SYLLABUS

Core, Complementary & Open Courses

UG PROGRAMME IN MATHEMATICS

Under Choice Based Credit Semester System

FAROOK COLLEGE

(AUTONOMOUS)

www.farookcollege.ac.in

CERTIFICATE

I hereby certify that the documents attached are the bonafide copies of the syllabus of Core Courses offered to B.Sc Mathematics programme and Complementary & Open Courses offered by the Department of Mathematics to be effective from 2022 admission onwards.

Principal

Date: 01 June 2023
Place: Farook College

TABLE OF CONTENT

MEMBERS OF BOARD OF STUDIES

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   Asst.Professor& HoD Dept. of Mathematics
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3. **Mr. Rabeeb Ali V.P**
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4. **Ms. Aysha Hadya K**
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1. **Mr. Annal Abdussalam P T**
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MERITORIOUS ALUMNUS

1. Mr. Riyasudheen K
   Research Scholar, NIT Calicut
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PROGRAMME SPECIFIC OUTCOMES (PSO)

Upon completion of BSc Mathematics programme, the students will be able to:

PSO 01 Understand the basic concepts, fundamental principles and theories in Mathematics and internalize their relevance in everyday life.

PSO 02 Demonstrate and apply fundamental knowledge in Mathematical Sciences and their application in research and industry.

PSO 03 Acquire good knowledge and understanding to solve specific theoretical and applied problems in Set Theory, Number Theory, Linear and Abstract Algebra, Calculus, Geometry.

PSO 04 Analyze and solve real world problems applying mathematical models

PSO 05 Develop a positive attitude towards mathematics as an interesting and valuable subject of study.

PSO 06 Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

SCHEME OF THE PROGRAMME

Credit and Mark Distribution in Each Semester Total Credits: 140

Semester	Course	Credit	Internal Mark	External Mark	Total Mark
I	Common course: English	4	20	80	100
	Common course: English	3	15	60	75
	Common course: Additional Language	4	20	80	100
	Core Course I: Basic Logic and Calculus-1	4	20	80	100
	Complementary course: Introductory Statistics	3	15	60	75
	Complementary course: Physics (Properties of Matter and Thermodynamics)	2	15	60	75
	Audit Course -I Environment Studies	-	-	-	-
	Total	**20**			**525**
II	Common course: English	4	20	80	100
	Common course: English	3	15	60	75
	Common course: Additional Language	4	20	80	100
	Core Course II: Calculus-2	4	20	80	100
	Complementary course: Statistics (Probability Theory)	3	15	60	75
	Complementary course: Physics (Optics, Laser, Electronics and	2	15	60	75

	Communication)				
	Audit Course -II Disaster Management	-	-	-	-
	Total	**20**			**525**
III	Common course: English	4	20	80	100
	Common course: Additional Language	4	20	80	100
	Core Course III: Theory of Equations and Number Theory	4	20	80	100
	Complementary course: Statistics (Probability Distributions and Sampling Theory)	3	15	60	75
	Complementary course: Physics (Mechanics, Relativity, Waves and Oscillations)	2	15	60	75
	Audit Course -III Human Rights/Intellectual Property Rights/ Consumer Protection	-	-	-	-
	Total	**17**			**450**
IV	Common course: English	4	20	80	100
	Common course: Additional Language	4	20	80	100
	Core Course IV: Linear Algebra	4	20	80	100
	Complementary course: Statistics (Statistical Inference and Quality Control)	3	15	60	75
	Complementary course: Physics (Electricity, Magnetism and Nuclear Physics)	2	15	60	75
	Complementary course: Physics Practical	4	20	80	100
	Audit Course -IV Gender Studies/Gerontology	-	-	-	-

	Total	**21**			**550**
V	Core Course V: Abstract Algebra	4	20	80	100
	Core Course VI: Basic Analysis	4	20	80	100
	Core Course VII: Numerical Analysis	3	15	60	75
	Core Course VIII: Linear Programming	3	15	60	75
	Core Course IX: Calculus of Multi Variable-1	3	15	60	75
	Open course: (Offered by Other Departments)	3	15	60	75
	Total	**20**			**500**
VI	Core Course X: Real Analysis	5	20	80	100
	Core Course XI: Complex Analysis	5	20	80	100
	Core Course XII: Calculus of Multi variable-2	4	20	80	100
	Core Course XIII: Differential Equations	4	20	80	100
	Elective Course I: Mathematical Programming with Python and Latex	2	15	60	75
	Project Work	2	15	60	75
	Total	**22**			**550**
English		22			550
Additional Language		16			400
Complementary Course: Statistics		12			300
Complementary Course: Physics		12			400
Core Course: Mathematics		53			1300

Open Course	3			75
Project	2			75
Audit Course	*16*			-
Extra Credit Activities	*4*			-
Total	**140**			**3100**

Credit Distribution

Semester	Common Course		Core Course	Complementary Course		Open Course	Project	Audit Course	Total
	English	Additional languag		Statistics	Physics				
1	**4***(A1)* + **3***(A2)*	**4***(A7)*	4	3	2			4	24
2	**4***(A3)* + **3***(A4)*	**4***(A8)*	4	3	2			4	24

3	**4***(A5)*	**4***(A9)*	4	3	2			4	21
4	**4***(A6)*	**4***(A10)*	4	3	2 + 4			4	25
5			4 + 4 + 3 + 3 + 3			3			20
6			5 + 5 + 4 + 4 + 2				2		22
Total	**22**	**16**	**53**	**12**	**12**	**3**	**2**	**16**	**136**
								Extra Credit Activities	**4**
								Grand Total = (120 + 16 Audit Courses + 4 Extra Credit Activities)	**140**

Core Course Structure

Total Credits: 58 (Internal: 20%; External: 80%)

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Marks
I	BMT1B01	Core Course I: Basic Logic and Calculus-1	4	64	4	100
II	BMT2B02	Core Course II: Calculus-2	4	55	4	100
III	BMT3B03	Core Course III: Theory of Equations and Number Theory	5	65	4	100
IV	BMT4B04	Core Course IV: Linear Algebra	5	65	4	100
V	BMT5B05	Core Course V: Abstract Algebra	5	65	4	100
	BMT5B06	Core Course VI: Basic Analysis	5	83	4	100
	BMT5B07	Core Course VII: Numerical Analysis	4	64	3	75
	BMT5B08	Core Course VIII: Linear Programming	3	49	3	75
	BMT5B09	Core Course IX: Calculus of Multi Variable-1	4	64	3	75
	-	Core Course : Project Work	1		-	-

		Open Course (Offered by other Departments)		39	3	
VI	BMT6B10	Core Course X: Real Analysis	5	80	5	100
	BMT6B11	Core Course XI: Complex Analysis	5	80	5	100
	BMT6B12	Core Course XII: Calculus of Multi Variable-2	5	80	4	100
	BMT6B13	Core Course XIII: Differential Equations	5	80	4	100
	BMT6E01	Core Course XV: elective I - Graph Theory	3	48	2	75
	BMT6E02	Core Course XIV: elective II - Topology of Metric spaces				
	BMT6E03	Core Course: elective III - Mathematical Programming with Python and Latex				
	BMT6E04	Core Course: elective IV - Introduction to Geometry				
	BMT6P01	Core Course : Project Work	2		2	75
Total					**58**	**1375**

ELECTIVE COURSE STRUCTURE

Total Credits: 3 (Internal 20%; External 80%)

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Marks
VI	BMT6E01	Elective Course I: Graph Theory	3	48	75
	BMT6E02	Elective Course II: Topology of Metric spaces			
	BMT6E03	Elective Course III: Mathematical Programming with Python and Latex			
	BMT6E04	Elective Course IV: Introduction to Geometry			

OPEN COURSE STRUCTURE

(for students other than B.Sc. Mathematics) Total Credits: 3 (Internal 20%; External 80%)

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Marks
V	BMT5D01	Open Course 1: Applied Calculus	3	48	75
	BMT5D02	Open Course 2: Discrete Mathematics for Basic and Applied Sciences			
	BMT5D03	Open Course 3: Linear Mathematical Models			
	BMT5D04	Open Course 4: Mathematics for Decision Making			

COMPLEMENTARY COURSE STRUCTURE

Total Credits: 12 (Internal: 20%; External: 80%)

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Marks
I	BMT1C01	Mathematics-1	4	52	3	75
	BMT1C01(CS)					
II	BMT2C02	Mathematics-2	4	52	3	75
	BMT2C02(CS)					
III	BMT3C03	Mathematics-3	5	52	3	75
	BMT3C03(CS)					
IV	BMT4C04	Mathematics-4	5	72	3	75
	BMT4C04(CS)					

EVALUATION AND GRADING

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. The colleges shall send only the marks obtained for internal examination to the university.

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% ≤ CRP < 75%	1	1
75% ≤ 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 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%≤*TP* <45%	2	2
45%≤*TP* <55%	3	3
55%≤*TP* <65%	4	4
65%≤*TP* <85%	5	6
85%≤*TP*≤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)
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)

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 / Institutional Visit

The second or third year B.Sc Mathematics students shall be taken under the supervision of faculty members to visit industrial units, organizations or institutions involved in higher education, so as to enable them to have a deep understanding in specialized areas, and to explore various opportunities available at these institutions. The tour report should be submitted to the Head of the Department soon after the tour.

CORE COURSE SYLLABUS

SEMESTER 1

COURSE CODE: BMT1B01 **CORE COURSE I**: BASIC LOGIC & CALCULUS-1				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

Course Outcomes	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Reformulate*** statements from common language to formal logic and apply truth tables and rules of propositions.	Analyze	PSO1 PSO4
CO2	***Formulate*** short proofs of mathematical statements.	Create	PSO2 PSO3
CO3	***Determine*** the continuity and differentiability of a function at a point and on a set.	Evaluate	PSO3 PSO4
CO4	***Understand*** graphing functions using qualitative methods.	Understand	PSO1 PSO3
CO5	***Learn*** definite integral as the limit of sums and integration as derivatives.	Understand	PSO1 PSO2 PSO3

TEXT-1	Discrete Mathematics with Applications: Thomas Koshy, Elsevier Academic Press (2004) ISBN:0-12-421180-1
TEXT-2	Calculus: Soo T Tan Brooks/Cole, Cengage Learning (2010) ISBN: 978-0-534-46579-7

COURSE CONTENT		
Module 1. Logic	**Text -1**	**14 Hours**

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 2. Limit, Continuity and Derivatives	**Text-2**	**18 Hours**

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- ε - δ $definition$, 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.

