ST. THOMAS' COLLEGE (AUTONOMOUS)
THRISSUR, KERALA – 680001

Affiliated to University of Calicut
Nationally reaccredited with 'A' Grade

CURRICULUM AND SYLLABUS
FOR
UNDERGRADUATE PROGRAMME IN MATHEMATICS

(CORE, OPEN & COMPLEMENTARY COURSES)

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
(w.e.f. 2020 Admission onwards)

Syllabus structure

Core Courses

The following courses are compulsory for BSc Mathematics programme.

Sl. No	Code	Name of the course	Semester	No of contact hours/Week	Credits	Max. Marks			Exam dur.(Hrs)
						Internal	External	Total	
1	MTS1B01	Basic Logic and Number Theory	1	4	4	20	80	100	2.5
2	MTS2B02	Calculus of Single variable-1	2	4	4	20	80	100	2.5
3	MTS3B03	Calculus of Single variable-2	3	5	4	20	80	100	2.5
4	MTS4B04	Linear Algebra	4	5	4	20	80	100	2.5
5	MTS5B05	Theory of Equations and Abstract Algebra	5	5	4	20	80	100	2.5
6	MTS5B06	Basic Analysis	5	5	4	20	80	100	2.5
7	MTS5B07	Numerical Analysis	5	4	3	15	60	75	2
8	MTS5B08	Linear Programming	5	3	3	15	60	75	2
9	MTS5B09	Introduction to Geometry	5	3	3	15	60	75	2
		Project	5	2					
10		Open Course (Offered by Other Departments)	5	3	3	15	60	75	2
11	MTS6B10	Real Analysis	6	5	5	20	80	100	2.5
12	MTS6B11	Complex Analysis	6	5	5	20	80	100	2.5
13	MTS6B12	Calculus of Multi variable	6	5	4	20	80	100	2.5
14	MTS6B13	Differential Equations	6	5	4	20	80	100	2.5
15	MTS6B14	Elective	6	3	2	15	60	75	2
16	MTS6P15(PR)	Project Viva	6	2	2	15	60	75	
				68	58			1450	

Elective Courses

One of the following courses can be offered in the sixth semester as an elective course (Code MTS6B14(E01), MTS6B14(E02) and MTS6B14(E03).

Sl. No	Code	Name of the course	Semester	No of contact hours/Week	Credits	Max. Marks			Exam dur. (Hrs)
						Internal	External	Total	
1	MTS6B14(E01)	Graph Theory	6	3	2	15	60	75	2
2	MTS6B14(E02)	Topology of Metric spaces	6	3	2	15	60	75	2
3	MTS6B14(E03)	Mathematical Programming with Python and Latex	6	3	2	15	60	75	2

Open Courses

One of the following four courses can be offered in the fifth semester as an open course for students from other degree programmmes (MTS5D01, MTS5D02, MTS5D03 and MTS5D04).

Sl. No	Code	Name of the course	Semester	No of contact hours/Week	Credits	Max. Marks			Unty. exam Dur. (Hrs)
						Internal	External	Total	
1	MTS5D01	Applied Calculus	5	3	3	15	60	75	2
2	MTS5D02	Discrete Mathematics for Basic and Applied Sciences	5	3	3	15	60	75	2
3	MTS5D03	Linear Mathematical Models	5	3	3	15	60	75	2
4	MTS5D04	Mathematics for Decision Making	5	3	3	15	60	75	2

Complementary Courses

Sl. No	Code	Name of the course	Semester	No of contact hours/Week	Credits	Max. Marks Internal	Max. Marks External	Max. Marks Total	Unty. exam Dur. (Hrs)
1	MTS1C01	Mathematics-1	1	4	3	15	60	75	2
2	MTS2C02	Mathematics-2	2	4	3	15	60	75	2
3	MTS3C03	Mathematics-3	3	5	3	15	60	75	2
4	MTS4C04	Mathematics-4	4	5	3	15	60	75	2

Credit and Mark Distribution of BSc Mathematics Programme

Sl. No	Course		Credits	
1	English		22	
2	Additional Language		16	
3	Core Course	13 Courses	51	55
		1 Elective	2	
		Project	2	
4	Complementary course I		12	
5	Complementary course II		12	
6	Open Course		3	
Total			120	

Scheme of Evaluation

The evaluation scheme for each course shall contain two parts: internal evaluation and external evaluation.

Internal Evaluation

20% of the total marks in each course are for internal evaluation.

Components of Internal Evaluation

Sl No	Components	Marks (For Courses with Max. Marks 75)	Marks (For Courses with Max. Marks 100)
1	Class Room Participation(Attendance)	3	4
2	Assignment	3	4
3	Seminar	3	4
4	Test paper	6	8
Total		15	20

a) Percentage of Class Room Participation (Attendance) in a Semester and Eligible Internal Marks

% of Class Room Participation (Attendance)	Out of 3 (Maximum internal marks is 15)	Out of 4 (Maximum internal marks is 20)
$50\% \leq CRP < 75\%$	1	1
$75\% \leq CRP < 85\%$	2	2
85% and above	3	4

CRP means % of class room participation (Attendance)

b) Percentage of Marks in a Test Paper and Eligible Internal Marks

Range of Marks in test paper (TP)	Out of 6 (Maximum internal marks is 15)	Out of 8 (Maximum internal marks is 20)
Less than 35%	1	1
$35\% \leq TP < 45\%$	2	2
$45\% \leq TP < 55\%$	3	3
$55\% \leq TP < 65\%$	4	4
$65\% \leq TP < 85\%$	5	6
$85\% \leq TP \leq 100\%$	6	8

Evaluation of Project

1. Evaluation of the Project Report shall be done under Mark System.

2. The evaluation of the project will be done at two stages:

   - Internal Assessment (supervising teachers will assess the project and award internal Marks)

- External evaluation (external examiner appointed by the College)

3. Grade for the project will be awarded to candidates, combining the internal and external marks.

4. The internal to external components is to be taken in the ratio 1 : 4.

Assessment of different components may be taken as below.

Internal assessment of Project (15 Marks)

(Supervising Teacher will assess the Project and award internal Marks)

Sl. No.	Components	Internal Marks
1	Originality	3
2	Methodology	3
3	Scheme / Organization of Report	4.5
4	Viva Voce	4.5
Total		15

External Evaluation of Project (60 Marks)

(To be done by the External Examiner appointed by the College)

Sl. No.	Components	External Marks
1	Relevance of the Topic, Statement of Objectives	12
2	Reference/Bibliography, Presentation, quality of Analysis/Use of Statistical Tools.	12
3	Findings and recommendations	18
4	Viva-Voce	18
Total		60

Industrial Visit:

It is compulsory that every student has to undertake study tour of 2-3 days to visit Organizations / Institutes involved in higher education under the guidance of teachers. Submit a visit report countersigned by the Head of the department during the project evaluation. If a student fails to undergo the study tour he/she may not be permitted to attend the project examination.

Pattern of Question Paper for End Semester Examinations

	For Courses with Max. External Marks 80 (2.5 Hrs)		For Courses with Max. External Marks 60 (2Hrs)	
Section A	Short answer type carries 2 marks each - 15 questions	Ceiling-25	Short answer type carries 2 marks each - 12 ques-Tions	Ceiling-20
Section B	Paragraph/ Problem type carries 5 marks each - 8 questions	Ceiling-35	Paragraph/ Problem type carries 5 marks each - 7 questions	Ceiling-30
Section C	Essay type carries 10marks(2 out of 4)	2×10 = 20	Essay type carries 10marks(1 out of 2)	1×10 = 10
Total		80		60

* Questions are to be evenly distributed over the entire syllabus. At least 20% of questions from each module must be included in each section of the question paper for courses having four modules in the syllabus and 30% for courses having three modules in the syllabus.

ST. THOMAS COLLEGE (AUTONOMOUS), THRISSUR

OUTCOME BASED EDUCATION

UG: Program Outcomes

At the end of an Undergraduate Program at St. Thomas College (Autonomous), a student would have obtained the following:

PO1:	**Critical Thinking:** Ability to take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2:	**Effective Communication:** Ability to speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3:	**Effective Citizenship:** Ability to demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO4:	**Environment and Sustainability:** Ability to understand the issues of environmental contexts and sustainable development.
PO5:	**Ethical Living:** Ability to recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6:	**Social Interaction:** Ability to elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO7:	**Problem Solving and Analytical Skills:** Ability to think rationally, analyze situations and solve problems adequately.

Program Specific Outcomes:

PSO 1	Understand the basic concepts and tools of Mathematical logic, methods of proofs, set theory, Number theory, abstract structures and algebra.
PSO 2	Acquire knowledge in Calculus & Geometry.
PSO 3	Apply mathematical theories and principles accurately, precisely and effectively.
PSO 4	Analyze and solve real world problems applying mathematical models.

CORE COURSES

FIRST SEMESTER

MTS1 B01 BASIC LOGIC & NUMBER THEORY

4 hours/week 4 Credits 100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
1	MTS1B01	Core	Basic Logic and Number Theory					
CO	CO Statement							
CO 1	Model problems in mathematics using logic.			Ap	(C,P)	12	1	1
CO 2	Analyse results involving divisibility, GCD and LCM.			An	(C,P)	22	6	
CO 3	Understand methods of solving LDE.			U	(C,P)	5	1	
CO 4	Analyse the theory of congruence.			An	C	7	5	
CO 5	Solve congruences using Fermat's Theorem, Wilson's Theorem and Euler's Theorem.			Ap	(C,P)	12	7	
CO 6	Understand the concept of number theoretic functions.			U	C	6	1	

Syllabus

Text (1)	Discrete Mathematics with Applications : Thomas Koshy, *Elsever Academic Press(2004) ISBN:0-12-421180-1*
Text:(2)	Elementary Number Theory with Applications (2/e) :Thomas Koshy, *Elsever Academic Press(2007) ISBN:978-0-12-372487-8*

Module-I Text (1) (12 hrs)

1.1: Propositions- definition, Boolean (logic) variables, Truth Value, Conjunction , Boolean expression, Disjunction (inclusive and exclusive), Negation, Implication, Converse, Inverse and Contra positive, Biconditional statement, Order of Precedence, Tautology Contradiction and Contingency. [‘Switching Networks’ omitted]

1.2: Logical equivalences- laws of logic. [‘Equivalent Switching Networks’ ‘Fuzzy logic’ & ‘Fuzzy decisions’omitted]

1.3: Quantifiers- universal & existential, predicate logic.

1.4: Arguments- valid and invalid arguments, inference rules.

1.5: Proof Methods – vacuous proof, trivial proof, direct proof, indirect proof- contrapositive & contradiction, proof by cases , Existence proof- constructive & non constructive, counterexample.

Module-II Text (2) (22 hrs)

1.3: Mathematical induction- well ordering principle, simple applications, weak version of principle of mathematical induction, illustrations, strong version of induction (second principle of MI), illustration.

1.4: Recursion- recursive definition of a function, illustrations.

2.1: The division algorithm – statement and proof, div & mod operator, card dealing, The two queens puzzle (simple applications), pigeonhole principle and division algorithm, divisibility relation, illustration ,divisibility properties, union intersection and complement-inclusion-exclusion principle & applications, even and odd integers.

2.2: Base-b representation – base-b expansion of an integer & representation in nondecimal bases. [Proof of Theorem2.7, ‘algorithm2.1’ ‘Russian Peasant algorithm’, ‘Egyption multiplication ‘& ‘division’ omitted]

2.5: Prime and Composite Numbers- definitions, infinitude of primes, ['algorithm 2.4' omitted] The sieve of Eratosthenes, a number theoretic function, prime number theorem (statement only), distribution of primes (upto and including Example 2.25) . [rest of the section omitted]

2.6: Fibonacci and Lucas Numbers- Fibonacci Problem, Fibonacci Numbers F_n, ['algorithm2.5' omitted] Cassini's Formula, ['A Fibonacci Paradox' omitted], Lucas Numbers and Binet's Formula.

2.7: Fermat Numbers- definition, recurrence relation satisfied by f_n, non primality of f_5, primality of f_4 (upto and including example 2.30) [rest of the section omitted]

3.1: Greatest Common Divisor- gcd, symbolic definition, relatively prime integers, Duncan's identity, Polya's theorem, infinitude of primes, properties of gcd, linear combination, gcd as linear combination, an alternate definition of gcd, gcd of n positive integers, a linear combination of n positive integers, pairwise relatively prime integers, alternate proof for infinitude of prime.

3.2: The Euclidean Algorithm- The Euclidean algorithm [algorithm 3.1 omitted], A jigsaw puzzle, (Proof of Lemma 3.2 omitted) Lame's theorem (statement only; proof omitted)

3.3: The Fundamental Theorem of Arithmetic- Euclid's lemma on division of product by a prime, fundamental theorem of arithmetic, Canonical Decomposition, number of trailing zeros, highest power of a prime dividing n!, [only statement of Theorem3.14 required; proof omitted] Distribution of Primes Revisited, Dirichlet's Theorem(statement only)

Module-III Text (2) (15 hrs)

3.4: Least Common Multiple- definition, canonical decomposition to find lcm, relationship between gcd and lcm, relatively prime numbers and their lcm.

3.5: Linear Diophantine Equations – LDE in two variables, conditions to have a solution, Aryabhatta's method, number of solutions, general solution, Mahavira's puzzle, hundred fowls puzzle, Monkey and Coconuts Puzzle, ['Euler's method for solving LDE's ' omitted] Fibonacci numbers and LDE, LDE in more number of variables and their solutions- Theorem 3.20.

4.1:Congruences - congruence modulo m, properties of congruence, characterization of congruence, least residue, ['Friday-the-Thirteenth' omitted], congruence classes, A Complete Set of Residues Modulo m , properties of congruence, use of congruence to find the remainder on division, ['Modular Exponentiation' method omitted], Towers of Powers Modulo m, further properties of congruence and their application to find remainder ['Monkey and Cocunut Puzzle revisited'(example 4.17) omitted] congruences of two numbers with different moduli.

4.2: Linear Congruence- [only statement of Theorem4.9 required; proof omitted]solvability, uniqueness of solution, incongruent solutions, Modular Inverses, applications.

5.1: Divisibility Tests-Divisibility Test for 10, Divisibility Test for 5, Divisibility Test for 2^i , Divisibility Tests for 3 and 9, Divisibility Test for 11. [rest of the section from Theorem 5.1 onwards omitted]

Module-IV Text (2) (15 hrs)

7.1: Wilson's Theorem- self invertible modulo prime, Wilson's theorem and its converse. [' Factorial, Multifactorial and Primorial Primes' omitted]

7.2: Fermat's Little Theorem(FLT)- FLT and its applications, [Lagrange's alternate proof of Wilson's theorem omitted], inverse of a modulo p using FLT, application-solution of linear congruences [' Factors of $2^n + 1$ ' omitted], extension of FLT in various directions ['The Pollard p-1 factoring method' omitted]

7.3: Pseudoprimes- FLT to check compositeness, disproving converse of FLT, pseudoprimes, infinitude of pseudoprime. ['Carmichael Numbers' omitted]

7.4: Euler's Theorem- motivation**,** Euler's Phi Function φ, Euler's Theorem, applications, generalisation of Euler's theorem. (koshy)

8.1: Euler's Phi Function Revisited- multiplicative functions, fundamental theorem for multiplicative functions, formula for $\varphi(p^e)$, [Example 8.3 omitted] multiplicative nature of φ, use in computation, Gauss theorem on sum of $\varphi(d)$ values of divisors d of n.

