orthogonal matrix

8.12Diagonalization- diagonalizable matrix -*sufficient conditions*, orthogonal diagonalizability *of symmetric matrix*, Quadratic Forms

8.13: LU Factorization- d*efinition*, Finding an LU- factorization, Doolittlie method, solving linear systems *(by LU factorization),* relationship to determinants

References:

1	Soo T Tan: Calculus *Brooks/Cole, Cengage Learning(2010)ISBN 0-534-46579-X*
2	Gilbert Strang: Calculus *Wellesley Cambridge Press(1991)ISBN:0-9614088-2-0*
3	Ron Larson. Bruce Edwards: Calculus(11/e) *Cengage Learning(2018) ISBN: 978-1-337-27534-7*
4	Robert A Adams & Christopher Essex : Calculus *Single Variable (8/e) Pearson Education Canada (2013) ISBN:* 0321877403
5	Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus(14/e) *Pearson (2018) ISBN 0134438981*
6	Peter V O'Neil: Advanced Engineering Mathematics(7/e) *Cengage Learning(2012)ISBN: 978-1-111-42741-2*
7	Erwin Kreyszig : Advanced Engineering Mathematics(10/e) *John Wiley & Sons(2011) ISBN: 978-0-470-45836-5*
8	Glyn James: Advanced Modern Engineering Mathematics(4/e) *Pearson Education Limited(2011) ISBN: 978-0-273-71923-6*

THIRD SEMESTER

MTS3 C03:MATHEMATICS-3

5 hours/week **3 Credits** **75 Marks[Int.15 + Ext. 60]**

Text	Advanced Engineering Mathematics(6/e) : Dennis G Zill *Jones & Bartlett Learning, LLC(2018)ISBN: 978-1-284-10590-2*

Module I **21 hrs**

9.1: Vector Functions – Vector-Valued Functions, Limits, Continuity, and Derivatives, Geometric Interpretation of $r'(t)$, Higher-Order Derivatives, Integrals of Vector Functions, Length of a Space Curve, Arc Length as a Parameter

9.2: Motion on a Curve-Velocity and Acceleration, Centripetal Acceleration, Curvilinear Motion in the Plane

9.3: Curvature and components of Acceleration- *definition, Curvature of a Circle,* Tangential and Normal Components of Acceleration, The Binormal, Radius of Curvature

9.4: Partial Derivatives-Functions of Two Variables, Level Curves, Level Surfaces, Higher-Order and Mixed Derivatives, Functions of Three or More Variables, Chain Rule, Generalizations

9.5: Directional Derivative-The Gradient of a Function, A Generalization of Partial Differentiation, Method for Computing the Directional Derivative, Functions of Three Variables, Maximum Value of the Directional Derivative, Gradient Points in Direction of Most Rapid Increase of f

9.6: Tangent planes and Normal Lines-Geometric Interpretation of the Gradient, Tangent Plane, Surfaces Given by $z = f(x, y)$, Normal Line

Module II **24 hrs**

9.7: Curl and Divergence-Vector Fields, *definition of curl and divergence*, Physical Interpretations

9.8: Line Integrals-*definition of smooth.closed and simple closed curves*, Line Integrals in the Plane, Method of Evaluation-curve as explicit function and curve given parametrically, Line Integrals in Space, Method of Evaluation, Work, Circulation

9.9: Independence of Path- Conservative Vector Fields, Path Independence, A Fundamental Theorem, *definition of connected,simply connected and multiconnected*

regions, Integrals Around Closed Paths, Test for a Conservative Field, Conservative Vector Fields in 3-Space, Conservation of Energy

9.10: Double Integral- Integrability, Area, Volume, Properties, Regions of Type I and II, Iterated Integrals, Evaluation of Double Integrals (*Fubini theorem*), Reversing the Order of Integration, Laminas with Variable Density—Center of Mass, Moments of Inertia, Radius of Gyration

9.11: Double Integrals in Polar Coordinates- Polar Rectangles, Change of Variables: Rectangular to Polar Coordinates,

9.12: Green's Theorem- Line Integrals Along Simple Closed Curves, *Green's theorem in plane,* Region with Holes,

9.13: Surface Integral- Surface Area, Differential of Surface Area, Surface Integral, Method of Evaluation, Projection of *S* into Other Planes, Mass of a Surface, Orientable Surfaces, Integrals of Vector Fields-*Flux,*

9.14: Stokes's Theorem- Vector Form of Green's Theorem, Green's Theorem in 3-Space-*Stoke's Theorem*, Physical Interpretation of Curl