2.1. Differentiation - definition only.

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

Module 3. Applications of the Derivative	**Text-2**	**17 Hours**

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 4. Integration	**Text-2**	**15 Hours**

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.

MODE OF TRANSACTION

Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning.

Visual Aids: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts.

Real-Life Applications: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students.

Cooperative Learning: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Internal Test – One internal test: 8 Mark

b. Assignments: 4 Mark

c. Seminar Presentation: 3 Mark

d. Classroom participation based on attendance: 3 Mark

External Assessment (80 Marks) Duration $2\frac{1}{2}$ Hours, No of Questions: 27

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1. Logic	18
Module 2. Limit Continuity and Derivatives	22

Module 3. Applications of the Derivative	22
Module 4. Integration	18

***List of Practicals (using any software)**
• Plotting graph of functions. • Evaluating limits by plotting its graphs. • Plotting the graphs of polynomials of degrees 4 and 5, the derivative graph, and the second derivative graph and comparing them. • Finding relative and absolute extrema by plotting its graphs. • Finding the area under a curve and verifying the definite integral of a positive function and the area under its graph is the same.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

REFERENCES:

1. Kenneth H. Rosen: Discrete Mathematics and Its Applications(7/e) *McGraw-Hill, NY(2007)*
2. Joel Hass, Christopher Heil & Maurice D. Weir : Thomas' Calculus(14/e) *Pearson (2018) ISBN 0134438981*
3. Robert A Adams & Christopher Essex : Calculus *Single Variable (8/e) Pearson Education Canada (2013) ISBN*: 0321877403
4. Jon Rogawski & Colin Adams : Calculus *Early Transcendentals* (3/e) *W. H. Freeman and Company(2015) ISBN: 1319116450*
5. Anton, Bivens & Davis : Calculus *Early Transcendentals* (11/e) *John Wiley & Sons, Inc.(2016) ISBN: 1118883764*

SEMESTER 2

COURSE CODE: BMT2B02 **CORE COURSE II**: CALCULUS-2				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Solve*** problems in a range of mathematical applications using integration.	Apply	PSO2 PSO3
CO2	***Learn*** the key concepts of transcendental function including logarithmic, exponential, inverse trigonometric and hyperbolic functions.	Understand	PSO1 PSO2 PSO3
CO3	***Understand*** the concepts to evaluate the limits of indeterminate forms and the convergence of improper integrals.	Understand	PSO1 PSO2 PSO3
CO4	***Understand*** the concepts of sequences and series and determine limits of sequences and convergence of series.	Understand	PSO1 PSO2 PSO3
CO5	***Define***, ***differentiate*** and integrate functions represented as power series expansions.	Analyze	PSO1 PSO3 PSO4

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

COURSE CONTENT	
Module 1. Applications of Definite Integral	**12 Hours**

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.

Module 2. The Transcendental Functions	**21 Hours**

6.1 The Natural logarithmic function- *definition*, The Derivative of $ln\ x$, Laws of Logarithms, The Graph of the Natural Logarithmic Function, The Derivatives of Logarithmic Functions, Logarithmic Differentiation, Integration Involving Logarithmic 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 and 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*, Derivatives 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'H ˆopital rule- *motivation,* The Indeterminate Forms. 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 3. Infinite Sequences and Series	**11 Hours**
6.7 Improper integrals – *definition*, Infinite Intervals of Integration, Improper Integrals with Infinite Discontinuities, A Comparison Test for Improper Integrals. 6.7 Sequences- *definition, recursive definition,* Limit of a Sequence, *limit laws, squeeze theorem*, Bounded Monotonic Sequences, *definition, monotone convergence theorem (only statement; its proof omitted).* 6.7 Series- *defining the sum*, *convergence and divergence*, Geometric Series, The Harmonic Series, The Divergence Test, Properties of Convergent Series 6.7 The Integral Test – investigation of convergence, integral test, The *p* Series, *its convergence and divergence* 6.7 The Comparison Test- *test series*, The Comparison Test, The Limit Comparison Test	
Module 4. Power Series and Taylor Series	**11 Hours**
6.7 Alternating Series- *definition, the alternating series test*, *its proof, examples,* Approximating the Sum of an Alternating Series by Sn. 6.7 Absolute Convergence- *definition*, *conditionally convergent*, The Ratio Test, The Root Test, Summary of Tests for Convergence and Divergence of Series, Rearrangement of Series 6.7 Power Series- *definition*, Interval of Convergence, *radius of convergence*, Differentiation and Integration of Power Series 6.7 Taylor and Maclaurin Series- *definition, Taylor and Maclaurin series of functions,* Techniques for Finding Taylor Series	

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c. Seminar Presentation: 4 Mark

d. Classroom participation based on attendance: 4 Mark

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Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1: Applications of Definite Integral	15
Module 2: The Transcendental Functions	26
Module 3: Infinite Sequences and Series	25
Module 4: Power Series and Taylor Series	14

***List of Practicals (using any software)**

- Obtaining surface of revolution of curves.
- Plotting of graphs of function
- $e^{ax+b}, log(ax+b), 1/(ax+b), sin(ax+b), cos(ax+b), |ax+b|$ and to illustrate the effect of a and b on the graph.
- Plotting of graphs of inverse trigonometric and hyperbolic functions.
- Plotting of recursive sequences.
- Study the convergence of sequences through plotting.

- Calculate the sum $1 + 1/2 + 1/3 + 1/4 + \ldots + 1/n$.
- Study the convergence/divergence of infinite series by plotting their sequences of the partial sum.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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*

SEMESTER 3

COURSE CODE: BMT3B03 **CORE COURSE III:** THEORY OF EQUATIONS AND NUMBER THEORY				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Explain*** the notion of synthetic division of polynomials.	Understand	PSO1
CO2	***Identify*** the limits of roots of an n^{th} degree polynomial.	Remember	PSO1 PSO5
CO3	***Solve*** polynomial equations.	Apply	PSO1 PSO5
CO4	***Analyze*** the sign of a polynomial for small and large values of variable.	Analyze	PSO5
CO5	***Determine*** results involving divisibility, greatest common divisor, least common multiple and a few applications	Evaluate	PSO3
CO6	***Analyze*** the theory of congruences and solve linear congruent equations	Analyze	PSO3
CO7	***Solve*** Linear Diophantine Equations.	Apply	PSO1 PSO3 PS06
CO8	***Solve*** congruences using Fermat's Theorem,	Apply	PSO3

	Wilson's Theorem and Euler's Theorem.		
CO9	***Differentiate*** the concepts of number theoretic functions- Euler's phi function, tau and sigma function	Analyze	PSO3

Text:1	Theory of Equations : J V Uspensky *McGraw Hill Book Company, Inc. (1948) ISBN:07-066735-7*
Text:2	Elementary Number Theory with Applications (2/e): Thomas Koshy, Elsever Academic Press(2007) ISBN:978-0-12-372487-8

COURSE CONTENT		
Module 1. Theory of Equations	**Text:1**	**20 Hours**

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

II.4. The remainder theorem

II.5. Synthetic Division

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

III.2. Identity theorem

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

III.4. Imaginary roots of equations with real coefficients

III.5. Relations between roots and coefficients Chapter IV

IV.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

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

V.2. Carden's formula

V.3. Discussion of solution

V.4. Irreducible case

VI.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.

Module 2. Division Algorithm	**Text:2**	**15 Hours**

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' omitted], pigeonhole principle and division algorithm, divisibility relation, illustration, divisibility properties, union intersection and complement-inclusion-exclusion principle & applications, even and odd integers.

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

(Theorem 3.1, Lemma 3, Theorem 3.3 and Theorem 3.3, corollary 3.8 excluded)		
Module 3. Congruences	**Text:2**	**18 Hours**
3.2. The Euclidean Algorithm- The Euclidean algorithm [algorithm 3.1, 'A jigsaw puzzle' 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) 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- Linear Diophantine Equations (upto example 3.19 & example 3.20 onwards omitted) 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- 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 4. Applications of Congruences	**Text:2**	**12 Hours**
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 $\mathbf{2}^{n}+\mathbf{1}$'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, generalization of Euler's theorem (koshy)
8.1.	Euler's Phi Function Revisited- multiplicative functions, fundamental theorem for multiplicative functions, formula for $\varphi(pe)$, [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]

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Attendance: 8 Mark

b. Seminar/Viva: 4 Mark

c. Assignment: 4 Mark

d. Internal Test: 4 Mark

External Assessment (80 Marks) Duration $2\frac{1}{2}$ Hours, No of Questions: 27

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Theory of equations	33
Module 2: Division Algorithm	21
Module 3: Congruences	28
Module 4: Applications of Congruences	28

*List of Practicals (using any software)

- Finding roots of quadratic polynomial.
- Writing programming code to find the gcd of two numbers using Euclidean

algorithm.

- Writing programming code to find the lcm of two numbers.
- Finding highest power of a prime dividing $n!$.
- Performing divisibility test.
- Checking compositeness of numbers using Fermat's Little Theorem.
- Finding Euler's phi function value of a number.
- Checking solvability of linear congruence.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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. David M. Burton: Elementary Number Theory(7/e) McGraw-Hill (2011) ISBN: 978-0-07-338314-9
6. Gareth A. Jones and J. Mary Jones: Elementary Number Theory, Springer Undergraduate Mathematics Series (1998) ISBN: 978-3-540-76197-6
7. Underwood Dudley: Elementary Number Theory(2/e), Dover Publications (2008) ISBN:978-0-486-46931-7
8. James K Strayer: Elementary Number Theory, Waveland Press, inc. (1994), ISBN:978-1-57766-224-2
9. Kenneth H. Rosen: Elementary Number Theory(6/e), Pearson Education (2018) ISBN: 9780134310053.