8.2: The Tau and Sigma Function- definition, multiplicative nature of tau(τ) and sigma (σ) functions, formula for $\tau(n)$ and $\sigma(n)$. ['Application to a Brainteaser' omitted]

References:

1	Susanna S Epp: Discrete Mathematics with Applications(4/e) *Brooks/Cole Cengage Learning(2011) ISBN: 978-0-495-39132-6*
2	Kenneth H. Rosen: Discrete Mathematics and Its Applications(7/e) *McGraw-Hill, NY(2007) ISBN: 978-0-07-338309-5*
3	David M. Burton : Elementary Number Theory(7/e) *McGraw-Hill (2011) ISBN: 978-0-07-338314-9*
4	Gareth A. Jones and J. Mary Jones: Elementary Number Theory, *Springer Undergraduate Mathematics Series(1998) ISBN: 978-3-540-76197-6*
5	Underwood Dudley :Elementary Number Theory(2/e), *Dover Publications (2008)ISBN:978-0-486-46931-7*
6.	James K Strayer: Elementary Number Theory, *Waveland Press, inc.* (1994), *ISBN:978-1-57766-224-2*
7	Kenneth H. Rosen: Elementary Number Theory(6/e), *Pearson Education(2018)ISBN: 9780134310053*

SECOND SEMESTER

MTS2 B02 CALCULUS OF SINGLE VARIABLE-1

4 hours/week 4 Credits 100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
2	**MTS2B02**	**Core**	**Calculus of Single variable-1**					
CO	**CO Statement**							
CO 1	Define limit, continuity and differentiability.			R	C	20	1	2
CO 2	Explain basic theorems of differential calculus.			U	C	7	1	
CO 3	Apply the concepts and theorems in calculus to draw the graph of a function.			Ap	(C,P)	10	7	
CO 4	Define anti derivatives and area under the graph of a function.			R	C	8	1	
CO 5	Understand basic theorems of integral calculus.			U	C	6	1	
CO 6	Apply the concept of definite integral to find the area between two curves, volume and arc length.			Ap	(C,P)	13	7	

Syllabus

Text	Calculus: Soo T Tan *Brooks/Cole, Cengage Learning (2010)* *ISBN: 978-0-534-46579-7*

Module-I (20hrs)

(*Functions and Limits*)

0.2: Functions and their Graphs- Definition of a Function, Describing Functions, Evaluating Functions, Finding the Domain of a Function, The Vertical Line Test, Piecewise Defined Functions, Even and Odd Functions. (Quick review)

0.4: Combining functions- Arithmetic Operations on Functions, Composition of Functions, Graphs of Transformed Functions, Vertical Translations, Horizontal Translations, Vertical Stretching and Compressing, Horizontal Stretching and Compressing, Reflecting. (Quick review)

1.1: Intuitive introduction to Limits- A Real-Life Example, Intuitive Definition of a Limit, One-Sided Limits, Using Graphing Utilities to Evaluate Limits.

1.2: Techniques for finding Limits- Computing Limits Using the Laws of Limits, Limits of Polynomial and Rational Functions, Limits of Trigonometric Functions, The Squeeze Theorem.

1.3: Precise Definition of a Limit-$\varepsilon - \delta$ definition, A Geometric Interpretation, Some illustrative examples.

1.4: Continuous Functions- Continuity at a Number, Continuity at an Endpoint, Continuity on an Interval, Continuity of Composite Functions, Intermediate Value Theorem

1.5: Tangent Lines and Rate of change- An Intuitive Look, Estimating the Rate of Change of a Function from Its Graph, More Examples Involving Rates of Change, Defining a Tangent Line, Tangent Lines, Secant Lines, and Rates of Change.

2.1: The Derivatives- Definition, Using the Derivative to Describe the Motion of the Maglev, Differentiation, Using the Graph of f to Sketch the Graph of f', Differentiability and Continuity.

2.4: The role of derivative in the real world- Motion along a Line, Marginal Functions in Economics.

2.9: Differentials and Linear Approximations- increments, Differentials, Error Estimates, Linear Approximations, Error in Approximating Δy by dy.

Module-II (17 hrs)

(Applications of the Derivative)

3.1: Extrema of Functions -Absolute Extrema of Functions, Relative Extrema of Functions, Fermat's Theorem, Finding the Extreme Values of a Continuous Function on a Closed Interval, An Optimization Problem.

3.2: The Mean Value Theorem- Rolle's Theorem, The Mean Value Theorem, Some Consequences of the Mean Value Theorem, Determining the Number of Zeros of a Function.

3.3: Increasing and Decreasing Functions- definition , inferring the behaviour of function from sign of derivative, Finding the Relative Extrema of a Function, first derivative test.

3.4: Concavity and Inflection points- Concavity, Inflection Points, The Second Derivative Test, The Roles of f' and f'' in Determining the Shape of a Graph.

3.5: Limits involving Infinity; Asymptotes- Infinite Limits, Vertical Asymptotes, Limits at Infinity, Horizontal Asymptotes, Infinite Limits at Infinity, Precise Definitions.

3.6: Curve Sketching-The Graph of a Function, Guide to Curve Sketching, Slant Asymptotes , Finding Relative Extrema Using a Graphing Utility.

3.7: Optimization Problems – guidelines for finding absolute extrema, Formulating Optimization Problems- application involving several real life problems.

Module-III (14 hrs)

(Integration)

4.1: Anti derivatives, Indefinite integrals, Basic Rules of Integration, a few basic integration formulas and rules of integration, Differential Equations, Initial Value Problems.

4.3: Area- An Intuitive Look, The Area Problem, Defining the Area of the Region Under the Graph of a Function-technique of approximation ['Sigma Notation' and 'Summation Formulas' Omitted] An Intuitive Look at Area (Continued), Defining the Area of the Region Under the Graph of a Function-precise definition, Area and Distance.

4.4: The Definite Integral- Definition of the Definite Integral, Geometric Interpretation of the Definite Integral, The Definite Integral and Displacement, Properties of the Definite Integral , More General Definition of the Definite Integral.

4.5: The Fundamental Theorem of Calculus- How Are Differentiation and Integration Related?, The Mean Value Theorem for Definite Integrals, The Fundamental Theorem of Calculus: Part I, inverse relationship between differentiation and integration, Fundamental Theorem of Calculus: Part 2, Evaluating Definite Integrals Using Substitution, Definite Integrals of Odd and Even Functions, The Definite Integral as a Measure of Net Change.

Module-IV (13 hrs)

(Applications of Definite Integral)

5.1: Areas between Curves- A Real Life Interpretation, The Area Between Two Curves, Integrating with Respect to y —adapting to the shape of the region, What Happens When the Curves Intertwine?

5.2: Volume – Solids of revolution, Volume by Disk Method, Region revolved about the x-axis, Region revolved about the y-axis , Volume by the Method of Cross Sections. [' Washer Method' omitted]

5.4: Arc Length and Areas of surfaces of revolution- Definition of Arc Length, Length of a Smooth Curve, arc length formula, The Arc Length Function, arc length differentials, Surfaces of Revolution, surface area as surface of revolution.

Seminar topics

5.5: Work-Work Done by a Constant Force, Work Done by a Variable Force, Hook's Law, Moving non rigid matter, Work done by an expanding gas.

5.7: Moments and Center of mass – Measures of Mass, Center of mass of a system on a line, center of mass of a system in a plane, center of mass of Laminas. (up to example 3)

References:

1	Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus(14/e) *Pearson (2018) ISBN 0134438981*
2	Robert A Adams & Christopher Essex : Calculus *Single Variable (8/e) Pearson Education Canada (2013) ISBN:* 0321877403
3	Jon Rogawski & Colin Adams : Calculus *Early Transcendentals* (3/e) *W. H. Freeman and Company(2015) ISBN: 1319116450*
4	Anton, Bivens & Davis : Calculus *Early Transcendentals* (11/e) *John Wiley & Sons, Inc.(2016) ISBN: 1118883764*
5	James Stewart : Calculus (8/e) *Brooks/Cole Cengage Learning(2016) ISBN: 978- 1-285-74062-1*
6	Jerrold Marsden & Alan Weinstein : Calculus I and II (2/e*) Springer Verlag NY (1985) ISBN 0-387-90974-5 : ISBN 0-387-90975-3*

THIRD SEMESTER

MTS3 B03 CALCULUS OF SINGLE VARIABLE-2

5 hours/week 4 Credits 100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
3	**MTS3B03**	**Core**	**Calculus of Single variable-2**					
CO	**CO Statement**							
CO 1	Explain logarithmic function, exponential function, trigonometric function and hyperbolic function.			U	C	14	1	2
CO 2	Apply L'Hopital Rule to solve indeterminate forms.			Ap	(C,P)	6	7	
CO 3	Illustrate convergence and divergence in sequences and series.			U	(C,P)	20	1	
CO 4	Illustrate Taylor and Maclaurin series .			U	(C,P)	10	7	
CO 5	Explain the calculus of parametric equations.			U	(C,P)	15	1	
CO 6	Understand differentiation and integration of vector valued functions.			U	C	15	1	

Syllabus

Text	Calculus: Soo T Tan *Brooks/Cole, Cengage Learning (2010)* *ISBN: 978-0-534-46579-7*

Module-I (20 hrs)

(The Transcendental Functions)
6.1: The Natural logarithmic function- definition, The Derivative of ln x, Laws ofLogarithms, The Graph of the Natural Logarithmic Function, The Derivatives of Logarithmic Functions, Logarithmic Differentiation, Integration Involving Logarithmic Functions.

6.2: Inverse Functions-The Inverse of a Function, The Graphs of Inverse Functions, Which Functions have Inverses?, Finding the Inverse of a Function, Continuity and Differentiability of Inverse Functions.

6.3: Exponential Functions- The number e , Defining the Natural Exponential Function, properties, The Laws of Exponents, The Derivatives of Exponential Functions, Integration of the Natural Exponential Function.

6.4: General Exponential and Logarithmic Functions - Exponential Functions with Base a, laws of exponents, The Derivatives of a^x, a^u, Graphs of $y = a^x$, integrating a^x, Logarithmic Functions with Base a, change of base formula, The Power Rule (General Form), The Derivatives of Logarithmic Functions with Base a , The Definition of the Number e as a Limit. [‘Compound Interest’ omitted]

6.5: Inverse trigonometric functions- definition, graph, inverse properties, Derivative of inverse trigonometric functions, Integration Involving Inverse Trigonometric Functions.

6.6: Hyperbolic functions- The Graphs of the Hyperbolic Functions, Hyperbolic Identities, Derivatives and Integrals of Hyperbolic Functions, Inverse Hyperbolic Functions, representation in terms of logarithmic function, Derivatives of Inverse Hyperbolic Functions, An Application.

6.7: Indeterminate forms and l’Hôpital rule- motivation, The indeterminate forms $\frac{0}{0}$ and $\frac{\infty}{\infty}$, The indeterminate forms $\infty - \infty$ and $0.\infty$, The indeterminate forms $0^0, \infty^0$ and 1^∞.

Module-II (20 hrs)

(Infinite Sequences and Series)
7.6: Improper integrals – definition, Infinite Intervals of Integration, Improper Integrals with Infinite Discontinuities, A Comparison Test for Improper Integrals.

9.1: Sequences- definition, recursive definition, Limit of a Sequence, limit laws, squeeze theorem, Bounded Monotonic Sequences, definition, monotone convergence theorem. (only statement; its proof omitted)

9.2: Series- defining the sum, convergence and divergence, Geometric Series, The Harmonic Series, The Divergence Test, Properties of Convergent Series.

9.3: The Integral Test – investigation of convergence, integral test, The p- Series, its convergence and divergence.

9.4: The Comparison Test- test series, The Comparison Test, The Limit Comparison Test.

9.5: Alternating Series- definition, the alternating series test, its proof, examples, Approximating the Sum of an Alternating Series by S_n.

9.6: Absolute Convergence- definition, conditionally convergent, The Ratio Test, The Root Test, Summary of Tests for Convergence and Divergence of Series, Rearrangement of Series.

Module-III (20hrs)

9.7: Power Series- definition, Interval of Convergence, radius of convergence, Differentiation and Integration of Power Series.

9.8: Taylor and Maclaurin Series- definition, Taylor and Maclaurin series of functions, Techniques for Finding Taylor Series.

10.2: Plane Curves and Parametric Equations- Why We Use Parametric Equations, Sketching Curves Defined by Parametric Equations.

10.3: The Calculus of parametric equations- Tangent Lines to Curves Defined by Parametric Equations, Horizontal and Vertical Tangents, Finding $\frac{d^2y}{dx^2}$ from Parametric Equations, The Length of a smooth Curve, The Area of a Surface of Revolution.

10.4: Polar coordinate-The Polar Coordinate System, Relationship Between Polar and Rectangular Coordinates, Graphs of Polar Equations, Symmetry, Tangent Lines to Graphs of Polar Equations 10.5: Areas and Arc Lengths in polar coordinates-Areas in Polar Coordinates, area bounded by polar curves, Area Bounded by Two Graphs, Arc Length in Polar Coordinates, Area of a Surface of Revolution, Points of Intersection of Graphs in Polar Coordinates.

Module-IV (20hrs)

11.5: Lines and Planes in Space-Equations of Lines in Space, parametric equation, symmetric equation of a line, Equations of Planes in Space, standard equation, Parallel and Orthogonal Planes, The Angle Between Two Planes, The Distance Between a Point and a Plane.

11.6: Surfaces in Space- Traces, Cylinders, Quadric Surfaces, Ellipsoids, Hyperboloids of One Sheet, Hyperboloids of Two Sheets, Cones, Paraboloids, Hyperbolic Paraboloids.

11.7: Cylindrical and Spherical Coordinates-The Cylindrical Coordinate System, converting cylindrical to rectangular and vice verse, The Spherical Coordinate System, converting spherical to rectangular and vice verse.

12.1: Vector Valued functions and Space Curves- definition of vector function, Curves Defined by Vector Functions, [‘Example 7’ omitted] Limits and Continuity.

12.2: Differentiation and Integration of Vector-Valued Function- The Derivative of a Vector Function, Higher-Order Derivatives, Rules of Differentiation, Integration of Vector Functions.

Seminar topics

12.4: Velocity and Acceleration- Velocity, Acceleration, and Speed; Motion of a Projectile.

References:

1	Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus (14/e) *Pearson(2018) ISBN 0134438981*
2	Robert A Adams & Christopher Essex : Calculus *Single Variable (8/e) Pearson Education Canada (2013) ISBN:* 0321877403
3	Jon Rogawski & Colin Adams : Calculus *Early Transcendentals* (3/e) W. H. Freeman and Company(2015) *ISBN: 1319116450*
4	Anton, Bivens & Davis : Calculus *Early Transcendentals* (11/e) *John Wiley & Sons, Inc.(2016) ISBN: 1118883764*
5	James Stewart : Calculus (8/e) *Brooks/Cole Cengage Learning(2016) ISBN: 978-1-285-74062-1*
6	Jerrold Marsden & Alan Weinstein : Calculus I and II (2/e*) Springer Verlag NY(1985) ISBN 0-387-90974-5 : ISBN 0-387-90975-3*

FOURTH SEMESTER

MTS4 B04 LINEAR ALGEBRA

5 hours/week 4 Credits 100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
4	**MTS4B04**	**Core**	**Linear Algebra**					
CO	**CO Statement**							
CO 1	Solve system of linear equations using various methods.			Ap	(C,P)	17	7	1
CO 2	Illustrate vector space, sub space, linear independence, linear dependence and basis.			U	C	22	1	
CO 3	Understand dimension theorem for matrices.			U	C	12	1	
CO 4	Explain basic matrix transformations.			U	(C,P)	6	1	
CO 5	Demonstrate diagonalization.			U	(C,P)	15	7	
CO 6	Apply Gram-schmidt orthonormalization process.			Ap	(C,P)	8	7	

Syllabus

Text	Elementary Linear Algebra: Application Version(11/e) :Howard Anton & Chris Rorres *Wiley(2014) ISBN 978-1-118-43441-3*

Module-I (17 hrs)

Systems of Linear Equations & Matrices :-

1.1: Introduction to Systems of Linear Equations- linear equation in n variables, linear system of m equations in n variables, solution, Linear Systems in Two and Three Unknowns, solution by geometric analysis, consistent and inconsistent systems, linear system with no, one, and infinite number of solutions, augmented matrix and elementary row operations.

1.2: Gaussian elimination - Considerations in Solving Linear Systems, Echelon Forms, reduced row echelon form, Elimination Methods, Gauss–Jordan elimination, Gaussian elimination, Homogeneous Linear Systems, Free Variables, Free Variable Theorem for Homogeneous Systems, Gaussian Elimination and Back- Substitution, Some Facts about Echelon Forms.

1.3: Matrices and Matrix operations-Matrix Notation and Terminology, row vector , column vector , square matrix of order n , Operations on Matrices , Partitioned Matrices, Matrix Multiplication by Columns and by Rows, Matrix Products as Linear Combinations, linear combination of column vectors, Column-Row Expansion, Matrix Form of a Linear System, Transpose of a Matrix, Trace of a Matrix.

1.4: Inverses and algebraic properties of matrices- Properties of Matrix Addition and Scalar Multiplication, Properties of Matrix Multiplication, Zero Matrices and Properties, Identity Matrices, Inverse of a Matrix, Properties of Inverses, Solution of a Linear System by Matrix Inversion, Powers of a Matrix , Matrix Polynomials, Properties of the Transpose.

1.5: Elementary matrices and a method for finding A^{-1}-row equivalence, elementary matrix, Row Operations by Matrix Multiplication, invertibility of elementary matrices, invertibility and equivalent statements, A Method for Inverting Matrices, Inversion Algorithm, illustrations.