Module III 21 hrs

9.15:Triple Integral- *definition*, Evaluation by Iterated Integrals, Applications, Cylindrical Coordinates, Conversion of Cylindrical Coordinates to Rectangular Coordinates, Conversion of Rectangular Coordinates to Cylindrical Coordinates, Triple Integrals in Cylindrical Coordinates, Spherical Coordinates, Conversion of Spherical Coordinates to Rectangular and Cylindrical Coordinates, Conversion of Rectangular Coordinates to Spherical Coordinates, Triple Integrals in Spherical Coordinates

9.16: Divergence Theorem- Another Vector Form of Green's Theorem , *divergence or Gauss' theorem, (proof omitted),* Physical Interpretation of Divergence

9.17: Change of Variable in Multiple Integral- Double Integrals, Triple Integrals

17.1: Complex Numbers- definition, arithmetic operations, conjugate, Geometric Interpretation

17.2: Powers and roots-Polar Form, Multiplication and Division, Integer Powers of z , DeMoivre's Formula, Roots

17.3: Sets in the Complex Plane- *neighbourhood, open sets, domain, region etc.*

17.4: Functions of a Complex Variable- *complex functions*, Complex Functions as Flows, Limits and Continuity, Derivative, Analytic Functions - *entire functions*

17.5: Cauchy Riemann Equation- A Necessary Condition for Analyticity, *Criteria for analyticity,* Harmonic Functions, Harmonic Conjugate Functions,

17.6:Exponential and Logarithmic function- (Complex)Exponential Function, Properties, Periodicity, *('Circuits' omitted), Complex Logarithm-principal value, properties*, Analyticity

17.7: Trigonometric and Hyperbolic functions- Trigonometric Functions, Hyperbolic Functions, Properties -*Analyticity, periodicity, zeros etc.*

Module IV 14 hrs

18.1: Contour integral- *definition*, Method of Evaluation, Properties, *ML*-inequality. Circulation and Net

18.2: Cauchy-Goursat Theorem- Simply and Multiply Connected Domains, Cauchy's Theorem, *Cauchy–Goursat theorem,* Cauchy–Goursat Theorem for Multiply Connected Domains,

18.3: Independence of Path- *Analyticity and path independence*, *fundamental theorem for contour integral, Existence of Antiderivative*

18.4: Cauchy's Integral Formula- First Formula, Second Formula-*C.I.F. for derivatives*. Liouville's Theorem, Fundamental Theorem of Algebra

References:

1	Soo T Tan: Calculus *Brooks/Cole, Cengage Learning(2010)ISBN 0-534-46579-X*
2	Gilbert Strang: Calculus *Wellesley Cambridge Press(1991)ISBN:0-9614088-2-0*
3	Ron Larson. Bruce Edwards: Calculus(11/e) *Cengage Learning(2018) ISBN: 978-1-337-27534-7*
4	Robert A Adams & Christopher Essex : Calculus *several Variable (7/e) Pearson Education Canada (2010) ISBN:* 978-0-321-54929-7
5	Jerrold Marsden & Anthony Tromba : Vector Calculus (6/e) *W. H. Freeman and Company ISBN 978-1-4292-1508-4*
6	Peter V O'Neil: Advanced Engineering Mathematics(7/e) *Cengage Learning(2012)ISBN: 978-1-111-42741-2*
7	Erwin Kreyszig : Advanced Engineering Mathematics(10/e) John Wiley & Sons(2011) ISBN: 978-0-470-45836-5
8	Glyn James: Advanced Modern Engineering Mathematics(4/e) Pearson Education Limited(2011) ISBN: 978-0-273-71923-6

FOURTH SEMESTER

MTS4 C04:MATHEMATICS-4

5 hours/week **3 Credits** **75 Marks[Int.15 + Ext. 60]**

Text	Advanced Engineering Mathematics(6/e) : Dennis G Zill *Jones & Bartlett Learning, LLC(2018)ISBN: 978-1-284-10590-2*

Module I **21 hrs**

Ordinary Differential Equations

1.1: Definitions and Terminology- definition, Classification by Type, Classification by Order, Classification by Linearity, Solution, Interval of Definition, Solution Curve, Explicit and Implicit Solutions, Families of Solutions, Singular Solution, Systems of Differential Equations

1.2: Initial Value Problems-First- and Second-Order IVPs, *Existence of solution*

1.3: Differential Equations as Mathematical Models- *some specific differential-equation models in biology, physics and chemistry.*

2.1: Solution Curves without Solution-Direction Fields *['Autonomous First-Order DEs' omitted]*