SEMESTER 4

COURSE CODE –BMT4B04 **CORE COURSE IV**: LINEAR ALGEBRA				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No.**
CO1	***Use*** computational techniques and algebraic skills essential for the study of systems of linear equations and matrix algebra.	Apply	PSO1
CO2	***Compute*** and use determinants	Apply	PSO1 PSO5
CO3	***Identify*** vector spaces and subspaces.	Analyze	PSO1 PSO5
CO4	***Recognize*** the concept of the terms span, linear independence, basis and dimension and apply these concepts to various vector spaces and subspaces	Remember	PSO5
CO5	***Analyze*** vectors in $\mathbb{R}^n$ geometrically and algebraically	Analyze	PSO3
CO6	***Determine*** the relationship among the solutions of a given system of linear equations and some important subspaces associated with the coefficient matrix of the system	Evaluate	PSO3

CO7	***Explain*** the notion of a linear transformation and its matrix.	Apply	PSO1 PSO3 PS06
CO8	***Find*** the eigen values and eigen vectors of a square matrix using the characteristic polynomial and ***determine*** whether a matrix is diagonalizable	Evaluate	PSO3

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

COURSE CONTENT	
Module 1. Systems of Linear Equations & Matrices	**17 Hours**

1.1. Introduction to Systems of Linear Equations- linear equation in variables, linear system of equations in 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.	
Module 2. General Vector Space	**14 Hours**
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. 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.	
Module 3. Change of Basis, Rank, Nullity	**20 Hours**
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. 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, Overdetermined and Underdetermined Systems.	
Module 4. Eigen values and Eigen Vectors	**14 Hours**
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. 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. 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.
7.1	Orthogonal Matrices- definition, characterization of orthogonal matrices, properties of orthogonal matrices [rest of the section omitted].

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Internal test 8 Mark
b. Assignment 4 Mark
c. Seminar/ Viva 4 Mark
d. Attendance 4 Mark

External Assessment (80 Marks): Duration: $2\frac{1}{2}$ Hours, *No. of Questions: 27*

MODULE WISE MARK DISTRIBUTION	**Marks**
Module 1. Systems of Linear Equations & Matrices	11
Module 2. General Vector space	26
Module 3. Change of Basis, Rank, Nullity	18

Module 4. Eigen values and Eigen Vectors	26
Total	**80**

***List of Practicals (using any software)**
• Matrix operation (addition, multiplication, inverse, transpose). • Reorganizing systems of linear equations into matrix form and solve. • Calculating the eigen values and eigen vectors of a matrix.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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*

SEMESTER 5

COURSE CODE –BMT5B05 CORE COURSE V: ABSTRACT ALGEBRA				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** the concept of binary operations by definition and examples.	Understand	PSO1, PSO2
CO2	***Understand*** the concept of algebraic structures.	Understand	PSO1, PSO2
CO3	***Learn*** different types of subgroups such as groups, rings, integral domains, fields and fields of quotient of integral domain.	Remember	PSO1, PSO3
CO4	The students will actively ***participate*** in the transition of important concepts such homomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.	Analyse	PSO5, PSO6

TEXT	JOHN B. FRALEIGH, A FIRST COURSE IN ABSTRACT ALGEBRA (7th Edn.), Pearson Education Inc., 2003.

COURSE CONTENT	
Module 1. Binary Operations and Groups	**20 Hours**
Binary Operations; Isomorphic binary structures; Groups; Subgroups (Sections 2, 3, 4 & 5)	
Module 2. Cyclic groups and Alternating Groups	**25 Hours**
Cyclic groups; Groups and permutations; Orbits, Cycles and Alternating Groups (Sections 6, 8 & 9)	
Module 3. Cosets and Homomorphisms	**5 Hours**
Cosets and Theorem of Lagrange; Homomorphisms (Sections 10 & 13)	
Module 4. Rings and Fields	**15 Hours**
Rings and Fields; Integral Domains, The Field of Quotients of an Integral Domain (Sections 18, 19 & 21)	

MODE OF TRANSACTION
Lecture method Problem solving method Questioning method.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)	
a. Classroom participation:	4 Mark
b. Test papers I:	8 Mark
c. Assignment:	4 Mark
d. Seminar:	4 Mark
External Assessment (80 Marks)	Duration $2\frac{1}{2}$ Hours, No of Questions: 27

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Binary Operations and Groups	30
Module 2: Cyclic groups and Alternating Groups	20
Module 3: Cosets and Homomorphisms	16
Module 4: Rings and Fields	14

REFERENCES:

1. Joseph A. Gallian: Contemporary Abstract Algebra(9/e) Cengage Learning, Boston(2017) ISBN: 978-1-305-65796-0
2. John B Fraleigh: A First Course in Abstract Algebra(7/e) Pearson Education LPE(2003) ISBN 978-81-7758-900-9

3. David Steven Dummit, Richard M. Foote: Abstract Algebra(3/e) Wiley, (2004) ISBN: 8126532289

4. Linda Gilbert and Jimmie Gilbert: Elements of Modern Algebra (8/e) Cengage Learning, Stamford(2015) ISBN: 1-285-46323-4

5. John R. Durbin: Modern Algebra: An Introduction(6/e) Wiley(2015) ISBN: 1118117611

6. 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

COURSE CODE –BMT5 B06 **CORE COURSE VI:** BASIC ANALYSIS				
Credit	Hours/week	Marks		
		Internal	External	Total
4	80	20	80	100

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Learn*** and deduce rigorously many properties of the real number system by assuming a few fundamental facts about it as axioms.	Understand	PSO1
CO2	***Learn*** about sequences, their limits, several basic and important theorems involving sequences and their applications.	Understand	PSO1
CO3	***Recognize*** bounded, convergent, divergent, Cauchy and monotonic sequences and calculate their limit superior, limit inferior, and the limit of a bounded sequence.	Analyze	PSO3
CO4	***Understand*** some basic topological properties of real numbers and complex number systems, such as the concept of open and closed sets, their properties, their characterization and so on	Understand	PSO1
CO5	***Represent*** complex numbers algebraically and geometrically and learn complex functions as mappings.	Understand	PSO1

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: Dennis Zill & Patric Shanahan *Jones and Bartlett Learning(2015) ISBN:0-7637-1437-2.*

COURSE CONTENT	
Module 1. The Real Numbers	**20 Hours**
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 2. Sequences of Real Numbers	**21 Hours**
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 3. Open and Closed sets in $\mathbb{R}$	**21 Hours**
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 $\mathbb{R}$ - neighbourhood, 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 4. Complex Numbers	**21 Hours**
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 nth 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.
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].
2.4.	Special Power functions- The power function Z^n, The power function $Z^{\frac{1}{n}}$, principal square root function, Inverse Functions, multiple valued functions.

MODE OF TRANSACTION
Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning. **Visual Aids**: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts. **Real-Life Applications**: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students. **Cooperative Learning**: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of

mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Internal test: 8 Mark
b. Assignments: 4 Mark
c. Class room Participation 4 Mark
d. Seminar Presentation: 4 Mark

External Assessment (80 Marks) Duration $2\frac{1}{2}$ Hours, No of Questions: 27

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: The Real Numbers	20
Module II: Sequences of Real Numbers	21
Module III: Open and Closed sets in $\mathbb{R}$	18
Module IV: Complex Numbers	21

***List of Practicals (using any software)**

- Plotting of recursive sequences.
- Study the convergence of sequences through plotting.
- Verify Bolzano-Weierstrass theorem through the plotting of sequences and hence identify convergent subsequences from the plot.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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)*

COURSE CODE –BMT5B07 **CORE COURSE VII**: NUMERICAL ANALYSIS				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Illustrate*** several methods such as bisection method, fixed point iteration method, regula falsi method etc. to find out the approximate numerical solutions of algebraic and transcendental equations with desired accuracy	Analyze	PSO4
CO2	***Explain*** the concept of interpolation and also learn some well-known interpolation techniques.	Understand	PSO4
CO3	***Develop*** a few techniques for numerical differentiation and integration and also realize their merits and demerits.	Create	PSO4
CO4	***Find out*** numerical approximations to solutions of initial value problems and also to understand the efficiency of various methods.	Apply	PSO4

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

COURSE CONTENT	
Module 1. Solutions of Equations in One Variable & Interpolation and Polynomial Approximation	**28 Hours**

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

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.

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

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 2. Numerical Differentiation and Integration	**18 Hours**

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 [Algorithms are omitted]	
Module 3. Initial-Value Problems for Ordinary Differential Equations Introduction	**18 Hours**
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]. [Algorithms are omitted]	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark

b. Test papers I: 6 Mark

c. Assignment: 3 Mark

d. Seminar/ Viva: 3 Mark

External Assessment (60 Marks) *D*uration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1: Solutions of Equations in One Variable & Interpolation and Polynomial Approximation	28
Module 2: Numerical Differentiation and Integration	16
Module 3: Initial-Value Problems for Ordinary Differential Equations Introduction	16

*List of Practicals (using any software)

- Bisection Method.
- Newton Raphson Method.
- Fixed-Point Iteration
- Secant Method.