1.6: More on linear systems and invertible matrices - Number of Solutions of a Linear System, Solving Linear Systems by Matrix Inversion, Linear Systems with a Common Coefficient Matrix, Properties of Invertible Matrices, equivalent statements for unique solution of $Ax = b$, determining consistency.

1.7: Diagonal, Triangular and Symmetric matrices-Diagonal Matrices, Inverses and Powers of Diagonal Matrices, Triangular Matrices. Properties of Triangular Matrices, Symmetric Matrices, algebraic properties of symmetric matrices, Invertibility of Symmetric Matrices

1.8: Matrix transformation- definition, Properties of Matrix Transformations, standard matrix, A Procedure for Finding Standard Matrices.

2.1: Determinants by cofactor expansion- minors, cofactors, cofactor expansion, Definition of a General Determinant, A Useful Technique for Evaluating 2×2 and 3×3 Determinants.

2.2: Evaluating determinants by row reduction- a few basic theorems, elementary row operations and determinant, determinant of elementary matrices, determinant by row reduction.

Module-II (18 hrs)

General Vector Spaces
4.1: Real vector space - Vector Space Axioms, examples, Some Properties of Vectors.

4.2: Subspaces- definition, criteria for a subset to be a subspace, examples, Building Subspaces, linear combination, spanning, Solution Spaces of Homogeneous Systems as subspace, The Linear Transformation Viewpoint, kernel, different set of vectors spanning the subspace.

4.3: Linear Independence- Linear Independence and Dependence, illustrations , A Geometric Interpretation of Linear Independence, Wronskian, linear independence using wronskian.

4.4: Coordinates and basis-Coordinate Systems in Linear Algebra, Basis for a Vector Space, finite and infinite dimensional vector spaces, illustrations, Coordinates Relative to a Basis, Uniqueness of Basis Representation.

4.5: Dimension- Number of Vectors in a Basis , dimension, Some Fundamental Theorems, dimension of subspaces.

Module-III (22 hrs)

4.6: Change of basis -Coordinate Maps, Change of Basis, Transition Matrices, Invertibility of Transition Matrices, An Efficient Method for Computing Transition Matrices for $\mathbb{R}^n$, Transition to the Standard Basis for $\mathbb{R}^n$.

4.7: Row space, Column space and Null space- vector spaces associated with matrices, consistency of linear system, Bases for Row Spaces, Column Spaces, and Null Spaces, basis from row echelon form, Basis for the Column Space of a Matrix, row equivalent matrices and relationship between basis for column space, Bases Formed from Row and Column Vectors of a Matrix.

4.8: Rank Nullity and Fundamental matrix spaces- equality of dimensions of row and column spaces, Rank and Nullity, Dimension Theorem for Matrices, The Fundamental Spaces of a Matrix, rank of a matrix and its transpose, A Geometric Link Between the Fundamental Spaces, orthogonal complement, invertibility and equivalent statements, Applications of Rank, Over determined and Under determined Systems.

4.9: Basic matrix transformations in R^2 and R^3 -Reflection Operators, Projection Operators, Rotation Operators, Rotations in $\mathbb{R}^3$, Dilations and Contractions, Expansions and Compressions, Shears, Orthogonal Projections onto Lines Through the Origin, Reflections About Lines Through the Origin.

4.10: Properties of matrix transformation- Compositions of Matrix Transformations, One-to-One Matrix Transformations, Kernel and Range, fundamental relationship between invertibility of a matrix and its matrix transformation, Inverse of a One-to-One Matrix Operator.

Module-IV (23 hrs)

4.11: Geometry of matrix operators-Transformations of Regions, Images of Lines Under Matrix Operators, Geometry of Invertible Matrix Operators, Elementary matrix and its matrix transformation, consequence.

5.1: Eigen values and Eigen Vectors- definition, Computing Eigenvalues and Eigenvectors, characteristic equation, alternative ways of describing eigen values, Finding Eigenvectors and Bases for Eigenspaces, Eigenvalues and Invertibility, Eigenvalues of General Linear Transformations.

5.2: Diagonalization-The Matrix Diagonalization Problem, linear independence of eigen vectors and diagonalizability, Procedure for Diagonalizing a Matrix, Eigenvalues of Powers of a Matrix, Computing Powers of a Matrix, Geometric and Algebraic Multiplicity.

6.1: Inner Product – definition of General inner product, Euclidean inner product (or the standard inner product) on $\mathbb{R}^n$, norm of a vector, properties (upto and including theorem 6.1.1), a few examples. (only example7 and example 10) [rest of the section omitted]

6.2: Angle and orthogonality in Inner product spaces- only the definition of orthogonality in a real inner product space (to be motivated by the relation in the definition (3) of section 3.2) and examples(2),(3) and (4).

6.3:Gram–Schmidt Process- definition of Orthogonal and Orthonormal Sets, examples, linear independence of orthogonal set, orthonormal basis, Coordinates Relative to Orthonormal Bases ['Orthogonal Projections' omitted] The Gram–Schmidt Process [only statement of Theorem 6.3.5 and the step by step construction technique are required; derivation omitted], illustrations- examples 8 and 9, Extending Orthonormal Sets to Orthonormal Bases. [rest of the section omitted]

7.1: Orthogonal Matrices- definition, characterisation of orthogonal matrices, properties of orthogonal matrices, Orthogonal Matrices as Linear Operators, a geometric interpretation. [rest of the section omitted]
7.2: Orthogonal Diagonalization- The Orthogonal Diagonalization Problem, Conditions for Orthogonal Diagonalizability, Properties of Symmetric Matrices, Procedure for Orthogonally Diagonalizing an $n \times n$ Symmetric Matrix, Spectral Decomposition .(upto and including example2) [rest of the section omitted]

References:

1	Jim DeFranza, Daniel Gagliardi: Introduction to Linear Algebra with Applications *Waveland Press, Inc(2015)ISBN: 1-4786-2777-8*
2	Otto Bretscher: Linear Algebra with Applications(5/e) Pearson Education, Inc (2013) ISBN: 0-321-79697-7
3	Ron Larson, Edwards, David C Falvo : Elementary Linear Algebra(6/e) *Houghton Mifflin Harcourt Publishing Company(2009) ISBN: 0-618-78376-8*
4	David C. Lay, Steven R. Lay, Judi J. McDonald: Linear Algebra and its Application (5/e) *Pearson Education, Inc(2016) ISBN: 0-321-98238-X*
5	Martin Anthony, Michele Harvey: Linear Algebra: Concepts and Methods *Cambridge University Press(2012) ISBN: 978-0-521-27948-2*
6	Jeffrey Holt: Linear Algebra with Applications *W. H. Freeman and Company (2013) ISBN: 0-7167-8667-2*

FIFTH SEMESTER

MTS5 B05 THEORY OF EQUATIONS AND ABSTRACT ALGEBRA

5 hours/week **4 Credits** **100 Marks [Int:20+Ext:80]**

Course Outcomes:

Course No	**Code**	**Course Category**	**Name of the course**	**CL**	**KC**	**Hrs**	**PO**	**PSO**
5	**MTS5B05**	**Core**	**Theory of Equations and Abstract algebra**					
CO	**CO Statement**							
CO 1	Understand division of polynomials, remainder theorem, Taylor's formula and limits of roots.			U	(C,P)	10	1	1
CO 2	Solve polynomial equations.			Ap	(C,P)	15	1	
CO 3	Illustrate groups and sub groups.			U	C	23	1	
CO 4	Demonstrate isomorphism and homomorphism of groups.			U	(C,P)	18	7	
CO 5	Illustrate commutative rings.			U	C	14	1	

Syllabus

Text (1)	Theory of Equations : J V Uspensky *McGraw Hill Book Company, Inc. (1948) ISBN:07-066735-7*
Text:(2)	Abstract Algebra(3/e):John A Beachy and William D Blair *Waveland Press, Inc.(2006) ISBN: 1-57766-443-4*

Module-I Text(1) (25hrs)

Theory of Equations

Chapter II

II.3: Division of polynomials, quotient and remainder, method of detached coefficients.

II.4: The remainder theorem.

II.5: Synthetic Division.

II. 7: Taylor formula, expansion of a polynomial in powers of x – c.

Chapter III

III. 1: Algebraic equations, roots, maximum number of roots.

III.2: Identity theorem.

III.3:The Fundamental theorem of Algebra (statement only), factorisation to linear factors, multiplicity of roots.

III. 4: Imaginary roots of equations with real coefficients.

IV. III.5: Relations between roots and coefficients.

Chapter IV

V. 1: Limits of roots.

IV.2: Method to find upper limit of positive roots.

IV.3: Limit for moduli of roots. [only the method to find out upper limit from the auxiliary equation is required; derivation omitted]

IV. 4: Integral roots.

IV.5: Rational roots.

Chapter V

V. 1: What is the solution of an equation, algebraic solution or solution by radical

VI. V.2: Carden's formula.

V.3: Discussion of solution.

V.4: Irreducible case.

Chapter VI

V. 1: Object of the Chapter.

VI.2: The sign of a polynomial for small and large values of variables- locating roots of polynomial between two numbers having values of opposite sign- geometric illustration only- [rigorous reasoning in the starred section omitted]

VI.4: Corollaries- roots of odd and even degree polynomial, number of roots in an interval counted according to their multiplicity.
VI.5: Examples.
VI.6: An important identity and lemma .[derivation not needed]
VI.7: Rolle's theorem [proof omitted], use in separating roots.
VI.10: Descarte's rule of signs-only statement and illustrations are required.
Chapter XI
XI.1: Symmetric Functions–definition, sigma functions, elementary symmetric functions.
XI.4: Practical Methods-representation of symmetric functions through elementary symmetric functions.

Module-II Text (2) (23 hrs)

Abstract Algebra

1.4: Integers modulo n- congruence class modulo n , addition and multiplication, divisor of zero, multiplicative inverse.

2.2: Equivalence relations-basic idea, definition, equivalence class, factor set, partition and equivalence relation, examples and illustrations.

2.3: Permutations- definition, cycles, product of cycles, permutation as product of disjoint cycles, order of cycles, transposition, even and odd transpositions.

3.1: Definition of Group-binary operation, uniqueness of identity and inverse, definition and examples of groups, properties, Abelian group, finite and infinite groups, general linear groups.

3.2: Subgroups-the notion of subgroup, examples, conditions for a subgroup, cyclic subgroups, order of an element, Lagrange theorem, Euler's theorem.

Module-III Text (2) (18 hrs)

3.3: constructing examples- groups with order upto 6, multiplication table, product of subgroups, direct products, Klein four group as direct product, subgroup generated by a subset.

3.4: Isomorphism – definition, consequences, structural properties, method of showing that groups are not isomorphic, isomorphic and non isomorphic groups.

3.5: Cyclic groups- subgroups of cyclic groups, characterisation, generators of a finite cyclic group, structure theorem for finite cyclic group, exponent of a group, characterisation of cyclic groups among finite abelian groups.

3.6: Permutation groups- definition, Cayley's theorem, rigid motions of n-gons, dihedral group, alternating group

3.7: Homomorphism - basic idea, examples, definition, properties, kernel, normal subgroups, subgroups related via homomorphism.

Module-IV Text (2) (14hrs)

3.8: Cosets- left and right cosets, normal subgroups and factor groups, fundamental homomorphism theorem, simple groups, examples and illustrations of concepts.

7.1: (Structure of Groups) Isomorphism theorems; Automorphism- first isomorphism theorem, second isomorphism theorem,(Proofs of Theorems are omitted) inner automorphism.

5.1: Commutative Rings ; Integral Domains- definition, examples, subring, criteria to be a subring, divisor of zero, integral domain, finite integral domain.

References:

1	Dickson L.E: Elementary Theory of Equations *John Wiley and Sons,Inc. NY(1914)*
2	Turnbull H.W: Theory of Equations(4/e) *Oliver and Boyd Ltd. Edinburg(1947)*
3	Todhunter I: An Elementary Treatise on the Theory of Equations(3/e) *Macmillan and Co. London(1875*)
4	William Snow Burnside and Arthur William Panton: The Theory of Equations *with* An Introduction to Binary Algebraic Forms *Dublin University Press Series(1881)*
5	Joseph A. Gallian : Contemporary Abstract Algebra(9/e) *Cengage Learning, Boston(2017) ISBN: 978-1-305-65796-0*
6	John B Fraleigh : A First Course in Abstract Algebra(7/e) *Pearson Education LPE(2003) ISBN 978-81-7758-900-9*
7	David Steven Dummit, Richard M. Foote: Abstract Algebra(3/e) *Wiley, (2004) ISBN: 8126532289*
8	Linda Gilbert and Jimmie Gilbert: Elements of Modern Algebra (8/e) *Cengage Learning, Stamford(2015) ISBN: 1-285-46323-4*
9	John R. Durbin : Modern Algebra: An Introduction(6/e) *Wiley(2015) ISBN: 1118117611*
10	Jeffrey Bergen: A Concrete Approach to Abstract Algebra- From the integers to Insolvability of Quintic *Academic Pres [Elsever](2010)ISBN: 978-0- 12-374941-3*

FIFTH SEMESTER

MTS5 B06 BASIC ANALYSIS

5 hours/week **4 Credits** **100 Marks [Int:20+Ext:80]**

Course Outcomes:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><th>6</th><th>MTS5B06</th><th>Core</th><th>Basic Analysis</th></tr>
<tr><th>CO</th><th colspan="3">CO Statement</th></tr>
<tr><td>CO 1</td><td colspan="3">Understand various properties of $\mathbb{R}$.</td><td>U</td><td>C</td><td>25</td><td>1</td><td rowspan="5">3</td></tr>
<tr><td>CO 2</td><td colspan="3">Explain sequences of real numbers and related theorems.</td><td>U</td><td>(C,P)</td><td>25</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="3">Analyze basic topology on $\mathbb{R}$.</td><td>An</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 4</td><td colspan="3">Understand complex numbers and complex functions.</td><td>U</td><td>(C,P)</td><td>10</td><td>1</td></tr>
<tr><td>CO 5</td><td colspan="3">Illustrate limit and continuity of complex valued functions.</td><td>U</td><td>(C,P)</td><td>10</td><td>1</td></tr>
</table>

Syllabus

Text (1)	Introduction to Real Analysis(4/e) : Robert G Bartle, Donald R Sherbert *John Wiley & Sons(2011) ISBN 978-0-471-43331-6*
Text (2)	Complex Analysis A First Course with Applications (3/e): Dennis Zill & Patric Shanahan *Jones and Bartlett Learning(2015) ISBN:1-4496-9461-6*

Module-I Text(1) (20 hrs)

1.3: Finite and Infinite Sets-definition, countable sets, denumerability of $\mathbb{Q}$, union of countable sets, cantor's theorem.

2.1: The Algebraic and Order Properties of $\mathbb{R}$ − algebraic properties, basic results, rational and irrational numbers, irrationality of $\sqrt{2}$, Order properties, arithmetic-geometric inequality, Bernoulli's Inequality.

2.2: Absolute Value and the Real Line- definition, basic results, Triangle Inequality, The real line, ε −neighborhood.

2.3: The Completeness Property of $\mathbb{R}$ − Suprema and Infima, alternate formulations for the supremum, The Completeness Property.

Module-II Text(1) (21 hrs)

2.4: Applications of the Supremum Property- The Archimedean Property, various consequences, Existence of $\sqrt{2}$, Density of Rational Numbers in $\mathbb{R}$, The Density Theorem, density of irrationals.

2.5: Intervals-definition, Characterization of Intervals, Nested Intervals, Nested Intervals Property, The Uncountability of $\mathbb{R}$, [binary, decimal and periodic representations omitted] Cantor's Second Proof.

3.1: Sequences and Their Limits- definitions, convergent and divergent sequences, Tails of Sequences, Examples.

3.2: Limit Theorems- sum, difference, product and quotients of sequences, Squeeze Theorem, ratio test for convergence.

3.3: Monotone Sequences-definition, monotone convergence theorem, divergence of harmonic series, calculation of square root, Euler's number.

Module-III Text(1) (18 hrs)

3.4: Subsequences and the Bolzano-Weierstrass Theorem- definition, limit of subsequences, divergence criteria using subsequence, The Existence of Monotone Subsequences, monotone subsequence theorem, The Bolzano-Weierstrass Theorem, Limit Superior and Limit Inferior.

3.5: The Cauchy Criterion- Cauchy sequence, Cauchy Convergence Criterion, applications, contractive sequence.