2.2: Separable Equations- definition. Method of solution, losing a solution, An Integral-Defined Function

2.3: Linear Equations-definition, standard form, homogeneous and non homogeneous DE, *variation of parameter technique,* Method of Solution, General Solution, Singular Points, Piecewise-Linear Differential Equation, Error Function

2.4: Exact Equations- Differential of a Function of Two Variables**,** *Criteria for an exact differential,* Method of Solution, Integrating Factors,

2.5: Solutions by Substitution-Homogeneous Equations, Bernoulli's Equation, Reduction to Separation of Variables

2.6: A Numerical Method- Using the Tangent Line, Euler's Method *[upto and including Example 2; rest omitted]*

Module II **22 hrs**

Higher Order Differential Equations

3.1: Theory of Linear Equations- Initial-Value and Boundary-Value Problems [Existence and Uniqueness *(of solutions),* Boundary-Value Problem]

Homogeneous Equations [Differential Operators, Superposition Principle, Linear Dependence and Linear Independence, Wronskian]

Nonhomogeneous Equations [Complementary Function, Another Superposition Principle]

3.2: Reduction of Order- *a general method to find a second solution of linear second order equation by reducing to linear first order equation*

3.3: Homogeneous Linear Equations with Constant Coefficients- Auxiliary Equation, *Distinct Real Roots , Repeated Real Roots , Conjugate Complex Roots,* Higher-Order Equations , Rational Roots *['Use of computer' part omitted]*

3.4: Undetermined Coefficients- Method of Undetermined Coefficients for finding out particular solution

3.5: Variation of parameter- *General solution using Variation of parameter technique*

3.6: Cauchy-Euler Equations- Method of solution, *Distinct Real Roots, Repeated Real Roots, Conjugate Complex Roots*

3.9: Linear Models & Boundary Value Problems- Deflection of a Beam, Eigenvalues and *Eigenfunctions [upto and including Example 3: the rest is omitted]*

Module III **19 hrs**

Laplace Transforms

4.1: Definition of Laplace Transform- *definition, examples, linearity, Transforms of some basic functions,* Sufficient Conditions for Existence of transform,

4.2: Inverse Transform and Transforms of Derivative- Inverse Transforms:- *A few important inverse transforms,* Linearity, Partial Fractions, Transforms of Derivatives, Solving Linear ODEs

4.3: Translation Theorems- Translation on the *s*-axis, *first translation theorem*, *its inverse form*, Translation on the *t*-axis, Unit step function, second translation theorem. *Its Inverse form* , Alternative Form of second translation theorem. Beams

4.4: Additional Operational Properties- Derivatives of Transforms, Transforms of Integrals-convolution, *convolution theorem (without proof) and its inverse form,* Volterra Integral Equation, Series Circuits *['*Post Script—Green's Function Redux' *omitted],* Transform of a Periodic Function

4.5: The Dirac delta Function- Unit Impulse, The Dirac Delta Function *and its transform,*

Module IV 18 hrs

12.1: Orthogonal Functions- Inner Product, Orthogonal Functions, Orthonormal Sets, Vector Analogy, Orthogonal Series Expansion, Complete Sets,

12.2: Fourier Series-Trigonometric Series, *Fourier Series*, Convergence of a Fourier Series, Periodic Extension, Sequence of Partial Sums,

12.3: Fourier Cosine and Sine Series- Even and Odd Functions., Properties, Cosine and Sine Series, Gibbs Phenomenon, Half-Range Expansions, Periodic Driving Force,

13.1: Separable Partial Differential Equations- Linear Partial Differential Equation, Solution of a PDE, Separation of Variables (*Method*), Superposition Principle, Classification of Equations (- *hyperbolic, parabolic, elliptic)*

13.2: Classical PDE's and BVP's- Heat Equation, Wave Equation, Laplace's Equation, Initial Conditions, Boundary Conditions, Boundary-Value Problems *('Variations' omitted)*

13.3: Heat Equation- Solution of the BVP **(** *method of Separation of Variables***)**

References:

1	Peter V O'Neil: Advanced Engineering Mathematics(7/e) *Cengage Learning(2012)ISBN: 978-1-111-42741-2*
2	Erwin Kreyszig : Advanced Engineering Mathematics(10/e) *John Wiley & Sons(2011) ISBN: 978-0-470-45836-5*
3	Alan Jeffrey: Advanced Engineering Mathematics *Harcourt/Academic Press(2002) ISBN: 0-12-382592-X*
4	Glyn James: Advanced Modern Engineering Mathematics(4/e) Pearson Education Limited(2011) ISBN: 978-0-273-71923-6