- Regulai Falsi Method.
- Interpolating discrete data to continues data for data interpretation.
- Lagrange interpolation.
- Approximating definite integral by using Simpson's rule and Trapezoidal rule.
- Solving ODE by using Euler's and Runge-Kutta methods.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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

COURSE CODE –BMT5B08 CORE COURSE VIII: LINEAR PROGRAMMING				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Design*** real life situations as linear programming models.	Create	PSO2 PSO4 PSO5 PSO6
CO2	***Solve*** linear programming problems using graphical method, simplex method and dual simplex method.	Apply	PSO1 PSO4
CO3	***Develop*** and solve transportation and assignment problems using mathematical algorithms.	Create	PSO2 PSO4 PS05 PSO6

Text	**Linear Programming and Its Applications**: James K. Strayer Under graduate Texts in Mathematics Springer (1989) ISBN: 978-1-4612-6982-3

COURSE CONTENT	
Module 1. Geometric Linear Programming and The Simplex Algorithm	**15 Hours**
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. 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, The Simplex Algorithm for Maximum Tableaus, Negative Transposition; The Simplex Algorithm for Minimum Tableaus, Cycling, Simplex Algorithm Anti cycling Rules, Concluding Remarks.	
Module 2. Noncanonical Linear Programming Problems and Duality Theory	**14 Hours**
Noncanonical Linear Programming Problems: - Unconstrained Variables, Equations of Constraint, Concluding Remarks. 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 3. Transportation Problems and Assignment Problems	**10 Hours**
Transportation Problems: - The Balanced Transportation Problem, The Vogel Advanced-Start Method (VAM), The Transportation Algorithm, Another Example, Unbalanced Transportation Problems. Assignment Problems: - The Assignment Problem, The Hungarian Algorithm, Concluding Remarks, The Minimum-Entry Method, The Northwest-Corner Method.	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Internal test: 3 Mark
b. Attendance: 6 Mark
c. Assignment: 3 Mark
d. Seminar/ Viva: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1: Noncanonical Linear Programming Problems and Duality Theory	18
Module 2: Noncanonical Linear Programming Problems and Duality Theory	26
Module 3: Transportation Problems and Assignment Problems	16

*List of Practicals (using any software)
• Solving linear programming problems. • Solving transportation models.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

APPLICATIONS:

** The application part is beyond the part of the syllabus. Questions should not be asked from this part.

SOFTWARE: TORA

TORA Package is a computer application software package used for statistical computation and analysis. It is an already written program or suite of programs written for statistical application. It is basically applied for Operations Research (OR) analysis. TORA Optimization Window is a graphical user interface (GUI). This is what makes it unique from other statistical packages that have spreadsheets windows. TORA software offers modules for matrix inversion, solution of simultaneous linear equations, linear programming, transportation models, network models, project planning with CPM and PERT, queuing analysis, and game theory.

REFERENCES:

1. Robert J. Vanderbei: Linear Programming: 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-Hill Education, 2 Penn Plaza, New York(2015)ISBN: 978-0-07-352345-3*

3. Paul R. Thie, G. E. Keough : An Introduction to Linear Programming and 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, Springer Verlag, 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*

COURSE CODE –BMT5B09 CORE COURSE IX: Calculus of Multi Variable-1				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Explain*** the calculus of parametric equations	Understand	PSO3
CO2	***Understand*** differentiation and integration of vector valued functions	Understand	PSO1
CO3	***Understand*** multivariable functions and their representations.	Understand	PSO3
CO4	***Understand*** the idea of limit and continuity for functions of several variables.	Understand	PSO3
CO5	***Apply*** the notion of partial derivatives to evaluate directional derivatives.	Apply	PSO2
CO6	***Compute*** the length and area of surface of revolution of smooth curves.	Apply	PSO4
CO7	***Graph*** the polar equations	Apply	PSO4
CO8	***Determine*** the equations of a line, plane and surface in space.	Evaluate	PSO2

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

COURSE CONTENT	
Module 1. Calculus of Parametric and Polar Equations of a Plane Curve	**17 Hours**
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 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 2. Surfaces in Space	**12 Hours**
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 versa, The Spherical Coordinate System, converting spherical to rectangular and vice versa.	
Module 3. Calculus of Vector Valued functions and Space Curves	**15 Hours**
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.	

12.3.	Arc length and Curvature- Arc Length of a space curve, Smooth Curves, Arc Length Parameter, arc length function, Curvature, formula for finding curvature, Radius of Curvature. 12.4. Velocity and Acceleration- Velocity, Acceleration, and Speed; Motion of a Projectile. 12.5. Tangential and Normal Components of Acceleration- The Unit Normal, principal unit normal vector, Tangential and Normal Components of Acceleration [The subsections 'Kepler's Laws of Planetary Motion', and 'Derivation of Kepler's First Law' omitted]	
Module 4. Calculus of Functions of two variables		**20 Hours**
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 nonexistence 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 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 by [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 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.	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark
b. Test papers I: 6 Mark
c. Assignment: 3 Mark
d. Seminar: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: Calculus of Parametric and Polar Equations of a Plane Curve	26
Module II: Surfaces in Space	16
Module III: Calculus of Vector Valued functions and Space Curves	21
Module IV: Calculus of Functions of two variables	16

***List of Practicals (using any software)**

- Plotting area bounded by two graphs.
- Sketching parametric curves.
- Tracing of conics in Cartesian coordinates/ polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
- Evaluating limits by plotting of graphs of multi variable functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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

SEMESTER 6

COURSE CODE –BMT6 B10 CORE COURSE X: REAL ANALYSIS				
Credits	Hours/week	Marks		
		Internal	External	Total
4	80	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** and deduce rigorously many properties of the real number system by assuming a few fundamental facts about it as axioms. Learn the definition of continuous functions, apply sequential criteria for continuity, and understand several deep and fundamental results of continuous functions on intervals.	Understand	PSO1
CO2	***Realize*** the difference between continuity and uniform continuity and the equivalence of these ideas for functions on closed and bounded intervals their applications.	Analyse	PSO1
CO3	***Develop*** the notion of Riemann integrability of a function using the idea of tagged partitions and calculate the integral value of some functions using the definition.	Create	PSO1
CO4	***Formulate*** Cauchy criteria for integrability and a few applications of it. In particular, they learn	Create	PSO1

	to use Cauchy criteria in proving the non-integrability of certain functions.		
CO5	***Understand*** two forms of the fundamental theorem of calculus and their significance in the practical problem of evaluation of an integral.	Apply	PSO2
CO6	***Prove*** convergence and divergence of sequences of functions and series. Understand the difference between point-wise and uniform convergence of sequences and series of functions.	Create	PSO1
CO7	***Understand*** the notion of improper integrals, their convergence, principal value and evaluation.	Understand	PSO1
CO8	***Learn*** the properties of and relationship among two important improper integrals, namely beta and gamma functions that frequently appear in mathematics, statistics, science and engineering.	Apply	PSO2

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 & Manicavachagom Pillay: Calculus, Vol. II

COURSE CONTENT

Module 1. Continuity	**Text: 1**	**18 Hours**

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 2. Riemann Integral	**Text: 1**	**22 Hours**

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 3. Sequences and Series of Functions	Text: 1	17 Hours
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 4. Improper Riemann Integrals	**Text: 2 & 3**	**23 Hours**
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, Sections 2.1, 2.2, 2.3, 3, 4, 5 of text 3)		

MODE OF TRANSACTION

Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning.

Visual Aids: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts.

Real-Life Applications: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students.

Cooperative Learning: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 4 Mark

b. Test papers I: 8 Mark c. Assignment: 4 Mark d. Seminar Presentation: 4 Mark	
External Assessment (80 Marks) Duration $2\frac{1}{2}$ Hours, No of Questions: 27	

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Continuity	18
Module 2: Riemann Integral	22
Module 3: Sequences and Series of Functions	17
Module 4: Improper Riemann Integrals	23

***List of Practicals (using any software)**

- Find Riemann Integral by using Riemann sum.
- Plotting of recursive sequences of functions.
- Study the convergence of sequences of functions through plotting.
- Study the convergence/divergence of infinite series of functions by plotting their sequences of partial sum.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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)

COURSE CODE –BMT6 B11 CORE COURSE XI: COMPLEX ANALYSIS				
Credit	Hours/week	Marks		
		Internal	External	Total
5	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Distinguish*** the concepts of differentiability and analyticity of Complex functions.	Understand	PSO1
CO2	***Understand*** necessary and sufficient condition for checking analyticity	Understand	PSO1
CO3	***Relate*** harmonic functions and analytic functions	Analyze	PSO4
CO4	***Analyze*** elementary complex functions	Analyze	PSO4
CO5	***Understand*** complex integral, its properties and evaluation	Understand	PSO1
CO6	***Explain*** a few fundamental results on contour integration theory such as Cauchy's theorem, Cauchy-Goursat theorem and their applications	Understand	PSO1
CO7	***Apply*** Cauchy's integral formula and derive Liouville's theorem, Morera's theorem and power series expansion of an analytic function	Apply	PSO2
C08	***Apply*** Residue theorem to evaluate contour integrals	Apply	PSO2

TEXT	Complex Analysis A First Course with Applications: Dennis Zill & Patric Shanahan Jones and Bartlett Learning (2015) ISBN:0-7637-1437-2

COURSE CONTENT	
Module 1. Analytic Functions, Elementary Functions and Mappings	**21 Hours**
2.6. 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. 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, sufficient condition for differentiability, Cauchy Riemann equations in polar coordinates. 3.4. Harmonic Functions- definition, analyticity and harmonic nature, harmonic conjugate functions, finding harmonic conjugate. 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, 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 2. Integration in the Complex plane	**21 Hours**
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, Cauchy-Goursat theorem for simply connected domain (without proof), Multiply Connected Domains, principe of deformation of contours, Cauchy-Goursat theorem for multiply connected domains, 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 3. Series	**18 Hours**

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, Maclaurian series , illustrations.

6.3. Laurent’s Series- isolated singularities, Laurent’s Theorem [proof omitted], illustrations.

Module 4. Residues	**20 Hours**

6.4. Zeros and Poles- classification of isolated singular points, removable singularity, pole, essential singularity, order of zeros and poles.