3.6: Properly divergent sequences-definition, examples, properly divergent monotone sequences, ‘‘comparison theorem’’ , ‘‘limit comparison theorem’’.

11.1: Open and Closed sets in $\mathbb{R}$ – neighborhood, open sets, closed sets, open set properties, closed set properties, Characterization of Closed Sets, cluster point, Characterization of Open Sets, The Cantor Set, properties.

Module-IV Text (2) (21 hrs)

1.1: Complex numbers and their properties- definition, arithmetic operations, conjugate, inverses, reciprocal.

1.2: Complex Plane- vector representation, modulus, properties, triangle inequality.

1.3: Polar form of complex numbers- polar representation, principal argument, multiplication and division, argument of product and quotient, integer powers, de Moivre’s formula.

1.4: Powers and roots- roots, principal n^{th} root.

1.5: Sets of points in the complex plane- circles, disks and neighbourhoods, open sets, annulus, domains, regions, bounded sets.

2.1: Complex Functions- definition, real and imaginary parts of complex function, complex exponential function, exponential form of a complex number, Polar Coordinates.

3.1: Limit and Continuity- Limit of a complex function, condition for non existence of limit, real and imaginary parts of limit, properties of complex limits, continuity, discontinuity of principal square root function, properties of continuous functions, continuity of polynomial and rational functions, Bounded Functions, Branches, Branch Cuts and Points.

Seminar topics

2.2: Complex Functions as mappings- complex mapping, illustrations, Parametric curves in complex planes, common parametric curves, image of parametric curves under complex mapping. [The subsection ‘Use of Computers’ omitted]

2.3: Linear Mappings- Translations, Rotations, Magnifications, general linear mapping, image of geometric shapes under linear map.

2.4: Special Power functions- The power function z^n, The power function $z^{\frac{1}{n}}$, principal square root function, Inverse Functions, multiple valued functions.

References:	
1	Charles G. Denlinger: Elements of Real Analysis *Jones and Bartlett Publishers Sudbury, Massachusetts (2011) ISBN:0-7637-7947-4 [Indian edition: ISBN-9380853157]*
2	David Alexander Brannan: A First Course in Mathematical Analysis *Cambridge University Press,US(2006) ISBN: 9780521684248*
3	John M. Howie: Real Analysis *Springer Science & Business Media(2012) [Springer Undergraduate Mathematics Series] ISBN: 1447103416*
4	James S. Howland: Basic Real Analysis *Jones and Bartlett Publishers Sudbury, Massachusetts (2010) ISBN:0-7637-7318-2*
5	James Ward Brown, Ruel Vance Churchill: Complex variables and applications(8/e) *McGraw-Hill Higher Education, (2009) ISBN: 0073051942*
6	Alan Jeffrey: Complex Analysis and Applications(2/e) *Chapman and Hall/CRC Taylor Francis Group(2006)ISBN:978-1-58488-553-5*
7	Saminathan Ponnusamy, Herb Silverman: Complex Variables with Applications *Birkhauser Boston(2006) ISBN:0-8176-4457-4*
8	Terence Tao: Analysis I & II (3/e) *TRIM 37 & 38 Springer Science+Business Media Singapore 2016; Hindustan book agency(2015) ISBN 978-981-10-1789-6 (eBook) & ISBN 978-981-10-1804-6 (eBook)*
9	Ajith Kumar & S Kumaresan : A Basic Course in Real Analysis *CRC Press, Taylor & Francis Group(2014) ISBN: 978-1-4822-1638-7 (eBook - PDF)*
10	Hugo D Junghenn : A Course in Real Analysis *CRC Press, Taylor & Francis Group(2015) ISBN: 978-1-4822-1928-9 (eBook - PDF)*

FIFTH SEMESTER

MTS5 B07 NUMERICAL ANALYSIS

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

Course outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
7	MTS5B07	Core	Numerical Analysis					
CO	CO Statement							
CO 1	Find out the approximate numerical solutions of algebraic and transcendental equations with desired accuracy using Bisection method, Fixed point iteration and Newton's method.			R	(C,P)	10	1	4
CO 2	Explain interpolation and Lagrange polynomial.			U	(C,P)	10	7	
CO 3	Solve problems using Newton's forward difference, Newton'sbackward difference, centred differences and Stirling's formula.			Ap	(C,P)	8	7	
CO 4	Apply numerical differentiation and integration.			Ap	(C,P)	18	7	
CO 5	Solve ordinary differential equations using numerical methods.			Ap	(C,P)	18	7	

Syllabus

Text	Numerical Analysis (10/e): *Richard L. Burden, J Douglas Faires, Annette M. Burden Brooks Cole Cengage Learning(2016) ISBN:978-1-305-25366-7*

Module-I (28 hrs)

Solutions of Equations in One Variable

Note: Students should be familiar with concepts and definitions such as 'round off error', rate of convergence ' etc. discussed in sections 1.2 and 1.3

Introduction

2.1: The Bisection Method.

2.2: Fixed-Point Iteration.

2.3: Newton's Method and Its Extensions- Newton's Method (Newton- Raphson method), Convergence using Newton's Method, The Secant Method, The Method of False Position.

2.4: Error Analysis for Iterative Methods- Order of Convergence, linear and quadratic convergence, Multiple Roots, Modified Newton's method for faster convergence.[Algorithms are omitted]

Interpolation and Polynomial Approximation

Introduction

3.1: Interpolation and the Lagrange Polynomial- motivation, Lagrange Interpolating Polynomials, error bound.

3.2: Data Approximation and Neville's Method- motivation, Neville's Method, recursive method to generate Lagrange polynomial approximations.

3.3: Divided Differences- k^{th} divided difference, Newton's divided difference formula, Forward Differences, Newton Forward-Difference Formula, Backward Differences, Newton Backward–Difference Formula, Centered Differences, Stirling's formula.[Algorithms are omitted]

Module-II (18 hrs)

Numerical Differentiation and Integration

Introduction

4.1: Numerical Differentiation- approximation of first derivative by forward difference formula, backward difference formula, Three-Point Formulas, Three- Point Endpoint Formula, Three-Point Midpoint Formula [Five-Point Formulas, Five-Point Endpoint Formula, Five-Point Midpoint Formula omitted] Second Derivative Midpoint Formula to approximate second derivative, Round-Off Error Instability.

4.3: Elements of Numerical Integration-numerical quadrature, The Trapezoidal Rule, Simpson's Rule, Measuring Precision, Closed Newton- Cotes Formulas, Simpson's Three-Eighths rule, Open Newton-Cotes Formulas.

4.4: Composite Numerical Integration-composite Simpson's rule, composite trapezoidal rule, composite midpoint rule, round off error stability.

4.7:Gaussian Quadrature-motivation, Legendre Polynomial, Gaussian Quadrature on Arbitrary Intervals.[Algorithms are omitted]

Module-III (18 hrs)

Initial-Value Problems for Ordinary Differential Equations

Introduction

5.1:The Elementary Theory of Initial-Value Problems.

5.2: Euler's Method- derivation using Taylor formula, Error bounds for Euler Method.

5.3: Higher-Order Taylor Methods- local truncation error, Taylor method of order n and order of local truncation error.

5.4: Runge-Kutta Methods- only Mid Point Method, Modified Euler's Method and Runge-Kutta Method of Order Four are required. [derivation of formula omitted in each case]

5.6: Multistep Methods- basic idea, definition, Adams-Bashforth Two-Step Explicit Method, Adams-Bashforth Three-Step Explicit Method, Adams- Bashforth Four-Step Explicit Method, Adams-Moulton Two-Step Implicit Method, Adams-Moulton Three-Step Implicit Method, Adams-Moulton ,Four-Step Implicit Method, Predictor-Corrector Methods. [derivation of formula omitted in each case][Algorithms are omitted]

References:

1	Kendall E. Atkinson, Weimin Han: Elementary Numerical Analysis(3/e) *John Wiley & Sons(2004) ISBN:0-471-43337-3[Indian Edition by Wiley India ISBN: 978-81-265-0802-0]*
2	James F. Epperson: An Introduction to Numerical Methods and Analysis(2/e) *John Wiley & Sons(2013)ISBN: 978-1-118-36759-9*
3	Timothy Sauer: Numerical Analysis(2/e) *Pearson (2012) ISBN: 0-321-78367-0*
4	S S Sastri : Introductory Methods of Numerical Analysis(5/e) *PHI Learning Pvt. Ltd.(2012) ISBN:978-81-203-4592-8*
5	Ward Cheney,David Kincaid : Numerical Mathematics and Computing (6/e) *Thomson Brooks/Cole(2008) ISBN: 495-11475-8*

FIFTH SEMESTER

MTS5 B08 LINEAR PROGRAMMING

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

Course Outcomes:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><th>8</th><th>MTS5B08</th><th>Core</th><th>Linear Programming</th></tr>
<tr><th>CO</th><th colspan="3">CO Statement</th></tr>
<tr><td>CO 1</td><td colspan="3">Solve linear programming problems geometrically.</td><td>Ap</td><td>(C,P)</td><td>6</td><td>7</td><td rowspan="5">4</td></tr>
<tr><td>CO 2</td><td colspan="3">Solve LP problems more effectively using Simplex algorithm.</td><td>Ap</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 3</td><td colspan="3">Explain duality theory.</td><td>U</td><td>(C,P)</td><td>14</td><td>1</td></tr>
<tr><td>CO 4</td><td colspan="3">Illustrate game theory.</td><td>U</td><td>(C,P)</td><td>8</td><td>1</td></tr>
<tr><td>CO 5</td><td colspan="3">Solve transportation and assignment problems.</td><td>Ap</td><td>(C,P)</td><td>10</td><td>7</td></tr>
</table>

Syllabus

Text	Linear Programming and Its Applications: James K. Strayer *Under-graduateTextsinMathematicsSpringer(1989)ISBN:978-1-4612-6982-3*

Module-I (16hrs)

Chapter1 Geometric Linear Programming: Profit Maximization and Cost Minimization, typical motivating examples, mathematical formulation, Canonical Forms for Linear Programming Problems, objective functions, constraint set, feasible solution, optimal solution , Polyhedral Convex Sets, convex set, extreme point, theorems asserting existence of optimal solutions, The Two Examples Revisited, graphical solutions to the problems, A Geometric Method for Linear Programming, the difficulty in the method, Concluding Remarks.

Chapter2 The Simplex Algorithm:- Canonical Slack Forms for Linear Programming Problems; Tucker Tableaus, slack variables, Tucker tableaus, independent variables or non basic variables, dependent variables or basic variables, An Example: Profit Maximization, method of solving a typical canonical maximization problem, The Pivot Transformation, The Pivot Transformation for Maximum and Minimum Tableaus, An Example: Cost Minimization, method of solving a typical canonical minimization problem, The Simplex Algorithm for Maximum Basic Feasible Tableaus.

Module-II (14hrs)

Chapter3 Noncanonical Linear Programming Problems:- Unconstrained Variables, Equations of Constraint, Concluding Remarks.

Chapter 4 : Duality Theory :- Duality in Canonical Tableaus, The Dual Simplex Algorithm, The Dual Simplex Algorithm for Minimum Tableaus, The Dual Simplex Algorithm for Maximum Tableaus, Matrix Formulation of Canonical Tableaus ,The Duality Equation, Duality in Noncanonical Tableaus, Concluding Remarks.

Module-III (18hrs)

Chapter 5: MatrixGames:-An Example; Two-Person Zero-Sum Matrix Games, Domination in a Matrix Game, Linear Programming Formulation of Matrix Games, The Von Neumann Minimax Theorem, The Example Revisited, Two More Examples, Concluding Remarks.

Chapter 6: Transportation and Assignment Problems :-The Balanced Transportation Problem, The Vogel Advanced-Start Method (VAM), The Transportation Algorithm, Another Example, Unbalanced Transportation Problems, The Assignment Problem, TheMinimum-EntryMethod, The Northwest-Corner Method.

References:

1	RobertJ.Vanderbei:LinearProgramming:Foundations and Extensions (2/e) Springer Science+Business Media LLC(2001) ISBN: 978-1-4757- 5664-7
2	Frederick S Hiller, Gerald J Lieberman: Introduction to Operation Research(10/e)*McGraw-HillEducation,2PennPlaza,NewYork(2015)ISBN: 978-0-07-352345-3*
3	PaulR.Thie,G.E.Keough:AnIntroductiontoLinearProgrammingand Game Theory(3/e) *John Wiley and Sons,Ins.(2008)ISBN:978-0-470-23286-6*
4	Louis Brickman: Mathematical Introduction to Linear Programming and Game Theory *UTM,SpringerVerlag,NY(1989)ISBN:0-387-96931-4*
5	Jiri Matoušek, Bernd Gartner: Understanding and Using Linear Programming *Universitext, Springer-Verlag Berlin Heidelberg (2007)ISBN: 978-3-540-30697-9*

FIFTH SEMESTER

MTS5 B09 INTRODUCTION TO GEOMETRY

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

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
9	MTS5B09	Core	Introduction to Geometry					
CO	CO Statement							
CO 1	Understand basic facts about conics.			U	C	6	2	2
CO 2	Classify conics.			U	(C,P)	4	1	
CO 3	Explain Kleinian view of Euclidean geometry.			U	(C,P)	5	7	
CO 4	Analyze affine transformations.			An	(C,P)	8	7	
CO 5	Understand the fundamental theorem of affine geometry.			U	C	7	1	
CO 6	Interpret various perspectives of projective geometry and projective transformations.			U	(C,P)	18	2	

Text	Geometry(2/e): David A Brannan, Mathew F Espen, Jeremy J Gray *Cambridge University Press(2012) ISBN: 978-1-107-64783-1*

Module-I (10 hrs)

Conics
1.1.1: Conic Sections.

1.1.3: Focus-Directrix Definition of the Non-Degenerate Conics- definition, parabola in standard form, ellipse in standard form, hyperbola in standard form, Rectangular Hyperbola, Polar Equation of a Conic.

1.1.4: Focal Distance Properties of Ellipse and Hyperbola-Sum of Focal Distances of Ellipse, Difference of Focal Distances of Hyperbola.

1.2: Properties of Conics- Tangents, equation of tangents to ellipse, hyperbola, and parabola , polar of a point w.r.to. unit circle, normal, Reflections, The Reflection Law, Reflection Property of the Ellipse, Reflection Property of the Hyperbola, Reflection Property of the Parabola, Conics as envelopes of tangent families.

1.3: Recognizing Conics- equation of conic in general form, identifying a conic.

Module-II (20 hrs)

Affine Geometry
2.1: Geometry and Transformations- What is Euclidean Geometry? Isometry, Euclidean properties, Euclidean transformation, Euclidean-Congruence.

2.2: Affine Transformations and Parallel Projections- Affine Transformations, Basic Properties of Affine Transformations, Parallel Projections, Basic Properties of Parallel Projections, Affine Geometry, Midpoint Theorem, Conjugate Diameters Theorem, Affine Transformations and Parallel Projections, affine transformations as composite of two parallel projections.

2.3: Properties of Affine Transformations-Images of Sets Under Affine Transformations, The Fundamental Theorem of Affine Geometry, Proofs of the Basic Properties of Affine Transformations.

2.4: Using the Fundamental Theorem of Affine Geometry-The Median Theorem, Ceva's Theorem, converse, Menelaus' Theorem, converse [Proofs of these theorems are omitted. Also subsection2.4.4 is omitted.]

Module-III (18 hrs)

Projective Geometry: Lines
3.1: Perspective- Perspective in Art, Mathematical Perspective, Desargues' Theorem.

3.2: The Projective Plane $\mathbb{RP}^2$ —Projective Points, Projective Lines, Embedding Planes, An equivalent definition of Projective Geometry.