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Classroom participation: 4 Mark
b. Test papers: 8 Mark
c. Assignment: 4 Mark
d. Seminar: 4 Mark

External Assessment (80 Marks) *Duration* $2\frac{1}{2}$ *Hours, No of Questions: 27*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: Analytic Functions, Elementary Functions and Mappings	22
Module II: Integration in the Complex plane	22
Module III: Series	18
Module IV: Residues	18

***List of Practicals (using any software)**

- Plotting of complex functions on the complex plane.
- Study the convergence of sequences of complex numbers through plotting.
- Study the convergence/divergence of infinite series of complex numbers by plotting their sequences of partial sum.
- Plotting the region of convergence of series.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

REFERENCES:

1. James Ward Brown, Ruel Vance Churchill: Complex variables and applications (8/e), McGrawHill 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

COURSE CODE –BMT6 B12 CORE COURSE XIII: CALCULUS OF MULTI VARIABLE-2				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** the geometrical interpretation of the gradient.	Understand	PSO3
CO2	***Understand*** how we use the gradient to get various local information about the function including tangent planes and normal lines.	Understand	PSO2
CO3	***Develop*** various techniques such as second derivative tests to find relative and extreme of multi variable functions.	Analyze	PSO3
CO4	***Develop*** Lagrange's multiplier methods to find absolute extreme of a multivariable function	Analyze	PSO2
CO5	**Define** the double integrals and triple integrals as a limit of Riemann sum and to see their interpretations as average value, volume under graphs, volume of a solid, area of a region, total mass from density	Remember and Apply	PSO3, PSO4 & PSO5
CO6	***Demonstrate*** the ability to think critically by setting up and solving application problems involving double and triple integrals.	Understand	PSO2&PSO3
CO7	***Learn*** iterated integrals and Fubini's theorem.	Understand	PSO1
CO8	***Evaluate*** the double integrals in polar	Evaluate	PSO3

	coordinates and triple integrals in cylindrical coordinates and spherical coordinates.		
CO9	***Understand*** the idea of vector fields, curl, divergence, their evaluation, path independence and conservative field.	Understand	PSO4&PSO6
CO10	**Study** the major theorems: Greens theorem, Divergence theorem and Stokes theorem.	Analyze	PSO6

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

COURSE CONTENT	
Module 1. Functions of several variables	**20 Hours**
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 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.	

Module 2. Multiple Integral	20 Hours

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

14.5: 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.

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 3. Vector Fields	20 Hours

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.t. 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, work done by conservative vector field, Independence of Path and Conservative Vector Fields, Determining Whether a Vector Field Is Conservative, test for conservative vector field Finding a Potential Function, Conservation of Energy

Module 4. Vector Analysis	20 Hours
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.	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning method**

MODE OF ASSESSMENT
Internal Assessment (20 Marks) a. Classroom participation: 4 Mark

b. Test papers I:	8 Mark
c. Assignment:	4 Mark
d. Seminar:	4 Mark
External Assessment (80 Marks)	*Duration* $2\frac{1}{2}$ *Hours, No of Questions: 27*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**2**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1:	20
Module 2:	20
Module 3:	20
Module 4:	20

***List of Practicals (using any software)**

- Plotting tangent planes and normal lines of a surface.
- Finding relative and absolute extrema by plotting of its graphs.
- Plotting volume of a solid between a surface and a rectangle.
- Sketching parametric curves.
- Tracing of conics in cartesian coordinates/ polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic,

paraboloid, hyperbolic paraboloid using cartesian coordinates.

• Evaluating limits by plotting of graphs of multi variable functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

REFERENCES:

1. Joel Hass, Christopher Heil & Maurice D Weir: Thoma's Calculus(14/e) Pearson (2018) ISBN: 013443898I
2. Robert A Adams & Christopher Essex: Calculus, A complete Course (8/e), Pearson Education Canada (2013) , ISBN: 032187742X
3. John Rogawski: Multi variable Calculus early Transcendentals (2/e) W.H. Freeman and Company 2012, ISBN: 1-4292-3187-4
4. Anton, Biven & Davis: Calculus early Transcendentals(10/e), John Wliey & Sons, Inc.(2012) ISBN: 978-0-470
5. James Stewart: Calculus (8/e), Brooks/Cole Cengage Learning (2016), ISBN: 978-1-285-74062-I

COURSE CODE –BMT6B13 CORE COURSE XIII: DIFFERENTIAL EQUATIONS				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Identify*** a number of areas where the modelling process results in a differential equation.	Remember	PSO3
CO2	***Discuss*** what an ODE is, what it means by its solution, how to classify DEs, what it means by an IVP and so on.	Understand	PSO1
CO3	***solve*** DEs that are in linear, separable and in exact forms and also to analyze the solution.	Apply	PSO4
CO4	***Distinguish*** between linear and non-linear DEs and conditions for occurrence of their solutions.	Understand	PSO2
CO5	***Illustrate*** the theory and method for solving a a first order IVP and second order linear homogeneous and nonhomogeneous equations with constant coefficients.	Analyze	PSO4
CO6	***Determine*** the Laplace Transform and Inverse Laplace Transform of a function.	Evaluate	PSO4
CO7	***Solve*** differential equations using Laplace method.	Apply	PSO4
CO8	***Explain*** periodic functions and their Fourier series expansion.	Apply	PSO4

CO9	***Solve*** partial differential equations using the method of separation of Variables.	Apply	PSO4

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.

COURSE CONTENT	
Pre-Requisites 1.1: Some Basic Mathematical Models; Direction Fields 1.2: Solutions of some Differential equations 1.3: Classification of Differential Equations	
Module 1. First-Order Differential Equations	**22 Hours**
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 2. Second-Order Differential Equations	**23 Hours**
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	
Module 3. Laplace Transform	**15 Hours**
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 4. Fourier Series	**20 Hours**
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	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning method**

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Classroom participation: 4 Mark

b. Test papers I: 8 Mark

c. Assignment: 4 Mark

d. Seminar: 4 Mark

External Assessment (80 Marks) *Duration* $2\frac{1}{2}$ *Hours, No of Questions: 27*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**15**	**15**	**1**	**25**
Paragraph	**8**	**8**	**5**	**35**
Essay	**4**	**2**	**10**	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1: First-Order Differential Equations	22
Module 2: Second-Order Differential Equations	24
Module 3: Laplace Transform	16
Module 4: Fourier Series	18

***List of Practicals (using any software)**

- Plotting the solutions of some famous model like Population model, Predatory-prey, Epidemic model of influenza models, etc.
- Plotting of first and second order solutions of ordinary differential equations.
- Plotting the solutions of heat and wave equations.

- Finding the Laplace transforms of some functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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 COURSE SYLLABUS

SEMESTER 6

COURSE CODE – BMT6E01 ELECTIVE COURSE I: GRAPH THEORY				
Credits	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** and apply the fundamental concepts in graph theory.	Understand	PSO1
CO2	***Apply*** graph theory-based tools in solving practical problems.	Apply	PSO2
CO3	***Develop*** the proof writing skills.	Create	PSO5
CO4	***Analyze*** properties of graphs.	Analyse	PSO4
CO5	***Understand*** trees and their properties.	Understand	PSO1
CO6	***Analyze*** Distinguish between Eulerian and Hamiltonian graphs.	Analyze	PSO4
CO7	***Analyze*** planar graphs.	Analyse	PSO4

TEXT	A First Look at Graph Theory: John Clark & Derek Allan Holton, Allied Publishers, First Indian Reprint 1995.

COURSE CONTENT	
Module 1. Basic Concepts of Graphs	**13 Hours**
1.1 Definition of a graph 1.2 Graphs as models 1.3 More definitions 1.4 Vertex degrees 1.5 Sub graphs 1.6 Paths and Cycles 1.7 Matrix representation of a graph [up to Theorem 1.6; proof of Theorem 1.5 is omitted]	
Module 2. Trees	**13 Hours**
2.1. Definitions and Simple Properties 2.2. Bridges [Proof of Theorem 2.6 and Theorem 2.9 are omitted] 2.3 Spanning Trees 2.6. Cut Vertices and Connectivity [Proof of Theorem 2.21omitted]	
Module 3. Planar Graphs	**13 Hours**
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 Theorem 5.1 omitted] 5.2. Euler's Formula [Proofs of Theorems 5.3 and Theorem 5.6 omitted]	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark
b. Test papers: 6 Mark
c. Assignment: 3 Mark
d. Seminar: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**16**
Essay	**2**	**1**	**10**	**24**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Basic Concepts of Graphs	20
Module 2: Trees	20
Module 3: Planar Graphs	20

*List of Practicals (using any software)
• Drawing of graphs using Techard. • Constructing spanning trees. • Find the number of spanning trees in a graph.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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: Graph Theory with Application to Engineering and Computer Science, PHI.

COURSE CODE –BMT6B14(E02) ELECTIVE COURSE II: TOPOLOGY OF METRIC SPACES				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

* Examination will be held at the end of sixth semester

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Define*** the notion of metric space and construct the topology by using the metric.	Remember	PSO1
CO2	***Explain*** the notion of distance, open/ closed balls, open/ closed sets, dense subsets and related concepts.	Understand	PSO1
CO3	***Express*** the concept of boundary points, convergence of sequences and Cauchy sequences.	Understand	PSO1
CO4	***Develop*** the concept of boundedness, uniform and pointwise convergence.	Analyze	PSO4
CO5	***Construct*** new examples of metric spaces with interesting topological properties.	Create	PSO4

TEXT	Metric Spaces: Mícheál Ó Searcóid Undergraduate Mathematics Series Springer-Verlag London Limited (2007) ISBN: 1-84628-369-8

COURSE CONTENT	
Module 1: Metrics, Distance and Boundary	**18 Hours**
Metrics 1.1. Metric Spaces 1.3. Metric Subspaces and Metric Super spaces 1.4. Isometries 1.6. Metrics on Products 1.7. Metrics and Norms on Linear Spaces- [example1.7.8 omitted] **Distance** 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 **Boundary** 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 2: Open, Closed and Dense subsets; Balls	**15 Hours**
Open, Closed and Dense subsets 4.1. Open and Closed Subsets 4.2. Dense Subsets 4.3. Topologies 4.4. Topologies on Subspaces and Superspaces 4.5. Topologies on Product Spaces	

Balls

5.1. Open and Closed Balls

5.2. Using Balls

Module 3: Convergence and Bounds	**15 Hours**

Convergence

6.1. Definition of Convergence for Sequences

6.2. Limits

6.4. Convergence in Subspaces and Super spaces

6.6. Convergence Criteria for Interior and Closure

6.7. Convergence of Subsequences

6.8. Cauchy Sequences

Bounds

7.1. Bounded Sets

7.4. Spaces of Bounded Functions

7.6. Convergence and Boundedness

7.7. Uniform and Pointwise Convergence

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Class Room Participation:	3 Mark
b. Assignment:	3 Mark
c. Test Paper 1:	6 Mark
d. Seminar:	3 Mark
External Assessment (60 Marks):	