3.3: Projective Transformations- The Group of Projective Transformations, Some Properties of Projective Transformations, Fundamental Theorem of Projective Geometry. [The subsection "3.3.4.Geometrical Interpretation of Projective Transformations" omitted]

3.4: Using the Fundamental Theorem of Projective Geometry- Desargues' Theorem and Pappus' Theorem, [The subsection "3.4.2. Duality" omitted]

References:

1	George A Jennings: Modern Geometry with Applications *Universitext, Springer (1994) ISBN:0-387-94222-X*
2	Walter Meyer: Geometry and its Application(2/e) *Elsever, Academic Press (2006)ISBN:0-12-369427-0*
3	Judith N Cederberg : A Course in Modern Geometries(2/e) *UTM,Springer (2001) ISBN: 978-1-4419-3193-1*
4	Patric J Ryan: Euclidean and Non Euclidean Geometry-An Analytic Approach *Cambridge University Press, International Student Edition (2009) ISBN:978-0-521- 12707-3*
5	David C Kay: College Geometry: A Unified Approach *CRC Press Tayloe and Francic Group(2011) ISBN: 978-1-4398-1912-8 (Ebook-PDF)*
6	James R Smart: Modern Geometries(5/e) *Brooks/Cole Publishing Co.,(1998) ISBN:0- 534-35188-3*
7	Michele Audin: Geometry *Universitext, Springer(2003)ISBN:3-540-43498-4*

SIXTH SEMESTER

MTS6 B10 REAL ANALYSIS

5 hours/week	5 Credits	100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
10	MTS6B010	Core	Real Analysis					
CO	CO Statement							
CO 1	Understand fundamental properties of continuous functions on intervals.			U	(C,P)	10	1	3
CO 2	Distinguish continuity and uniform continuity.			An	(C,P)	8	2	
CO 3	Develop the notion of Riemann integrability of a function using Riemann sums.			Ap	(C,P)	8	2	
CO 4	Understand basic and fundamental results of integration theory.			U	C	14	1	
CO 5	Illustrate convergence and divergence of sequences and series of functions.			U	(C,P)	17	1	
CO 6	Explain the notion of improper integrals and their convergence.			U	(C,P)	23	7	

Syllabus

Text(1)	Introduction to Real Analysis(4/e) : Robert G Bartle, Donald R Sherbert *John Wiley & Sons(2011) ISBN 978-0-471-43331-6*
Text(2)	R.R. Goldberg : Methods of Real Analysis.
Text(3)	Narayanan&ManicavachagomPillay : Calculus, Vol. II

Module-I Text(1) (18 hrs)

5.1: Continuous Functions- definition, sequential criteria for continuity, discontinuity criteria, examples of continuous and discontinuous functions, Dirichlet and Thomae function.

5.3: Continuous Functions on Intervals- Boundedness Theorem, The Maximum-Minimum Theorem, Location of Roots Theorem, Bolzano's Intermediate Value Theorem, Preservation of Intervals Theorem.

5.4: Uniform Continuity- definition, illustration, Nonuniform Continuity Criteria, Uniform Continuity Theorem, Lipschitz Functions, Uniform Continuity of Lipschitz Functions, converse, The Continuous Extension Theorem, Approximation by step functions & piecewise linear functions, Weierstrass Approximation Theorem. (only statement)

Module-II Text(1) (22 hrs)

7.1: Riemann Integral –Partitions and Tagged Partitions, Riemann sum, Riemann integrability, examples, Some Properties of the Integral, Boundedness Theorem

7.2: Riemann Integrable Functions-Cauchy Criterion, illustrations, The Squeeze Theorem, Classes of Riemann Integrable Functions, integrability of continuous and monotone functions, The Additivity Theorem

7.3: The Fundamental Theorem-The Fundamental Theorem (First Form), The Fundamental Theorem (Second Form), substitution theorem, Lebesgue's Integrability criterion, Composition Theorem, The Product Theorem, Integration by Parts, Taylor's Theorem with the Remainder.

Module-III Text(1) (17 hrs)

8.1: Pointwise and Uniform Convergence-definition, illustrations, The Uniform Norm, Cauchy Criterion for Uniform Convergence.

8.2: Interchange of Limits- examples leading to the idea, Interchange of Limit and Continuity, Interchange of Limit and Derivative [only statement of theorem 8.2.3 required; proof omitted] Interchange of Limit and Integral , Bounded convergence theorem.(statement only) [8.2.6 Dini's theorem omitted]

9.4: Series of Functions – (A quick review of series of real numbers of section 3.7 without proof) definition, sequence of partial sum, convergence, absolute and uniform convergence, Tests for Uniform Convergence , Weierstrass M-Test. (only upto and including 9.4.6)

Module-IV Text(2) (23 hrs)

Improper Riemann Integrals

Improper Integrals, Improper integrals of the first kind, Improper integrals of the second kind, Cauchy Principal value, Improper Integrals of the third kind.(Sections: 7.9, 7.10 of text 2),

Beta and Gamma functions

Beta Functions, Gamma Functions, Relation between Beta and Gamma Functions.(Chapter IX, Sec: 2.1, 2.2, 2.3, 3, 4, 5 of text 3)

References:

1	Charles G. Denlinger: Elements of Real Analysis *Jones and Bartlett Publishers Sudbury, Massachusetts (2011) ISBN:0-7637-7947-4 [Indian edition: ISBN-9380853157]*
2	David Alexander Brannan: A First Course in Mathematical Analysis *Cambridge University Press,US(2006) ISBN: 9780521684248*
3	John M. Howie: Real Analysis *Springer Science & Business Media(2012)[Springer Undergraduate Mathematics Series] ISBN: 1447103416*
4	James S. Howland: Basic Real Analysis *Jones and Bartlett Publishers Sudbury, Massachusetts (2010) ISBN:0-7637-7318-2*
5	Terence Tao: Analysis I & II (3/e) *TRIM 37 & 38 Springer Science+Business Media Singapore 2016; Hindustan book agency(2015) ISBN 978-981-10-1789-6 (eBook) & ISBN 978-981-10-1804-6 (eBook)*
6	Richard R Goldberg: Methods of Real Analysis *Oxford and IBH Publishing Co.Pvt.Ltd. NewDelhi(1970)*
7	Saminathan Ponnusamy: Foundations of Mathematical Analysis *Birkhauser(2012) ISBN 978-0-8176-8291-0*
8	William F Trench: Introduction to Real Analysis *ISBN 0-13-045786-8*
9	Ajith Kumar & S Kumaresan : A Basic Course in Real Analysis *CRC Press, Taylor & Francis Group(2014) ISBN: 978-1-4822-1638-7 (eBook - PDF)*
10	Hugo D Junghenn : A Course in Real Analysis *CRC Press, Taylor & Francis Group(2015) ISBN: 978-1-4822-1928-9 (eBook - PDF)*

MTS6 B11 COMPLEX ANALYSIS

5 hours/week	5 Credits	100 Marks [Int:20+Ext:80]

SIXTH SEMESTER

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
11	**MTS6B011**	**Core**	**Complex Analysis**					
CO	**CO Statement**							
CO 1	Distinguish between differentiability and analyticity of complex functions.			An	(C,P)	5	2	3
CO 2	Understand necessary and sufficient condition for checking analyticity.			U	(C,P)	6	1	
CO 3	Relate harmonic functions and analytic functions.			U	(C,P)	5	1	
CO 4	Analyze elementary complex functions.			An	(C,P)	5	1	
CO 5	Understand complex integral, its properties and evaluation.			U	(C,P)	7	1	
CO 6	Explain a few fundamental results on contour integration theory such as Cauchy's theorem, Cauchy-Goursat theorem and their applications.			U	(C,P)	10	1	
CO 7	Apply Cauchy's integral formula and derive Liouville's theorem, Morera's theorem and power series expansion of an analytic function.			Ap	(C,P)	22	7	
CO 8	Apply Residue theorem to evaluate contour integrals.			Ap	(C,P)	20	7	

Syllabus

Text	Complex Analysis A First Course with Applications (3/e): Dennis Zill & Patric Shanahan *Jones and Bartlett Learning(2015) ISBN:1-4496-9461-6*

Module-I (21 hrs)

Analytic Functions

3.2: Differentiability and Analyticity – Derivative of a complex Function, rules of differentiation, function that is nowhere differentiable, Analytic functions, entire functions, singular points, Analyticity of sum product and quotient, L'Hospital rule.

3.3: Cauchy Riemann Equations- Necessary condition for analyticity, Criterion for non analyticity, sufficient condition for analyticity(proof is omitted), sufficient condition for differentiability(proof is omitted), *Cauchy Riemann equations in polar coordinates.*

3.4: Harmonic Functions- *definition, analyticity and harmonic nature,* harmonic conjugate functions,*finding harmonic conjugate.*

Elementary Functions

4.1: Exponential and logarithmic functions-Complex Exponential Function*, its derivative*, *analyticity*, *modulus argument and conjugate*, *algebraic properties*, *periodicity*, exponential mapping *and its properties,* Complex Logarithmic Function, *logarithmic identities*, principal value of a complex logarithm, Lnz as inverse function, derivative, logarithmic mapping*, properties, other branches.*

4.3: Trigonometric and Hyperbolic functions- Complex Trigonometric Functions, identities, *periodicity of sine and cosine* , Trigonometric equations *and their solution,* Modulus, zeroes analyticity, *[subsection 'Trigonometric Mapping' omitted]*, Complex Hyperbolic Functions, relation to *sine* and *cosine.*

Module-II (21 hrs)

Integration in the Complex plane

5.1: Real Integrals- Definite Integral, *simple, smooth, closed curves,* Line integrals in the plane, Method of Evaluation-*curves defined parametrically and curves given as functions*, Orientation of a Curve.

5.2: Complex Integral-contours, *definition of* complex integral, complex valued function of a real variable, evaluation of contour integral, properties *of contour integral, ML-inequality.*

5.3: Cauchy-Goursat Theorem- simply and multiply connected regions, Cauchy theorem *(without proof)*, Cauchy-Goursat theorem *for simply connected domain* *(without proof),* Multiply Connected Domains, *principe of deformation of contours*, *Cauchy-Goursat theorem for multiply connected domains(without proof), illustrations.*

5.4: Independence of Path- *definition, analyticity and path independence, anti derivative*, *Fundamental theorem for contour integrals*, Some Conclusions, *Existence of anti derivative.*

5.5: Cauchy's Integral Formulas & their Consequences- Cauchy's Two Integral Formulas, *illustration of their use*, Some Consequences of the Integral Formulas- cauchy's inequality, Liouville theorem, Morera's theorem, Maximum modulus theorem.

Module-III	**(18 hrs)**

Series

6.1: Sequences and Series- *definition, criteria for convergence*, Geometric series, *necessary condition for convergence*, test for divergence*, absolute and conditional convergence, Ratio test, root test,* Power Series*, circle of convergence, radius of convergence*, Arithmetic of Power Series.

6.2: Taylor Series- differentiation and integration of power series, *term by term differentiation and integration*, Taylor Series(Proof of Taylor's Theorem is omitted), *Maclaurian series* , illustrations.

6.3: Laurent's Series- isolated singularities, *Laurent's Theorem [proof omitted], illustrations.*

6.4: Zeros and Poles- classification of isolated singular points, *removable singularity, pole, essential singularity*, *order of zeros and poles.[proofs of theorems in this section are omitted]*

Module-IV	**(20 hrs)**

Residues

6.5: Residues and Residue Theorem- residue , *method of evaluation of residue at poles,* Cauchy's Residue Theorem*, illustrations.*

6.6: Some Consequences of Residue theorem.

6.6.1:Evaluation of Real Trigonometric Integrals.

6.6.2: Evaluation of Real Improper Integrals- *C.P.V.*, indented contour.

6.6.4: Argument Principle and Rouche's Theorem- *[proof of Argument Principle omitted]* , *locating zeros of polynomials.*

References:	
1	James Ward Brown, Ruel Vance Churchill: Complex variables and applications(8/e) *McGraw-Hill Higher Education, (2009) ISBN: 0073051942*
2	Alan Jeffrey: Complex Analysis and Applications(2/e) *Chapman and Hall/CRC Taylor Francis Group(2006)ISBN:978-1-58488-553-5*
3	Saminathan Ponnusamy, Herb Silverman: Complex Variables with Applications *Birkhauser Boston(2006) ISBN:0-8176-4457-4*
4	John H. Mathews & Russell W. Howell : Complex Analysis for Mathematics and Engineering (6 /e)
5	H A Priestly : Introduction to Complex Analysis(2/e) *Oxford University Press(2003)ISBN: 0 19 852562 1*
6	Jerrold E Marsden, Michael J Hoffman: Basic Complex Analysis(3/e) *W.H Freeman,N.Y.(1999) ISBN:0-7167- 2877- X*

SIXTH SEMESTER

MTS6 B12 CALCULUS OF MULTI VARIABLE

5 hours/week　　　4 Credits　　　100 Marks[Int:20+Ext:80]

Course Outcomes:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><td>12</td><td>MTS6B012</td><td>Core</td><td>Calculus of Multi variable</td></tr>
<tr><td>CO</td><td colspan="3">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="3">Understand multivariable functions and their representations.</td><td>U</td><td>(C,P)</td><td>5</td><td>1</td><td rowspan="8">2</td></tr>
<tr><td>CO 2</td><td colspan="3">Understand the idea of limit and continuity for functions of several variables.</td><td>U</td><td>C</td><td>6</td><td>1</td></tr>
<tr><td>CO 3</td><td colspan="3">Apply the notion of partial derivatives to evaluate directional derivatives.</td><td>Ap</td><td>(C,P)</td><td>7</td><td>7</td></tr>
<tr><td>CO 4</td><td colspan="3">Find extreme values of a multivariable function using second derivative test and Lagrange multiplier method.</td><td>U</td><td>(C,P)</td><td>16</td><td>7</td></tr>
<tr><td>CO 5</td><td colspan="3">Apply polar, spherical and cylindrical coordinate systems in the evaluation of double and triple integrals .</td><td>Ap</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 6</td><td colspan="3">Apply double and triple integral in the problem of finding out surface area ,mass of lamina, volume, centre of mass and so on.</td><td>Ap</td><td>(C,P)</td><td>11</td><td>7</td></tr>
<tr><td>CO 7</td><td colspan="3">Understand the notion of a vector field, the idea of curl and divergence of a vector field, their evaluation and interpretation.</td><td>U</td><td>(C,P)</td><td>12</td><td>1</td></tr>
<tr><td>CO 8</td><td colspan="3">Illustrate Green's theorem, Gauss's theorem and Stokes' theorem of multivariable calculus and their use in several areas and directions.</td><td>U</td><td>(C,P)</td><td>13</td><td>1</td></tr>
</table>

Syllabus

Text	Calculus: Soo T Tan *Brooks/Cole, Cengage Learning (2010) ISBN 0- 534-46579-X)*

Module-I (18 hrs)

13.1: Functions of two or more variables- Functions of Two Variables, Graphs of Functions of Two Variables, Level Curves, Functions of Three Variables and Level Surfaces.

13.2: Limits and continuity-An Intuitive Definition of a Limit, existence and non existence of limit, Continuity of a Function of Two Variables, Continuity on a Set, continuity of polynomial and rational functions, continuity of composite functions, Functions of Three or More Variables, The $\varepsilon - \delta$ Definition of a Limit.

13.3: Partial Derivatives- Partial Derivatives of Functions of Two Variables, geometric interpretation, Computing Partial Derivatives, Implicit Differentiation, Partial Derivatives of Functions of More Than Two Variables, Higher-Order Derivatives, clairaut theorem, harmonic functions.

13.4: Differentials- Increments, The Total Differential, interpretation, Error in Approximating Δz by dz[only statement of theorem1 required ; proof omitted] Differentiability of a Function of Two Variables, criteria, Differentiability and Continuity, Functions of Three or More Variables.

13.5: The Chain rule- The Chain Rule for Functions Involving One Independent Variable, The Chain Rule for Functions Involving Two Independent Variables, The General Chain Rule, Implicit Differentiation.

Module-II (16 hrs)

13.6: Directional Derivatives and Gradient vectors - The Directional Derivative, The Gradient of a Function of Two Variables, Properties of the Gradient, Functions of Three Variables.

13.7: Tangent Planes and Normal Lines- Geometric Interpretation of the Gradient, Tangent Planes and Normal Lines, Using the Tangent Plane of f to approximate the Surface $z = f(x, y)$.

13.8: Extrema of Functions of two variables - Relative and Absolute Extrema, Critical Points—Candidates for Relative Extrema, The Second Derivative Test for Relative Extrema, Finding the Absolute Extremum Values of a Continuous Function on a Closed Set.
13.9: Lagrange Multipliers- Constrained Maxima and Minima, The Method of Lagrange Multipliers, Lagrange theorem, Optimizing a Function Subject to Two Constraints.

Module-III (21 hrs)

14.1: Double integrals- An Introductory Example, Volume of a Solid Between a Surface and a Rectangle, The Double Integral Over a Rectangular Region, Double Integrals Over General Regions, Properties of Double Integrals.

14.2: Iterated Integrals-Iterated Integrals Over Rectangular Regions, Fubini's Theorem for

Rectangular Regions, Iterated Integrals Over Nonrectangular Regions, $y -$ simple and $x -$ simple regions, advantage of changing the order of integration.

14.3: Double integrals in polar coordinates- Polar Rectangles, Double Integrals Over Polar Rectangles, Double Integrals Over General Regions, r- simple region, method of evaluation.

14.4: Applications of Double integral- Mass of a Lamina, Moments and Center of Mass of a Lamina, Moments of Inertia, Radius of Gyration of a Lamina.

14.5: Surface Area- Area of a Surface $z = f(x, y)$, Area of Surfaces with Equations $y = g(x, z)$ and $x = h(y, z)$.

14.6: Triple integrals- Triple Integrals Over a Rectangular Box, definition, method of evaluation as iterated integrals, Triple Integrals Over General Bounded Regions in Space, Evaluating Triple Integrals Over General Regions, evaluation technique, Volume, Mass, Center of Mass, and Moments of Inertia.

14.7: Triple Integrals in cylindrical and spherical coordinates- evaluation of integrals in Cylindrical Coordinates, Spherical Coordinates.

14.8: Change of variables in multiple integrals- Transformations, Change of Variables in Double Integrals [only the method is required; derivation omitted], illustrations, Change of Variables in Triple Integrals.

Module-IV (25 hrs)

15.1: Vector Fields- V.F. in two and three dimensional space, Conservative Vector Fields.

15.2: Divergence and Curl- Divergence- idea and definition, Curl- idea and definition.

15.3: Line Integrals- Line integral w.r.to. arc length-motivation, basic idea and definition, Line Integrals with Respect to Coordinate Variables, orientation of curve Line Integrals in Space, Line Integrals of Vector Fields.

15.4: Independence of Path and Conservative Vector Fields-path independence through example, definition, fundamental theorem for line integral, Line Integrals Along Closed Paths [proof of theorem is omitted], work done by conservative vector field[proof of theorem is omitted], Independence of Path and Conservative Vector Fields[proof of theorem is omitted], Determining Whether a Vector Field Is Conservative, test for conservative vector field Finding a Potential Function, Conservation of Energy.

15.5: Green's Theorem- Green's Theorem for Simple Regions, proof of theorem for simple regions, finding area using line integral, Green's Theorem for More General Regions, Vector Form of Green's Theorem.

15.6: Parametric Surfaces-Why We Use Parametric Surfaces, Finding Parametric Representations of Surfaces, Tangent Planes to Parametric Surfaces, Area of a Parametric Surface. [derivation of formula omitted]

15.7: Surface Integrals-Surface Integrals of Scalar Fields, evaluation of surface integral for surfaces that are graphs , [derivation of formula omitted; only method required] Parametric Surfaces, evaluation of surface integral for parametric surface, Oriented Surfaces, Surface Integrals of Vector Fields- definition, flux integral, evaluation of surface integral for graph[method only], Parametric Surfaces, evaluation of surface integral of a vector field for parametric surface. [method only]

15.8: The Divergence Theorem-divergence theorem for simple solid regions
(statement only), illustrations, Interpretation of Divergence.

15.9: Stokes Theorem-generalization of Green's theorem –Stokes Theorem, illustrations, Interpretation of Curl.

References:

1	Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus(14/e) *Pearson(2018) ISBN 0134438981*
2	Robert A Adams & Christopher Essex : Calculus: *A complete Course (8/e) Pearson Education Canada (2013) ISBN:* 032187742X
3	Jon Rogawski: Multivariable Calculus *Early Transcendentals* (2/e) W. H. Freeman and Company(2012) *ISBN: 1-4292-3187-4*
4	Anton, Bivens & Davis : Calculus *Early Transcendentals* (10/e) John Wiley & Sons, Inc.(2012) ISBN: 978-0-470-64769-1
5	James Stewart : Calculus (8/e) *Brooks/Cole Cengage Learning(2016) ISBN: 978-1-285-74062-1*
6	Jerrold E. Marsden & Anthony Tromba :Vector Calculus (6/e) *W. H. Freeman and Company ,New York(2012) ISBN: 978-1-4292-1508-4*
7	Arnold Ostebee & Paul Zorn: Multivariable Calculus (2/e) *W. H. Freeman Custom Publishing, N.Y.(2008)ISBN: 978-1-4292-3033-9*

SIXTH SEMESTER

MTS6 B13 DIFFERENTIAL EQUATIONS

5 hours/week 4 Credits 100 Marks [Int:20+Ext:80]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
13	MTS6B013	Core	Differential Equations					
CO	CO Statement							
CO 1	Identify some areas where the modelling process results in a differential equation.			Ap	(C,P)	6	1	4
CO 2	Solve linear, variable separable and exact DEs and analyse their solutions.			Ap	(C,P)	8	7	
CO 3	Distinguish between linear and non linear DEs and conditions for occurrence of their solutions.			An	(C,P)	8	1	
CO 4	Illustrate the theory and method for solving a second order linear homogeneous and nonhomogeneous equation with constant coefficients.			U	(C,P)	12	1	
CO 5	Find out a series solution for homogeneous equations with variable coefficients near ordinary points.			U	(C,P)	11	7	
CO 6	Solve differential equations using Laplace method.			Ap	(C,P)	15	7	
CO 7	Solve partial differential equations using the method of separation of Variables			Ap	(C,P)	20	7	

Syllabus

Text	Elementary Differential Equations and Boundary Value Problems (11/e): William E Boyce, Richard C Diprima And Douglas B Meade *John Wiley & Sons(2017) ISBN: 1119169879*

Module-I (22 hrs)

1.1: Some Basic Mathematical Models; Direction Fields.

1.2: Solutions of some Differential equations.

1.3: Classification of Differential Equations.

2.1: Linear Differential Equations; Method of Integrating Factors.

2.2: Separable Differential Equations.

2.3: Modelling with First Order Differential Equations.

2.4: Differences Between Linear and Nonlinear Differential Equations.

2.6: Exact Differential Equations and Integrating Factors.

2.8: The Existence and Uniqueness Theorem. (proof omitted)

Module-II (23 hrs)

3.1: Homogeneous Differential Equations with Constant Coefficients.

3.2: Solutions of Linear Homogeneous Equations; the Wronskian.

3.3: Complex Roots of the Characteristic Equation.

3.4: Repeated Roots; Reduction of Order.

3.5: Nonhomogeneous Equations; Method of Undetermined Coefficients.

3.6: Variation of Parameters.

5.2: Series solution near an ordinary point, part1.

5.3: Series solution near an ordinary point, part2.

Module-III (15 hrs)

6.1: Definition of the Laplace Transform.

6.2: Solution of Initial Value Problems.

6.3: Step Functions.

6.5: Impulse Functions.

6.6: The Convolution Integral.

Module-IV	(20 hrs)

10.1: Two-Point Boundary Value Problems.

10.2: Fourier Series.

10.3: The Fourier Convergence Theorem.

10.4: Even and Odd Functions.

10.5: Separation of Variables; Heat Conduction in a Rod.

10.7: The Wave Equation: Vibrations of an Elastic String.

References:

1	Dennis G Zill & Michael R Cullen: Differential Equations with Boundary Value Problems(7/e):*Brooks/Cole Cengage Learning(2009)ISBN: 0-495-10836-7*
2	R Kent Nagle, Edward B. Saff & Arthur David Snider: Fundamentals of Differential Equations(8/e) *Addison-Wesley(2012) ISBN: 0-321-74773-9*
3	C. Henry Edwards &David E. Penney: Elementary Differential Equations (6/e) *Pearson Education, Inc. New Jersey (2008) ISBN 0-13-239730-7*
4	John Polking, Albert Boggess & David Arnold : Differential Equations with Boundary Value Problems(2/e) *Pearson Education, Inc New Jersey(2006) ISBN 0-13-186236-7*
5	Henry J. Ricardo: A Modern Introduction to Differential Equations(2/e) *Elsevier Academic Press(2009)ISBN: 978-0-12-374746-4*
6	James C Robinson: An Introduction to Ordinary Differential Equations *Cambridge University Press (2004)ISBN: 0-521-53391-0*

ELECTIVE COURSES

SIXTH SEMESTER(Elective)

MTS6 B14 (E01) GRAPH THEORY

3hours/week **2Credits** **75 Marks[Int:15+Ext:60]**

Course outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
14	MTS6B14 (E01)	Elective	Graph Theory					
CO	CO Statement							
CO 1	Define graphs, sub graphs and degrees.			R	C	10	1	4
CO 2	Analyze properties of graphs.			An	(C,P)	6	1	
CO 3	Explain trees and their properties.			U	C	16	2	
CO 4	Distinguish between Eulerian and Hamiltonian graphs.			An	(C,P)	8	3	
CO 5	Illustrate planar graphs.			U	(C,P)	8	4	

Text	AFirstLookatGraphTheory:JohnClark&DerekAllanHolton, *Allied Publishers, First Indian Reprint 1995*

Module-I (16hrs)

1.1 Definition of a graph.
1.2 Graphs as models.
1.3 More definitions.
1.4 Vertex degrees.
1.5 Subgraphs.
1.6 Paths and Cycles.
1.7 Matrix representation of a graph.[uptoTheorem1.6;proofofTheorem 1.5 is omitted]

Module-II (16hrs)

2.1 Definitions and Simple Properties.
2.2 Bridges.[ProofofTheorem2.6andTheorem2.9areomitted]
2.3 Spanning Trees.
2.6 Cut Vertices and Connectivity. [Proof of Theorem 2.21omitted]

Module-III (16hrs)

3.1 Euler Tour. [up to Theorem 3.2, proof of Theorem 3.2 omitted]
3.3:Hamiltonian Graphs. [Proof of Theorem 3.6 omitted]
5.1:Plane and Planar graphs.[Proof of Theorem5.1omitted]
5.2 Euler's Formula.[Proofs of Theorems5.3 and Theorem5.6 omitted]

References:

1	R.J. Wilson: Introduction to Graph Theory, 4th ed., *LPE, Pearson Education*
2	J.A. Bondy& U.S.R. Murty : Graph Theory with Applications
3	J. Clark & D.A. Holton: A First Look at Graph Theory, *Allied Publishers*
4	N.Deo:GraphTheorywithApplicationtoEngineeringandComputer Science,*PHI.*

SIXTH SEMESTER(Elective)

MTS6 B14 (E02) TOPOLOGY OF METRIC SPACES

3hours/week 2Credits 75 Marks[Int:15+Ext:60]

Course outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
15	**MTS5B14 (E02)**	**Elective**	**Topology and Metric spaces**					
CO	**CO Statement**							
CO 1	Illustrate metric spaces.			U	(C,P)	10	1	3
CO 2	Explain various related terminologies.			U	(C,P)	16	1	
CO 3	Understand convergence for sequences.			U	(C,P)	10	2	
CO 4	Explain Continuity and connectedness in metric space.			U	(C,P)	12	7	

Text	Metric Spaces: *Mícheál Ó SearcóidUndergraduate Mathematics Series Springer-Verlag London Limited (2007) ISBN: 1-84628-369-8*

Module-I (19hrs)

Chapter 1:*Metrics(Definition and Examples only)*

1.1: Metric Spaces.

1.3: Metric Sub spaces and Metric Supers paces.

1.4: Isometries.

1.6: Metrics on Products.

1.7: Metrics and Norms on Linear Spaces-[example1.7.8omitted]

Chapter 2: Distance(Definition and Examples only)

2.1: Diameter.

2.2: Distances from Points to Sets.

2.3: Inequalities for Distances.

2.4: Distances to Unions and Intersections.

2.5: Isolated Points.

2.6: Accumulation Points.

2.7: Distances from Sets to Sets.

Chapter 3: Boundary (Definition and Examples only)
3.1: Boundary Points.

3.2: Sets with Empty Boundary.

3.3: Boundary Inclusion.

3.6: Closure and Interior.

3.7: Inclusion of Closures and Interiors.

Module-II (17hrs)

Chapter 4: Open, Closed and Dense Subsets(Definition and Examples only)

4.1: Open and Closed Subsets.

4.2: Dense Subsets.
4.3: Topologies.

4.4: Topologies on Sub spaces and Supers paces.

4.5: Topologies on Product Spaces.

Chapter 5: Balls(Definition and Examples only)

5.1:OpenandClosedBalls.

5.2: Using Balls.

Chapter 6: Convergence(Definition and Examples only)

6.1: Definition of Convergence for Sequences.

6.2: Limits.

6.4: Convergence in Sub spaces and Super spaces.

6.6: Convergence Criteria for Interior and Closure.

6.7: Convergence of Sub sequences.

6.8: Cauchy Sequences.

Module-III (12hrs)

Chapter7: Bounds(Definition and Examples only)

7.1: Bounded Sets.

7.4: Spaces of Bounded Functions.

7.6: Convergence and Boundedness.

7.7: Uniform and Pointwise Convergence.

Chapter8 Continuity(Definition and Examples only)

8.1: Local Continuity.

8.3: Global Continuity.

8.5: Continuity of Compositions.

Chapter11 Connectedness (Definition and Examples only)

11.1: Connected Metric Spaces.
11.2: Connected Subsets.

11.3: Connectedness and Continuity.

References:

1	E.T.Copson:MetricSpaces*CambridgeUniversityPress(1968)ISBN:0521 357322*
2	Irving Kaplansky: Set Theory and Metric Spaces *Allyn and Bacon,Inc. Boston(1972)*
3	S. Kumaresan: Topology of Metric Spaces *Alpha Science International Ltd.(2005) ISBN: 1-84265-250-8*
4	Wilson A Sutherland: Introduction to Metric and Topological Spaces(2/e)*OxfordUniversityPress(2009)ISBN:978-0-19-956308-1*
5	Mohamed A. Khamsi and William A. Kirk: An Introduction to Metric Spaces and Fixed Point Theory *John Wiley & Sons, Inc(2001) ISBN 0-471- 41825-0*

SIXTH SEMESTER(Elective)

MTS6B14(E03)MATHEMATICAL PROGRAMMING WITH PYTHON AND LATEX

3hours/week 2Credits 75 Marks[Int:15+Ext:60]

Course Outcomes:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><td>16</td><td>MTS5B14 (E03)</td><td>Elective</td><td>Mathematical Programming with Python and Latex</td></tr>
<tr><td>CO</td><td colspan="3">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="3">Understand basis of Python programming.</td><td>U</td><td>(C,P)</td><td>11</td><td>1</td><td rowspan="5">4</td></tr>
<tr><td>CO 2</td><td colspan="3">Apply Python programming in plotting mathematical functions.</td><td>Ap</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 3</td><td colspan="3">Apply Python programming in numerical analysis.</td><td>Ap</td><td>(C,P)</td><td>14</td><td>6</td></tr>
<tr><td>CO 4</td><td colspan="3">Understand typesetting using Latex.</td><td>U</td><td>(C,P)</td><td>5</td><td>2</td></tr>
<tr><td>CO 5</td><td colspan="3">Apply Latex in writing equations.</td><td>Ap</td><td>(C,P)</td><td>8</td><td>7</td></tr>
</table>

Text	Python for Education-Learning Maths and Physics using Python: Ajith Kumar B.P *Inter University Accelerator Centre 2010*

Course Contents

The course has Theory Part (external evaluation) and Practical Part (only for internal evaluation). A student has to maintain a practical record of the work. Practical should be carried out in a GNU/Linux computer system.

Theory

Module-I (15hrs)

Basics of Python Programming

Chapter2: Programming in Python: Two modes of using Python, Interpreter Variables and Data Types, Operators and their Precedence, Python Strings, Slicing, Python Lists, Mutable and Immutable Types, Input from the Keyboard, Iteration: while and for loops, Python Syntax, Colon& Indentation, Syntax of 'for loops', Conditional Execution: if, else if and else, Modify loops : break and continue, Line joining, Functions, Scope of variables, Optional and Named Arguments, More on Strings and Lists, split and join, Manipulating Lists, Copying Lists, Python Modules and Packages, Different ways to import, Packages, File Input/Output, The pickle module, Formatted Printing, Exception Handling, Turtle Graphics.

Chapter 3: Arrays and Matrices: The NumPy Module, Vectorized Functions. (sec. 2.1 to 2.19, 3.1 to 3.2)

Module-II (20hrs)

Applications of Python Programming

Chapter 4: Data visualization: The Matplotlib Module, Plotting mathematical functions, Famous Curves, Power Series, Fourier Series, 2D plot using colors, Meshgrids, 3D Plots, Mayavi, 3D visualization .