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Metrics, Distance and Boundary	24
Module 2: Open, Closed and Dense subsets; Balls	18
Module 3: Convergence and Bounds	18

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. E.T.Copson: Metric Spaces Cambridge University Press(1968)ISBN:0 52135732 2
5. Irving Kaplansky: Set Theory and Metric Spaces Allyn and Bacon,Inc. Boston(1972)

6. S. Kumaresan: Topology of Metric Spaces Alpha Science International Ltd.(2005) ISBN: 1-84265-250-8

7. Wilson A Sutherland: Introduction to Metric and Topological Spaces(2/e) Oxford University Press (2009)ISBN:978-0-19-956308-1

8. 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

COURSE CODE –BMT6E03 ELECTIVE COURSE III: MATHEMATICAL PROGRAMMING WITH PYTHON AND LATEX				
Credit	Hours/week	Mark		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	Understand one of the most popular and robust general purpose programming language Python.	Understand	PSO1
CO2	Understand how scientific programming can be performed using Python.	Apply	PSO6
CO3	Learn different data types, keywords, packages and modules in Python.	Understand	PSO5
CO4	Visualize mathematics concepts and get the ability to demonstrate mathematical ideas through Graphics.	Analyse	PSO4
CO5	Understand Applications of Python Programming.	Apply	PSO6
CO6	Understand the basic commands to prepare an input file in LATEX.	Understand	PSO2
CO7	Able to change the type style of a document.	Understand	PSO2
CO8	Able to create commands and environments for specific purposes.	Create	PSO6
CO9	The students will be able to typeset documents which involve accents of foreign languages, mathematical symbols, long tables pictures etc	Create	PSO6

	according to international standards.		

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

COURSE CONTENT	
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 1. Basics of Python Programming	**15 Hours**
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, elif and else, Modify loops : break and continue, Line joining, Functions, Scope of variables, Optional and Named Arguments, More onStrings 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	
Module 2. Applications of Python Programming	**20 Hours**
Turtle Graphics: Arrays and Matrices: The NumPy Module, Vectorized Functions. (sec. 2.1 to 2.19, 3.1 to	

3.2)

Data visualization: The Matplotlib Module, plotting mathematical functions, Famous Curves, Power Series, Fourier Series, 2D plot using colors, Meshgrids, 3D Plots, Mayavi, 3D visualization. (sec. 4.1 to 4.6, 4.8 to 4.10)

Module 3. Latex	**15 Hours**

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

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 3D curves
8. Plot 3D surfaces

Part B: LATEX

1. General documentation
2. Tables
3. Writing equations

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method** **Practical Method**

MODE OF ASSESSMENT				
Internal Assessment (15 Marks) a. Class Room Participation: 3 Mark b. Assignment: 3 Mark c. Test Paper 1: 6 Mark d. Seminar: 3 Mark				
External Assessment (75 Marks): ***Duration: 2 Hours,*** **No. Of Questions:** ***21***				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Marks for each question**	**Ceiling of Marks**
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1: Basics of Python Programming	30
Module 2: Applications of Python Programming	14
Module 3: Latex	16

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, Stefan van der 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 modelling. Princeton University Press, 2018.
5. McGreggor, Duncan: Mastering matplotlib. Packt Publishing Ltd, 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

COURSE CODE –BMT6E04 ELECTIVE COURSE IV: INTRODUCTION TO GEOMETRY				
Credit	Hours/week	Mark		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No.
CO1	***Understand*** the basic facts about conics.	Understand	PSO 1
CO2	***Understand*** the concept of geometry and transformations, affine transformations and their properties.	Understand	PSO 1
CO3	***Understand*** the basis results of the projective geometry.	Understand	PSO 1

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

COURSE CONTENT	
Module 1. Conics	**10 Hours**

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.t. 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 2. Affine Geometry	**20 Hours**
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 [subsection "2.4.4. Barycentric Coordinates" omitted]. 2.5: Affine Transformations and Conics-Classifying Non-Degenerate Conics in Affine Geometry, A few affine properties, Applying Affine Geometry to Conics.	
Module 3. Projective Geometry: Lines	**18 Hours**
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].

3.5. Cross-Ratio-Another Projective Property, properties of cross ratio, Unique Fourth Point Theorem, Pappus' Theorem, Cross-Ratio on Embedding Planes, An Application of Cross-Ratio.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Class Room Participation: 3 Mark

b. Assignment: 3 Mark

c. Test Paper 1: 6 Mark

d. Seminar:	3 Mark
External Assessment (60 Marks):	***Duration: 2 Hours,* No. of Questions: 21**

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Projective Geometry: Lines	13
Module 2: Affine Geometry	25
Module 3: Projective Geometry: Lines	22

***List of Practicals (using any software)**

- Sketching parabola, ellipse, hyperbola and rectangular hyperbola using Cartesian coordinates.
- Tracing of conics in Cartesian coordinates/ Polar coordinates.
- Plotting tangent planes.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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. J Ryan: Euclidean and Non Euclidean Geometry-An Analytic Approach Cambridge University Press, International Student Edition (2009) ISBN:978-0-5 21-12707-3
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

OPEN COURSE SYLLABUS

SEMESTER 5

COURSE CODE – BMT5D01 **OPEN COURSE 1**: APPLIED CALCULUS				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Identify*** the independent and dependent variables of a function and compute its domain and range.	Analyze	PSO3
CO2	***Evaluate*** functions given by formulas at given points.	Evaluate	PSO3
CO3	***Plot*** the graphs of straight lines and conics.	Create	PSO1
CO4	***Compute*** limits.	Evaluate	PSO1
CO5	***Check*** continuity.	Evaluate	PSO1
CO6	***Compute*** derivatives and write down the equation of the tangent line.	Evaluate	PSO5
CO7	***Determine*** whether the function is increasing or decreasing using derivatives.	Analyse	PSO6

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

COURSE CONTENT	
Module 1. Limits and Derivatives	**16 Hours**
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 **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]	
Module 2. Applications of Derivative	**18 Hours**
2.5. Marginal Analysis and Applications using increments 2.6. Implicit Differentiation and Related Rates **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	
Module 3. Integration	**14 Hours**
Integration 5.1. Antidifferentiation: 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]	

MODE OF TRANSACTION

Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning.

Visual Aids: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts.

Real-Life Applications: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students.

Cooperative Learning: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Classroom participation:	3 Mark
b. Test papers I:	6 Mark
c. Assignment:	3 Mark
d. Seminar:	3 Mark
External Assessment (60 Marks)	*Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Limits and Derivatives	20
Module II: Applications of Derivative	22
Module III: Integration	18

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

COURSE CODE –BMT5D02 OPEN COURSE 2: DISCRETE MATHEMATICS FOR BASIC AND APPLIED SCIENCES				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Identify*** correct and incorrect arguments.	Analyze	PSO4
CO2	***Understand*** the criteria for the evaluation of arguments.	Understand	PSO1
CO3	***Understand*** the scientific way of decision making using the laws of logic.	Understand	PSO3
CO4	***Understand*** the concept of algebraic structures in Mathematics.	Understand	PSO3
CO5	***Identify*** a given algebraic structure as belonging to a particular family of structures and to state the characteristic properties of the members of the family.	Analyze	PSO5
CO6	***Understand*** the concept of groups and derive basic theorems on groups.	Understand	PSO3
CO7	***Define*** the concept of Boolean algebra as an algebraic structure and list its properties.	Remember	PSO1
C08	***Understand*** the applications of Boolean algebra in switching circuits.	Understand	PSO5
C09	***Define*** a Graph and identify different classes of graphs.	Remember	PSO3
C010	***Understand*** various applications of Graph theory.	Understand	PSO5

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)

COURSE CONTENT	
Module 1. Logic	**14 Hours**

Logic

1.1. Propositions and Truth Values
1.2. Logical Connectives and Truth Tables- Disjunction, Conditional Propositions, Bi conditional Propositions
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)

Module 2. Algebraic Structures and Boolean Algebra	**18 Hours**

Algebraic Structures

8.1. Binary Operations and Their Properties
8.2. Algebraic Structures- Semigroups
8.3. More about Groups
8.4. Some Families of Groups- Cyclic Groups, Dihedral Groups, Groups of Permutations
8.5. Substructures
8.6. Morphisms

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	
Module 3. Graph Theory and Applications of Graph Theory	**16 Hours**
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 Graph **Applications of Graph Theory** 12.2. Rooted Trees 12.3. Sorting 12.4. Searching Strategies	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning method**

MODE OF ASSESSMENT
Internal Assessment (15 Marks) a. Classroom participation: 3 Mark b. Test papers: 6 Mark c. Assignment: 3 Mark d. Seminar 3 Mark

External Assessment (60 Marks) *Duration: 2 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Marks for each question**	**Ceiling of Marks**
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: Logic	18
Module II: Algebraic Structures and Boolean Algebra	23
Module III: Graph Theory and Applications of Graph Theory	19

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 Mathematics for Computer Science Thomson Brooks/Cole (2006)ISBN:0-534-49601-x
3. DPAcharjya, 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 Computer Science A Problem-Solving Primer Springer-Verlag London (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-

COURSE CODE – BMT5D03 OPEN COURSE 3: LINEAR MATHEMATICAL MODELS				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Compare*** Echelon Method and Gauss Jordan method to solve linear systems	Evaluate	PSO1
CO2	***Explain*** matrix operations and compute the inverse of a matrix.	Apply	PSO1
CO3	***Solve*** linear programming problems geometrically.	Apply	PSO1 PSO4
CO4	***Determine*** drawbacks of geometric methods and to solve LP problems more effectively using Simplex method.	Evaluate	PSO1 PSO5
CO5	***Construct*** real life problems as linear models and solve them.	Create	PSO2 PSO5 PSO6