Chapter 6: Numerical methods: Numerical Differentiation, Numerical Integration,OrdinaryDifferentialEquations,Polynomials,Findingrootsof an equation, System of Linear Equations, Least Squares Fitting, Interpolation.
(sec. 4.1 to 4.6, 4.8 to 4.10, 6.1 to 6.8)

Module-III (13hrs)

Latex

Chapter 5: Type setting using LATEX: Document classes, Modifying Text, Dividing the document, Environments, Type setting Equations, Arrays and matrices, Floating bodies, Inserting Images, Example, Application.
(sec. 5.1 to 5.8)

Practical

A practical examination, based on following topics, should be conducted for the internal assessment only.

Part A: Plotting

1. Cartesian plot of polynomials showing all zeros.
2. Cartesian plot of quotient of polynomials.
3. Cartesian plot of functions showing asymptotes.
4. Parametric plot of curves.
5. Polar plot of curves.
6. Plot Pi chart.
7. Plot 3Dcurves.
8. Plot 3Dsurfaces.

Part B: Numerical Analysis

1. Bisection Method.
2. Newton-Raphson Method.
3. Numerical differentiation.
4. Trapezoidal rule.
5. Simpson's rule, Euler Method to solve ODE.
6. Fourth order RK Method to solve ODE.

Part C: **LATEX**

1. General documentation.
2. Tables.
3. Writing equations.

Mark distribution for practical examination as test paper(Total6Marks)

Part A: 2 marks

PartB: 2 marks

PartC: 2 marks

Practical Record as Assignment: 3 marks

References:

1	Saha, Amit: Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More*!. No Starch Press, 2015*.
2	Nunez-Iglesias, Juan, Stefanvander Walt, and Harriet Dashnow: "Elegant SciPy: The Art of Scientific Python." (2017).
3	Stewart, John M.: Python for scientists. *Cambridge University Press, 2017.*
4	Kinder, Jesse M., and Philip Nelson: A student's guide to Python for physical modeling. *Princeton University Press, 2018*.
5	McGreggor,Duncan:.Mastering matplotlib.*PacktPublishingLtd,2015*
6	Lamport, Leslie. LaTeX: A Document Preparation System(2/e) *Pearson Education India, 1994.*
7	Hahn, Jane: LATEX for Everyone. *Prentice Hall PTR, 1993*
8	Grätzer, George: Mathinto LATEX. *Springer Science & Business Media, 2013*

OPEN COURSES

FIFTH SEMESTER (OPEN COURSE)
(For students not having Mathematics as Core Course)

MTS5 D01 APPLIED CALCULUS

3hours/week **3credits** **75marks[Int:15+Ext:60]**

COURCE OUTCOMES:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><td>17</td><td>MTS5D01</td><td>Open Course</td><td>Applied Calculus</td></tr>
<tr><td>CO</td><td colspan="3">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="3">Illustrate functions, limit, continuity and differentiability.</td><td>U</td><td>(C,P)</td><td>11</td><td>1</td><td rowspan="6">2</td></tr>
<tr><td>CO 2</td><td colspan="3">Find derivatives of various functions.</td><td>U</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 3</td><td colspan="3">Identify monotone functions.</td><td>Ap</td><td>(C,P)</td><td>4</td><td>1</td></tr>
<tr><td>CO 4</td><td colspan="3">Analyze concavity and points of inflection.</td><td>An</td><td>(C,P)</td><td>5</td><td>1</td></tr>
<tr><td>CO 5</td><td colspan="3">Define exponential and logarithmetic functions.</td><td>U</td><td>C</td><td>4</td><td>1</td></tr>
<tr><td>CO 6</td><td colspan="3">Explain integration and related theorems.</td><td>U</td><td>(C,P)</td><td>14</td><td>1</td></tr>
</table>

Text	Calculus: For Business, Economics, and the Social and Life Sciences BRIEF(10/e): Laurence D.H offmann, Gerald L. Bradley *McGraw-Hill(2010) ISBN:978–0–07–353231–8*

ModuleI 16hrs

Chapter1:- Functions, Graphs, and Limits

1.1: Functions.

1.2: The Graph of a Function.

1.3: Linear Functions.

1.4: Functional Models.

1.5: Limits.

1.6: One sided limits and continuity.

Chapter2:- Differentiation: Basic Concepts

2.1: The Derivative.

2.2: Techniques of Differentiation.

2.3: Product and quotient rules: Higher order derivatives. [proof of product and quotient rules omitted]

2.4: The Chain rule. [proof of general power rule omitted]

ModuleII 18hrs

2.5: Marginal Analysis and Applications using increments.

2.6: Implicit Differentiation and Related Rates.

Chapter3:- Additional Applications of Derivative

3.1: Increasing and Decreasing Functions; Relative Extrema.

3.2: Concavity and Points of Inflection.

3.4: Optimization; Elasticity of Demand.

3.5: Additional Applied Optimization.

Chapter4: Exponential and Logarithmic Functions

4.1: Exponential functions; continuous compounding.

4.2: Logarithmic functions.

ModuleIII 14hrs

Chapter5:- Integration

5.1: Anti differentiation: The Indefinite Integral.

5.2: Integration by Substitution.

5.3: The Definite Integral and the Fundamental Theorem of Calculus. [only statement of FTC required; Justification given at the end of the section omitted]

5.5: Additional Applications to Business and Economics.

5.6: Additional Applications to the Life and Social Sciences. [The derivation of volume formula omitted; only the formula and its applications required]

References:

1	Soo T Tan: Applied Calculus for the Managerial, Life, and social sciences(8/e) *Cengage Learning(2011) ISBN: 978-0-495-55969-6*
2	Ron Larson : Brief Calculus *An Applied Approach(8/e) Houghton Mifflin Company(2009)ISBN: 978-0-618-95847-4*
3	Stefan Waner, Steven R. Costenoble: Finite Mathematics and Applied Calculus(5/e) *Brooks/Cole Cengage Learning(2011) ISBN: 978-1-4390-4925-9*
4	Frank C. Wilson, Scott Adamson: Applied Calculus *Houghton Mifflin Harcourt Publishing Company(2009)*
5	Geoffrey C. Berresford, Andrew M. Rockett: Applied Calculus(7/e) *Cengage Learning(2016)ISBN: 978-1-305-08531-2*

FIFTH SEMESTER (OPEN COURSE)
(For students not having Mathematics as Core Course)

MTS5 D02 DISCRETE MATHEMATICS FOR BASIC AND APPLIED SCIENCES

3 hours/week **3 credits** **75marks [Int:15+Ext:60]**

Course Outcomes:

Course No	**Code**	**Course Category**	**Name of the course**	**CL**	**KC**	**Hrs**	**PO**	**PSO**
18	**MTS5D02**	**Open Course**	**Discrete Mathematics for Basic and Applied Sciences**					
CO	**CO Statement**							
CO 1	Explain ideas in precise and concise mathematical terms and also to make valid arguments using mathematical logic.			U	(C,P)	14	1	2
CO 2	Define semi groups, groups, cyclic groups and permutation groups.			R	C	7	1	
CO 3	Define Boolean algebra and state its properties.			R	C	4	1	
CO 4	Explain Boolean functions and give examples.			U	C	5	1	
CO 5	Define graph and tree and give examples.			R	C	4	1	
CO 6	Explain planar graphs and Euler's formula.			U	C	14	7	

Text	Discrete Mathematics; Proofs, Structures and Applications (3/e): *Rowan Garnier & John Taylor* *CRC Press, Taylor & Francis Group (2009)* *ISBN:978-1-4398-1280-8(hardback)/ 978-1-4398-1281-5 (eBook - PDF)*

Chaper-1 Logic

1.1: Propositions and Truth Values.

1.2:Logical Connectives and Truth Tables- Disjunction, Conditional Propositions, Biconditional Propositions

Module I 14 hrs

1.3: Tautologies and Contradictions.

1.4: Logical Equivalence and Logical Implication-More about conditionals.

1.5: The Algebra of Propositions-The Duality Principle, Substitution Rule.

1.6: Arguments.

1.7: Formal Proof of the Validity of Arguments.

1.8: Predicate Logic-The Universal Quantifier,The Existential Quantifier, Two-Place Predicates, Negation of Quantified Propositional Functions.

1.9: Arguments in Predicate Logic- Universal Specification (US), Universal Generalization (UG), Existential Specification (ES), Existential Generalization (EG).

ModuleII 16hrs

Chapter-8 Algebraic Structures

8.1: Binary Operations and Their Properties.

8.2: Algebraic Structures-Semi groups.

8.3: More about Groups.

8.4: Some Families of Groups-Cyclic Groups, Dihedral Groups, Groups of Permutations.

8.5: Sub structures.

8.6: Morphisms.

Chapter 10 Boolean Algebra

10.1: Introduction.

10.2: Properties of Boolean Algebras.

10.3: Boolean Functions.

10.4: Switching Circuits.

10.5: Logic Networks.

10.6: Minimization of Boolean Expressions.

ModuleIII 18hrs

Chapter 11 Graph Theory

11.1: Definitions and Examples.

11.2: Paths and Cycles.

11.3: Isomorphism of Graphs.

11.4: Trees.

11.5: Planar Graphs.[proof of Euler formula omitted]
11.6: Directed Graphs.

Chapter12ApplicationsofGraphTheory

12.2: Rooted Trees.
12.3: Sorting.
12.4: Searching Strategies.

References:

1	Edward R.Scheinerman: Mathematics *A Discrete Introduction(3/e) Brooks/Cole, Cengage Learning(2013)ISBN: 978-0-8400-4942-1*
2	Gary Haggard, John Schlipf, Sue Whitesides: Discrete Mathematicsf or Computer Science *Thomson Brooks/Cole(2006)ISBN:0-534-49601-x*
3	DP Acharjya, Sreekumar: Fundamental Approach to Discrete Mathematics *New Age International Publishers(2005) ISBN: 978-81-224-2304-4*
4	Gary Chartrand, Ping Zhang: Discrete Mathematics *Waveland Press, Inc(2011)ISBN: 978-1-57766-730-8*
5	Tom Jenkyns, Ben Stephenson: Fundamentals of Discrete Math for ComputerScience*AProblem-SolvingPrimerSpringer-VerlagLondon(2013) ISBN:978-1-4471-4068-9*
6	Faron Moller, Georg Struth: Modelling Computing *Systems Mathematics for Computer Science Springer-Verlag London (2013) ISBN 978-1-84800-321-7*

FIFTH SEMESTER (OPEN COURSE)
(For students not having Mathematics as Core Course)

MTS5 D03 LINEAR MATHEMATICAL MODELS

3 hours/week	3 credits	75marks [Int:15+Ext:60]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
19	MTS5D03	Open Course	Linear Mathematical Models					
CO	CO Statement							
CO 1	Explain the basic concepts of linear functions.			U	(C,P)	7	1	4
CO 2	Solve system of linear equations using various methods.			Ap	(C,P)	11	7	
CO 3	Solve linear programming problems geometrically.			Ap	(C,P)	12	7	
CO 4	Solve LP problems more effectively using Simplex algorithm.			Ap	(C,P)	12	7	
CO 5	Explain duality theory.			U	C	6	1	

Text	Finite Mathematics and Calculus with Applications (9/e) *Margaret L. Lial, Raymond N. Greenwell & Nathan P. Ritchey* Pearson Education, Inc(2012) ISBN: 0-321-74908-1

Module I 18 hrs

Chapter-1 Linear Functions

1.1: Slopes and Equations of Lines.

1.2: Linear Functions and Applications.

1.3: The Least Squares Line.

Chapter-2 Systems of Linear Equations and Matrices

2.1: Solution of Linear Systems by the Echelon Method.

2.2: Solution of Linear Systems by the Gauss-Jordan Method.

2.3: Addition and Subtraction of Matrices.

2.4: Multiplication of Matrices.

2.5: Matrix Inverses.

2.6: Input-Output Models.

ModuleII 12hrs

Chapter-3 Linear Programming: The Graphical Method

3.1: Graphing Linear Inequalitie.s

3.2: Solving Linear Programming Problems Graphically.

3.3: Applications of Linear Programming.

ModuleIII 18hrs

Chapter-4 Linear Programming: The Simplex Method

4.1: Slack Variables and the Pivot.

4.2: Maximization Problems.

4.3: Minimization Problems; Duality.

4.4: Non standard Problems.

References:	
1	Soo T Tan: Finite Mathematics For the Managerial, Life, and social sciences(11/e) *Cengage Learning(2015) ISBN: 1-285-46465-6*
2	Ronald J. Harshbarger, James J. Reynolds: Mathematical Applications For the Management, Life, and Social Sciences(9/e)*Brooks/Cole Cengage Learning(2009) ISBN:978-0-547-14509-9*
3	Stefan Waner, Steven R. Costenoble: Finite Mathematics and Applied Calculus(5/e) *Brooks/Cole Cengage Learning(2011) ISBN: 978-1-4390-4925-9*
4	Seymour Lipschutz, John J. Schiller, R. Alu Srinivasan: Beginning Finite Mathematics *Schaum's Outline Series, McGraw-Hill(2005)*
5	HowardL. Rolf: Finite Mathematics *Enhanced Edition*(7/e)*Brooks/Cole, Cengage Learning(2011)ISBN:978-0-538-49732-9*
6	Michael Sullivan: Finite Mathematics An Applied Approach(11/e*)John Wiley & Sons,Inc(2011)ISBN:978-0470-45827-3*

FIFTH SEMESTER (OPEN COURSE)
(For students not having Mathematics as Core Course)

MTS5 D04 MATHEMATICS FOR DECISION MAKING

3 hours/week **3 credits** **75marks [Int:15+Ext:60]**

Course Outcomes:

Course No	**Code**	**Course Category**	**Name of the course**	**CL**	**KC**	**Hrs**	**PO**	**PSO**
20	**MTS5D04**	**Open Course**	**Mathematics for Decision Making**					
CO	**CO Statement**							
CO 1	Define data classification and experimental design.			R	C	5	1	4
CO 2	Understand frequency distributions and their graphs.			U	(C,P)	5	7	
CO 3	Explain measures of central tendency.			U	(C,P)	4	1	
CO 4	Understand basic concepts of probability and counting			U	(C,P)	12	2	
CO 5	Explain discrete probability distributions.			U	C	12	1	
CO 6	Explain normal and standard normal distributions.			U	C	10	1	

Text	Elementary Statistics: Picturing the World (6/e) *Ron Larson & Betsy Farber* *Pearson Education, Inc (2015) ISBN: 978-0-321-91121-6*

Module I 14 hrs

Chapter1 Introduction to Statistics

1.1: An Overview of Statistics.

1.2: Data Classification.

1.3: Data Collection and Experimental Design.

Chapter2 Descriptive Statistics

2.1: Frequency Distributions and their Graphs.

2.2: More Graphs and Displays.

2.3: Measures of Central Tendency.

2.4: Measures of Variation.

2.5: Measures of Position.

ModuleII 12hrs

Chapter3 Probability

3.1: Basic Concepts of Probability and Counting.

3.2: Conditional Probability and the Multiplication Rule.

3.3: The Addition Rule.

3.4: Additional topics in probability and counting.

ModuleIII 22hrs

Chapter4 Discrete Probability Distribution

4.1: Probability Distributions.

4.2: Binomial Distributions.

4.3: More Discrete Probability Distributions.

Chapter5 Normal Probability Distribution

5.1: Introduction to Normal distributions and Standard Normal Distributions.

5.2: Normal Distributions: Finding Probabilities.

5.3: Normal Distributions: Finding Values.

References:

1	Mario F. Triola: Elementary Statistics(13/e) : *Pearson Education, Inc(2018) ISBN: 9780134462455*
2	Neil A. Weiss: Elementary Statistics(8/e) *Pearson Education, Inc(2012) ISBN: 978-0-321-69123-1*
3	Nancy Pfenning: Elementary Statistics: Looking at Big Picture *Brooks/Cole Cengage Learning(2011) ISBN: 978-0-495-01652-6*
4	Frederick J Gravetter, Larry B.Wallnau: Statistics for the Behavioral Sciences(10/e) *Cengage Learning(2017)ISBN:978-1-305-50491-2*
5	Seymour Lipschutz, John J. Schiller, R. Alu Srinivasan: Beginning Finite Mathematics *Schaum's Outline Series, McGraw-Hill(2005)*
6	Michael Sullivan: Finite Mathematics An Applied Approach(11/e*)John Wiley&Sons,Inc(2011)ISBN:978-0470-45827-3*

COMPLEMENTARY COURSES

FIRST SEMESTER

MTS1 C01:MATHEMATICS-1

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

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
21	MTS1C01	Complementary	Mathematics -1					
CO	CO Statement							
CO 1	Define limit, continuity and differentiability.			R	C	14	1	2
CO 2	Explain some basic theorems of differential calculus.			U	(C,P)	13	1	
CO 3	Apply the concepts and theorems in calculus to draw the graph of a function.			Ap	(C,P)	12	7	
CO 4	Illustrate L'hopital's rule.			U	(C,P)	6	7	
CO 5	Understand anti derivatives and area under the graph of a function.			U	C	5	1	
CO 6	Explain some basic theorems of integral calculus.			U	C	5	1	
CO 7	Apply the concept of definite integral to find the area between two curves and volume.			Ap	(C,P)	9	7	

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 behavior.

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

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

Course Outcomes:

Course No	**Code**	**Course Category**	**Name of the course**	**CL**	**KC**	**Hrs**	**PO**	**PSO**
22	**MTS2C02**	**Complementary**	**Mathematics -2**					
CO	**CO Statement**							
CO 1	Relate points in polar coordinates.			U	(C,P)	6	1	2
CO 2	Understand parametric curves.			U	C	6	1	
CO 3	Find length and area in polar coordinates.			R	(C,P)	6	7	
CO 4	Illustrate numerical integration.			U	(C,P)	6	1	
CO 5	Analysis convergence and divergence in series.			An	(C,P)	8	7	
CO 6	Explain Taylor and Maclaurin series.			U	(C,P)	6	1	
CO 7	Explain vector space, sub space, linear independence, linear dependence and basis.			U	(C,P)	12	1	
CO 8	Illustrate row space, column space null space and diagonalization.			U	(C,P)	14	1	

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 eigen values and eigenvectors, complex eigenvalues, eigenvalues and singular matrices, eigen values of inverse.

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

8.10: Orthogonal Matrices- symmetric matrices and eigen values, inner product, criterion for orthogonal matrix, construction of orthogonal matrix.

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

8.13: LU Factorization- definition, 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]

Course Outcomes:

<table>
<tr><th>Course No</th><th>Code</th><th>Course Category</th><th>Name of the course</th><th rowspan="3">CL</th><th rowspan="3">KC</th><th rowspan="3">Hrs</th><th rowspan="3">PO</th><th rowspan="3">PSO</th></tr>
<tr><td>23</td><td>MTS3C03</td><td>Complementary</td><td>Mathematics -3</td></tr>
<tr><td>CO</td><td colspan="3">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="3">Explain vector valued functions, limit, continuity and derivatives.</td><td>U</td><td>(C,P)</td><td>10</td><td>1</td><td rowspan="8">2</td></tr>
<tr><td>CO 2</td><td colspan="3">Illustrate the idea of directional derivative, its evaluation, interpretation, and relationship with partial derivatives.</td><td>U</td><td>(C,P)</td><td>11</td><td>1</td></tr>
<tr><td>CO 3</td><td colspan="3">Understand the notion of a vector field, the idea of curl and divergence of a vector field, their evaluation and interpretation.</td><td>U</td><td>(C,P)</td><td>6</td><td>1</td></tr>
<tr><td>CO 4</td><td colspan="3">Apply double in the problem of finding out mass of lamina, centre of mass, moment of inertia and so on.</td><td>Ap</td><td>(C,P)</td><td>10</td><td>7</td></tr>
<tr><td>CO 5</td><td colspan="3">Illustrate Green’s theorem of multivariable calculus and its their use in several areas and directions.</td><td>U</td><td>(C,P)</td><td>8</td><td>1</td></tr>
<tr><td>CO 6</td><td colspan="3">Apply the advantage of choosing other coordinate systems such as polar, spherical, cylindrical etc. in the evaluation of triple integrals.</td><td>Ap</td><td>(C,P)</td><td>21</td><td>1</td></tr>
<tr><td>CO 7</td><td colspan="3">Distinguish between differentiability and analyticity of a complex function.</td><td>An</td><td>(C,P)</td><td>21</td><td>7</td></tr>
<tr><td>CO 8</td><td colspan="3">Apply Cauchy-Goursat Theorem and Cauchy’s Integral formula to evaluate contour integrals.</td><td>Ap</td><td>(C,P)</td><td>14</td><td>7</td></tr>
</table>

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 multi connected 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.

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.

9.17: 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[Proof of is omitted],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.

18.2:Cauchy-Goursat Theorem- Simply and Multiply Connected Domains, Cauchy's Theorem, Cauchy–Goursat theorem, Cauchy–Goursat Theorem for Multiply Connected Domains. [Proofs of theorems are omitted]

18.3: Independence of Path- Analyticity and path independence, fundamental theorem for contour integral, Existence of Antiderivative. [Proofs of theorems are omitted]

18.4: Cauchy's Integral Formula- First Formula, Second Formula-C.I.F. for derivatives. Liouville's Theorem, Fundamental Theorem of Algebra.[Proofs of theorems are omitted]

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]

Course Outcomes:

Course No	Code	Course Category	Name of the course	CL	KC	Hrs	PO	PSO
24	**MTS4C04**	**Complementary**	**Mathematics -4**					
CO	**CO Statement**							
CO 1	Identify a number of areas where the modelling process results in a differential equation.			Ap	(C,P)	10	1	4
CO 2	Solve DEs that are in linear, separable and in exact forms.			Ap	(C,P)	11	7	
CO 3	Illustrate the theory and method of solving a second order linear homogeneous and non homogeneous equation with constant coefficients.			U	(C,P)	22	1	
CO 4	Understand Laplace transform and Fourier series.			U	(C,P)	19	1	
CO 5	Solve PDE using variable separable method.			Ap	(C,P)	18	7	

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]

ModuleII	22hrs

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, Eigen values and Eigen functions.[uptoandincludingExample3:therestis omitted]

ModuleIII 19hrs

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 Transformand 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-UnitImpulse, The Dirac Delta Function and its transform.

ModuleIV 18hrs

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 FourierSeries, 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

MODEL QUESTION PAPER

FIRST SEMESTER B.Sc DEGREE EXAMINATION

MTS1 B01: BASIC LOGIC & NUMBER THEORY

Time: 2.5 Hours Maximum: 80 Marks

PART-A

(Short Answer Type -Each Question carries 2 marks; Maximum 25 Marks)

1. Write down the converse of the implication: “If London is in France, then Paris is in England”
2. Define an argument.
3 .Give a direct proof of the theorem ‘Product of two odd integers is an odd integer’.
4. Find the quotient and the remainder when 18 is divided by 20.
5. Let a and b be positive integers such that $a|b$ and $b|a$. Prove that $a = b$..
6. Find the number of positive integers ≤ 2776 and divisible by 25.
7. Express 2345_{16} in base ten.
8. Prove that there are infinitely many primes.
9. Let a, b, and c be any positive integers. Prove that $(ac, bc) = c(a, b)$.
10. Find 18 consecutive composite integers.
11. Using the canonical decompositions of 1050 and 2574, find their lcm.
12. Prove that $a \equiv b\ (mod\ m)$ if and only if $a = b + km$ for some integer k.
13. Solve the linear congruence $12x \equiv 6\ (mod\ 7)$.
14. Compute $\varphi(13)$ and $\varphi(68)$.
15. Evaluate $\tau(78)$ and $\tau(83)$.

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PART-B

(Paragraph Answer Type- Each Question carries 5 marks; Maximum 35 Marks)

16. Construct the truth table for $(p \leftrightarrow q) \leftrightarrow p\ v\ q$.
17. State and prove De Morgan’s laws.
18. State and prove Cassini’s Formula.
19. Let f_n denote the n^{th} Fermat number. Prove that $f_n = f_{n-1}^2 - 2f_{n-1} + 2$, where $n \geq 1$.
20. Prove that two positive integers, a and b, are relatively prime iff there are integers α and β such that $\alpha a + \beta b = 1$.
21. State and prove Wilson’s Theorem.
22. Find the number of trailing zeros in 234!.
23. State and prove Euler’s Theorem.

PART-C

(Essay Type-Answer Any 2 Questions-2x10=20 Marks)

24. State and prove the triangle inequality
25. State and prove Euclidean Algorithm.
26. State and prove The Fundamental Theorem of Arithmetic.
27. (a) Let n be a positive integer. Prove that $\sum_{d|n} \varphi(d) = n$.

    (b) Find the remainder when 16^{53} is divided by 7.

SECOND SEMESTER B.Sc DEGREE EXAMINATION
MTS2 B02: CALCULUS OF SINGLE VARIABLE-1

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 1
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 2
10. From Module- 3
11. From Module- 3
12. From Module- 3
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 1
19. From Module- 2
20. From Module- 2
21. From Module- 2
22. From Module- 3
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

THIRD SEMESTER B.Sc DEGREE EXAMINATION
MTS3 B03: CALCULUS OF SINGLE VARIABLE-2

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 3
21. From Module- 3
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

FOURTH SEMESTER B.Sc DEGREE EXAMINATION
MTS4 B04: LINEAR ALGEBRA

Time:2.5 Hours   Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 3
8. From Module- 3
9. From Module- 3
10. From Module- 3
11. From Module- 4
12. From Module- 4
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 3
21. From Module- 3
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

FIFTH SEMESTER B.Sc DEGREE EXAMINATION

MTS5 B05: THEORY OF EQUATIONS AND ABSTRACT ALGEBRA

Time:2.5 Hours　　　　　　　　　　　　Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 1
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 2
10. From Module- 2
11. From Module- 3
12. From Module- 3
13. From Module- 3
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 1
19. From Module- 2
20. From Module- 2
21. From Module- 2
22. From Module- 3
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

FIFTH SEMESTER B.Sc DEGREE EXAMINATION

MTS5 B06: BASIC ANALYSIS

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 4
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 3
21. From Module- 3
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 B07: NUMERICAL ANALYSIS

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 1
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 1
16. From Module- 2
17. From Module- 2
18. From Module- 2/3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module-1
21. From Module-2/ 3

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 B08: LINEAR PROGRAMMING

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 1
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module-1/2/3
21. From Module-1/2/ 3

FIFTH SEMESTER B.Sc DEGREE EXAMINATION

MTS5 B09: INTRODUCTION TO GEOMETRY

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 2
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module-2
21. From Module- 3

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B10: REAL ANALYSIS

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 3
21. From Module- 4
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B11: COMPLEX ANALYSIS

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 3
21. From Module- 3
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B12: CALCULUS OF MULTIVARIABLE

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 3
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 4
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 3
20. From Module- 3
21. From Module- 4
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B13: DIFFERENTIAL EQUATIONS

Time:2.5 Hours Maximum Marks:80

Section A: Each question has 2 marks (Maximum 25 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 1
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 2
10. From Module- 3
11. From Module- 3
12. From Module- 4
13. From Module- 4
14. From Module- 4
15. From Module-4

Section B: Each question has 5 marks (Maximum 35 marks)

16. From Module- 1
17. From Module- 1
18. From Module- 2
19. From Module- 2
20. From Module- 2
21. From Module- 3
22. From Module- 4
23. From Module- 4

Section C: Answer any two questions (Each question has 10 marks)

24. From Module- 1
25. From Module- 2
26. From Module- 3
27. From Module- 4

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B14(E01): GRAPH THEORY

Time:2 Hours | Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 3
19. From Module- 1/2/3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/2/3
21. From Module- 1/2/3

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B14(E02): TOPOLOGY OF METRIC SPACES

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 3
19. From Module- 1/2/3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1
21. From Module- 2

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
MTS6 B14(E03): MATHEMATICAL PROGRAMMING WITH PYTHON AND LATEX

Time:2 Hours   Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 2
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/3
21. From Module- 2

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 D01: APPLIED CALCULUS

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 1
16. From Module- 2
17. From Module- 2
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/3
21. From Module- 2

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 D02: DISCRETE MATHEMATICS FOR BASIC AND APPLIED SCIENCES

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 2
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/2
21. From Module- 3

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 D03: LINEAR MATHEMATICAL MODELS

Time:2 Hours | Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 1
16. From Module- 2
17. From Module- 2
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1
21. From Module- 3

FIFTH SEMESTER B.Sc DEGREE EXAMINATION
MTS5 D04: MATHEMATICS FOR DECISION MAKING

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 1
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 2
9. From Module- 3
10. From Module- 3
11. From Module- 3
12. From Module- 3

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 3
19. From Module- 3

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/2
21. From Module- 3

FIRST SEMESTER B.Sc DEGREE EXAMINATION
MTS1 C01: MATHEMATICS-1

Time:2 Hours Maximum Marks:60

Part A

(Each question carries 2 marks; Maximum mark is 20.)

1. If f is a continuous function on $[a, b]$, then it is differentiable on (a, b). True or false? Justify your answer.
2. Let $s = t^5 - 2$ be the displacement of a particle at time t. Find the instantaneous velocity of the particle at $t = 2$.
3. Evaluate $\lim_{x \to 1} x^{10} - 2x^7 + 3x^5 - 4x^2 - 1$ using basic properties.
4. Calculate the approximate value for $(4.999)^2$.
5. Find equation of the tangent for the curve $f(x) = x^3 + 4x$ at $x = 3$.
6. Evaluate $\sum_{i=-10}^{1000} i^3$.
7. Show that the curve $y = x^2$ is concave up on the entire real line.
8. Evaluate $\lim_{x \to 0} \frac{1 - \cos x}{x + x^2}$.
9. Compute the signed area of the region between graph of $g(x) = \begin{cases} -2, -2 \leq x < 0 \\ 10, 0 \leq x \geq 3 \\ -1, 3 < x \leq 4 \end{cases}$ and $X -$ axis.
10. Air is escaping from a balloon at $3t^2 + 2t$ cubic centimeters per second for t between 0 and 3. How much air escapes during this period?
11. Find average value of $\sqrt{1 - x^2}$ on $[-1,1]$.
12. Find area between the graphs of $y = x^2$ and $y = x^3$ for $0 \leq x \leq 1$.

Part B

(Each question carries 5 marks; Maximum mark is 30.)

13. Evaluate (i) $\lim_{x \to \infty} \frac{(x-1)}{5x+7}$. (ii) $\lim_{x \to 2} \frac{-3x}{x^2 - 4x + 4}$
14. Find the derivative of $(g(x))^3$ where $g(x) = x^3 + 2x$ first by using power of a function rule and by expanding the cube. Compare the answers.

15. Using a division of the interval [1,2] into 4 equal parts, find $\int_1^2 \frac{1}{x} dx$ to within an error not more than $\frac{1}{10}$.

16. State fundamental theorem of Calculus. Hence evaluate the integral $\int_1^2 \frac{(x^2+5)^2}{x^4} dx$.

17. Find the area of the region bounded by the curves $y = x^2 - 1, X -$ axis, $Y -$axis and the line $x = 3$.

18. Write the following integral as a limit of sums and hence evaluate $\int_0^1 (4x^3 + 1)\, dx$

19. A pyramid $3\, m$ high has a square base that is $3\, m$ on a side. The cross section of the pyramid perpendicular to the altitude $x\, m$ down from the vertex is a square $x\, m$ on each side. Find the volume of the pyramid.

Part C

(Answer any one. Each question carries 10 marks.)

20. Graph the function $f(x) = x^{\frac{5}{3}} - 5x^{\frac{2}{3}}$.

21. Find area in the first quadrant that is bounded above by the curve $x = y^2$ below by the $X -$ axis and the line $y = x - 2$, by integrating with respect (i) x (ii) y .

SECOND SEMESTER B.Sc DEGREE EXAMINATION
MTS2 C02: MATHEMATICS-2

Time:2 Hours | Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 3
9. From Module- 3
10. From Module- 3
11. From Module- 4
12. From Module- 4

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 4
19. From Module- 4

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1
21. From Module- 2

THIRD SEMESTER B.Sc DEGREE EXAMINATION
MTS3 C03: MATHEMATICS-3

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 2
8. From Module- 3
9. From Module- 3
10. From Module- 3
11. From Module- 4
12. From Module- 4

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 3
19. From Module- 4

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/2/3
21. From Module- 1/2/3

FOURTH SEMESTER B.Sc DEGREE EXAMINATION
MTS4 C04: MATHEMATICS-4

Time:2 Hours Maximum Marks:60

Section A: Each question has 2 marks (Maximum 20 marks)

1. From Module- 1
2. From Module- 1
3. From Module- 1
4. From Module- 2
5. From Module- 2
6. From Module- 2
7. From Module- 3
8. From Module- 3
9. From Module- 3
10. From Module- 3
11. From Module- 4
12. From Module- 4

Section B: Each question has 5 marks (Maximum 30 marks)

13. From Module- 1
14. From Module- 1
15. From Module- 2
16. From Module- 2
17. From Module- 3
18. From Module- 4
19. From Module- 4

Section C: Answer any one questions (Each question has 10 marks)

20. From Module- 1/2/3/4
21. From Module- 1/2/3/4