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

COURSE CONTENT	
Module 1. Linear Functions, Systems of Linear Equations and Matrices	**16 Hours**
1.1. Slopes and Equations of Lines 1.2. Linear Functions and Applications 1.3. The Least Squares Line 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	
Module 2. Linear Programming: The Graphical Method	**10 Hours**
3.1. Graphing Linear Inequalities 3.2. Solving Linear Programming Problems Graphically 3.3. Applications of Linear Programming	
Module 3. Linear Programming: The Simplex Method	**13 Hours**
4.1. Slack Variables and the Pivot 4.2. Maximization Problems 4.3. Minimization Problems; Duality	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Classroom participation:	3 Mark
b. Test papers I:	6 Mark
c. Assignment:	3 Mark
d. Seminar:	3 Mark
External Assessment (60 Marks)	*Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Linear Functions, Systems of Linear Equations and Matrices	18
Module II: Linear Programming: The Graphical Method	16
Module III: Linear Programming: The Simplex Method	26

*List of Practicals (using any software)
• Solving linear programming problems.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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. Michael Sullivan: Finite Mathematics An Applied Approach(11/e) *John Wiley & Sons, Inc (2011) ISBN: 978-0470-45827-3*
5. Howard L. Rolf: Finite Mathematics *Enhanced Edition*(7/e) *Brooks/Cole, Cengage Learning (2011) ISBN:978-0-538-49732-9*
6. Seymour Lipschutz, John J. Schiller, R. Alu Srinivasan: Beginning Finite Mathematics *Schaum's Outline Series, McGraw-Hill (2005)*

COURSE CODE – BMT5D04 OPEN COURSE 3: MATHEMATICS FOR DECISION MAKING				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	Classify data and analyse various data collection techniques.	Analyse	PSO1 PSO4 PSO5
CO2	Compare various types of data with the use of frequency charts and appropriate graphs.	Evaluate	PSO1 PSO5
CO3	Explain concepts like measures of central tendency, measures of variation and measures of position.	Understand	PSO1
CO4	Describe basic probability concepts, conditional probability, addition rule and other basic theories in probability.	Remember	PSO1
CO5	Analyse various probability distributions of discrete and continuous variables.	Analyse	PSO1 PSO6
CO6	Examine the normal distribution, which is an important continuous probability distribution in inferential statistics.	Apply	PSO1 PSO5 PSO6

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

COURSE CONTENT	
Module 1. Introduction to Statistics and Descriptive Statistics	**14 Hours**
Introduction to Statistics 1.1. An Overview of Statistics 1.2. Data Classification 1.3. Data Collection and Experimental Design **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	
Module 2. Probability	**12 Hours**
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	
Module 3. Discrete Probability Distribution and Normal Probability Distribution	**22 Hours**
Discrete Probability Distribution 4.1. Probability Distributions 4.2 Binomial Distributions 4.3. More Discrete Probability Distributions 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	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

e. Classroom participation: 3 Mark

f. Test papers I: 6 Mark

g. Assignment: 3 Mark

h. Seminar: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: Introduction to Statistics and Descriptive Statistics	18
Module II: Probability	26
Module III: Discrete Probability Distribution and Normal Probability Distribution	16

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 COURSE SYLLABUS

SEMESTER 1

COURSE CODE –BMT1C01 COMPLEMENTARY COURSE I: Mathematics 1				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Discuss*** The fundamental ideas of limit, continuity, and differentiability.	Understand	PSO1 PSO2 PSO3
CO2	***Apply*** Increasing and decreasing functions, local maxima, minima, concavity, inflection points and drawing graphs using these ideas.	Apply	PSO2 PSO3 PSO4
CO3	***Utilize*** Find the solution of maximum-minimum problems using the idea of derivatives	Analyse	PS02 PSO3 PSO5
CO4	***Utilize*** The Mean Value Theorem for derivatives and L'Hospital rule.	Analyse	PS02 PSO3 PSO6
CO5	***Make use of*** Applications of definite integrals (arc length, area, volume and area of surface of revolution).	Apply	PS02 PSO3 PSO4

TEXT	George B. Thomas Jr. and Ross L. Finney: Calculus, LPE, Ninth edition, Pearson Education.

COURSE CONTENT	
Module 1. Limits and Continuity	**7 Hours**
Rates of change and limits, Rules for finding limits, Extensions of the limit concepts, Continuity, Tangent Lines (Sections 1.1 (from limits of function values onwards), 1.2, 1.4 (omit precise definitions of one-sided limits onwards), 1.5, 1.6)	
Module 2. Derivatives	**9 Hours**
Derivative of a function, Differentiation Rules, Rates of change, The Chain Rule, Implicit Differentiation and rational exponents (Section 2.1, 2.2, 2.3, 2.5, 2.6)	
Module 3. Application of Derivatives and L'Hopital's Rule	**19 Hours**
Application of derivatives: Related rates of change, Extreme values of a function. The mean value theorem, First derivative test, Graphing with y' and y". Limits as $x \to \pm\infty$. Asymptotes and Dominant Terms. L'Hopital's Rule. (Section 2.7, 3.1, 3.2, 3.3, 3.4, 3.5 and see section 6.6)	
Module 4. Integration and its Applications	**17 Hours**
Integration: Properties of definite integrals, areas and the Mean value theorem. The Fundamental theorem. (Section 4.6, 4.7). Application of Integrals: Areas between curves, Finding Volumes by slicing, Volumes of Solids of Revolution (Disk method only), Lengths of plane curves. Areas of surfaces of revolution. (Section 5.1, 5.2, 5.3, 5.5, 5.6)	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark
b. Test papers I: 6 Mark
c. Assignment: 3 Mark
d. Seminar: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1. Limits and Continuity	8

Module 2. Derivatives	10
Module 3. Application of Derivatives and L'Hopital's Rule	22
Module 4. Integration and its Applications	20

***List of Practicals (using any software)**

- Plotting graph of functions.
- Evaluating limits by plotting of its graphs.
- Finding relative and absolute extrema by plotting of its graphs.
- Finding area under a curve and verifying definite integral of a positive function and area under its graph are same.

  Obtaining surface of revolution of curves.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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*
7. Murray R. Spiegel, Advanced Calculus, Schaum's Outline Series.
8. Jerrold Marsden & Alan Weinstein: Calculus I (2/e) Springer-Verlag New York Inc (1985) ISBN 0-387-90974-5
9. Jerrold Marsden & Alan Weinstein: Calculus II (2/e) Springer-Verlag New York Inc (1985) ISBN 0-387-90975-3

SEMESTER 2

COURSE CODE – BMT2C02 COMPLEMENTARY COURSE II: Mathematics 2				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Discuss*** Find the derivatives and anti-derivatives of hyperbolic and inverse hyperbolic functions	Evaluate	PSO1 PSO2 PSO3
CO2	***Apply*** Represent points in polar coordinates, their graphing and Find the area and arc length of polar curves.	Analyse	PSO1 PSO2 PSO3
CO3	***Make use of*** Find the rank and inverse of a matrix using elementary row transformations.	Evaluate	PSO1 PSO2 PSO4
CO4	***Solve*** a system of linear equations using matrix theory.	Understand	PSO1 PSO3 PSO4
C05	***Utilize*** Find the characteristic roots values and the corresponding characteristic vectors of a matrix	Evaluate	PSO1 PSO2
C06	***Judge*** Verify Cayley Hamilton Theorem and understand its applications	Apply	PSO2 PSO3

C07	***Determine*** Find the limit of sequences, convergence and divergence of series.	Analyse	PSO1 PSO2 PSO3
C08	***Apply*** Represent a function as Power Series, Taylor Series and Maclaurin Series	Understand	PSO2 PSO3

TEXT 1	George B Thomas, Jr and Ross L Finney: CALCULUS, LPE, Ninth edition, Pearson Education.
TEXT 2	Frank Ayres JR: Matrices, Schaum's Outline Series, TMH Edition.

COURSE CONTENT		
Module 1. Hyperbolic Functions and Polar coordinates	**TEXT 1**	**16 Hours**
Hyperbolic Functions- Definitions and Identities, Derivatives and Integrals, Inverse Hyperbolic Functions, Derivatives and Integrals. Polar coordinates, Graphing in Polar Coordinates, Polar equations for conic sections, Integration in Polar coordinates. (Section 6.10, 9.6, 9.7, 9.8, 9.9 of the Text 1)		
Module 2. Matrices	**TEXT 2**	**14 Hours**
Rank of a Matrix, Non-Singular and Singular matrices, Elementary Transformations, Inverse of an elementary Transformations, Row Canonical form, Normal form. Systems of Linear equations: Homogeneous and Non-Homogeneous Equations, Characteristic equation of a matrix; Characteristic roots and characteristic vectors. Cayley Hamilton Theorem (statement only) and simple applications (relevant sections of Text 2).		
Module 3. Sequences	**TEXT 1**	**5 Hours**
Limit of Sequences of Numbers, Theorems for calculating limits of sequences (Excluding Picard's Method) (Sections 8.1, 8.2 of Text 1)		

Module 4. Infinite Series	TEXT 1	17 Hours
Infinite series, The ratio and root test for series of nonnegative terms, Power Series, Taylor and Maclaurin Series. (Sections 8.3, 8.6, 8.8, 8.9 of the Text 1)		

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT				
Internal Assessment (15 Marks) a. Classroom participation: 3 Mark b. Test papers I: 6 Mark c. Assignment: 3 Mark d. Seminar: 3 Mark				
External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of**	**No. of questions to be**	**Marks for each**	**Ceiling of**

	questions	answered	question	Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1: Hyperbolic Functions and Polar coordinates	18
Module 2: Matrices	16
Module 3: Sequences	6
Module 4: Infinite Series	20

***List of Practicals (using any software)**

- Plotting of graphs of hyperbolic functions.
- Matrix operation (addition, multiplication, inverse, transpose).
- Reorganizing systems of linear equations into matrix form and solve.
- Calculating the eigen values and eigen vectors of a matrix.
- Plotting of recursive sequences.
- Study the convergence of sequences through plotting.
- Calculate the sum $1 + 1/2 + 1/3 + 1/4 + \ldots + 1/n$.

  Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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*

SEMESTER 3

COURSE CODE –BMT3C03 COMPLEMENTARY COURSE III: Mathematics 3				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** Find the derivatives and anti-derivatives of hyperbolic and inverse hyperbolic functions	Understand	PSO1
CO2	***Compute*** Find limits, continuity and differentiability of functions of several variables.	Apply	PSO6
CO3	***Explain*** Work on the idea of limit, continuity, and derivative of vector-valued functions.	Understand	PS01
CO4	***Understand*** the concept of gradient and directional derivative and their geometrical interpretation	Understand	PS01
CO5	***Make use of*** Find the rank and inverse of a matrix using elementary row transformations.	Apply	PS06
C06	***Utilize*** Find the characteristic roots values and the corresponding characteristic vectors of a matrix	Analyse	PS04
C07	***Analyse*** Perform basic mathematical operations with complex numbers in cartesian	Analyse	PS04

	and polar forms.		
C08	***Determine*** continuity, differentiability, analyticity of a complex function.	Evaluate	PS04
C09	***Compare*** Relate harmonic functions and analytic functions.	Analyse	PS04

TEXT 1	George B Thomas, Jr and Ross L Finney: CALCULUS, LPE, Ninth edition, Pearson Education.
TEXT 2	Erwin Kreyszig: Advanced Engineering Mathematics, Eighth Edition, Wiley, India.

COURSE CONTENT		
Module 1. Numerical Integration and Functions of Several Variables	**TEXT 1**	**12 Hours**
Numerical Integration: Trapezoidal Rule, Simpson's Rule. (Section 4.9 of Text 1). Functions of Several Variables, Limits and Continuity, Partial Derivatives, differentiability, Chain rule (Sections 12.1, 12.2, 12.3, 12.4, 12.5 of the Text 1))		
Module 2. Vector Differential Calculus	**TEXT 2**	**14 Hours**
A quick Review of vector algebra, Inner product and vector product in $\mathbb{R}^2$ and $\mathbb{R}^3$. Vector and scalar functions and Fields, Derivatives, Curves, Tangents, Arc Length, Gradient of a scalar field; Directional Derivative, Divergence of a vector field, Curl of a Vector Field. (Sections 8.1, 8.2, 8.3, 8.4, 8.5, 8.9, 8.10, 8.11 of Text (2)).		
Module 3. Vector Integral Calculus	**TEXT 2**	**14 Hours**

Line Integrals, Independence of path, Green's Theorem in the Plane (without proof), surfaces for Surface Integrals, Surface Integrals, Triple Integrals, Divergence theorem of Gauss and Stoke's theorem (without proofs). (Sections 9.1, 9.2, 9.4, 9.5, 9.6, 9.7, 9.9, 9.10 of Text (2))		
Module 4. Complex Analysis	**TEXT 2**	**12 Hours**
A Quick Review: Complex Numbers, Complex Plane, Polar Form of Complex Numbers, Powers and Roots. Derivatives, Analytic functions, Cauchy-Riemann Equations, Laplace's Equation (All proofs omitted) (Section 12.1, 12.2, 12.3, 12.4, 13.1, 13.2, 13.3, 13.4 (statements only) of the Text (2))		

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark
b. Test papers I: 6 Mark
c. Assignment: 3 Mark

d. Seminar:	3 Mark
External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*	

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Numerical Integration and Functions of Several Variables	14
Module 2: Vector Differential Calculus	16
Module 3: Vector Integral Calculus	16
Module 4: Complex Analysis	14

***List of Practicals (using any software)**

- Approximating definite integral by using Simpson's rule and Trapezoidal rule.
- Evaluating limits by plotting of graphs of multi variable functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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

SEMESTER 4

COURSE CODE – BMT4C04 **COMPLEMENTARY COURSE IV**: Complementary Course - 4				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Learn*** the major classifications of differential equations.	Understand	PSO1
CO2	***Learn*** the conditions for the existence of solution of first and second order initial value problems.	Understand	PSO1
CO3	***Learn*** to solve the first order differential equations that are of linear, separable, exact, and Bernoulli's forms. .	Understand	PSO1
CO4	***Find*** the orthogonal trajectories of family of curves.	Analyse	PSO4
CO5	***Familiar*** with the theory and method of solving second order linear homogeneous and non-homogeneous equations with constant coefficients.	Analyse	PSO4
CO6	***Learn*** the method of reduction of order to find a second solution of linear second order equation by reducing to linear first order equation.	Apply	PSO2
CO7	***Learn*** the method of solution of Euler Cauchy	Understand	PSO1

	equations.		
CO8	***Determine*** the Laplace Transform and inverse Laplace Transform of a function.	Apply	PSO2
CO9	***Learn*** the linearity and shifting theorems	Understand	PSO1
CO10	***Acquire*** the knowledge of solving a differential equation using the Laplace method.	Evaluate	PSO4
CO11	***Understand*** periodic functions and their Fourier series expansion	Understand	PSO1
CO12	***Learn*** the basic concepts of partial differential equations	Understand	PSO1

TEXT	Erwin Kreyszig: Advanced Engineering Mathematics, Eighth Edition, Wiley, India

COURSE CONTENT	
Module 1. Ordinary Differential Equations	**18 Hours**
Basic concepts and ideas, Geometrical meaning of y' = f (x, y), Direction Fields, Separable Differential Equations. Exact Differential Equations; Integrating Factors, Linear Differential Equations; Bernoulli Equation, Orthogonal Trajectories of Curves. (Sections 1.1, 1.2, 1.3, 1.5, 1.6, 1.8)	
Module 2. Linear Differential equations of Second and Higher order	**20 Hours**
Linear Differential equations of Second and Higher order: Differential Operators, Euler-Cauchy Equation, Wronskian, Nonhomogeneous Equations, Solutions by Undetermined Coefficients, Solution by variation of Parameters. (Sections 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10).	
Module 3. Laplace Transforms	**22 Hours**
Laplace Transforms: Laplace Transform, Inverse Transform, Linearity, Shifting,	

Transforms of Derivatives of Integrals, Differential Equations. Unit step Function, Second Shifting Theorem, Dirac Delta Function, Differentiation and integration of Transforms, Convolution, Integral Equations, Partial Fractions, Differential Equations. (Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6).	
Module 4. Fourier Series and Partial differential Equations	**16 Hours**
Fourier Series: Periodic Functions, Trigonometric Series, Fourier Series, Even and Odd functions, Half-range Expansions. (Sections 10.1, 10.2, 10.4 – Excluding Proofs) Partial differential Equations: Basic Concepts. (Sections 11.1).	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Classroom participation:	3 Mark
b. Test papers I:	6 Mark
c. Assignment:	3 Mark

d. Seminar: 3 Mark
External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Ordinary Differential Equations	14
Module 2: Linear Differential equations of Second and Higher order	16
Module 3: Laplace Transforms	17
Module 4: Fourier Series and Partial differential Equations	13

***List of Practicals (using any software)**

- Plotting of first and second order solutions of ordinary differential equations.
- Finding the Laplace transforms of some functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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

SEMESTER 1

COURSE CODE – BMT1C01 (CS) **COMPLEMENTARY COURSE V**: Mathematics 1				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Discuss*** relations on a set, various types of relations, equivalence relation.	Understand	PSO1
CO2	***Discuss*** the basic concepts in set theory.	Understand	PSO1
CO3	***Discuss*** the cartesian product- definition and examples	Understand	PSO1
CO4	***Understand*** the concept of equivalence classes and partitions of a set.	Understand	PSO1
CO5	***Explain*** the negation of a statement, statements with quantifiers and its negation.	Apply	PSO2
CO6	***Analyse*** Increasing and decreasing functions, local maxima, minima, concavity, inflection points and drawing graphs using these ideas.	Analyse	PSO4
CO7	***Determine*** To find the solution of maximum-minimum problems using the idea of derivatives.	Evaluate	PS04

TEXT 1	S. Lipschutz: Set Theory and related topics (Second Edition), Schaum Outline Series, Tata McGraw-Hill Publishing Company, New Delhi.
TEXT 2	George B. Thomas Jr. and Ross L. Finney: Pearson Education
TEXT 3	Discrete Mathematics and its Applications: Press (2004)

COURSE CONTENT		
Module 1. Set theory and Relations	**TEXT 1**	**11 Hours**
Set theory: Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and the counting principle. Empty set, properties of empty set, set operations, Difference and Symmetric difference, Algebra of sets, Duality, Classes of sets, Power sets. (Sections 1.6, 1.7 & 1.9 of Text (1)). Relations: Product set, Relations (Directed graph of relations on set is omitted). Composition of relations, Types of relations, Partitions, Equivalence relations with examples. (Chapter 3 of Text 1 excluding 3.7).		
Module 2. Logics	**TEXT 3**	**7 Hours**
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] Logical equivalences- laws of logic [Equivalent Switching Networks 'Fuzzy logic& Fuzzy decisions' omitted] Quantifiers- universal & existential, predicate logic. (As in sections 1.1, 1.2 & 1.3 of Text 3).		
Module 3. Limits and Continuity and Derivatives	**TEXT 2**	**16 Hours**

Limits and Continuity: Rates of change and limits, Rules for finding limits, Extensions of the limit concepts, Continuity, Tangent Lines (Sections 1.1 (from limits of function values onwards), 1.2, 1.4 (omit precise definitions of one-sided limits onwards), 1.5, 1.6 of Text (2)) Derivatives: Derivative of a function, Differentiation Rules, Rates of change, The Chain Rule, Implicit Differentiation and rational exponents. (Section 2.1, 2.2, 2.3, 2.5, 2.6 of Text 2)		
Module 4. Application of Derivatives and L'Hopital's Rule	**TEXT 2**	**18 Hours**
Application of derivatives: Related rates of change, Extreme values of a function. The mean value theorem, First derivative test, Graphing with y' and y". Limits as $x \to \pm\infty$. Asymptotes and Dominant Terms, L'Hopital's Rule. (Section 2.7, 3.1, 3.2, 3.3, 3.4, 3.5 and see section 6.6 of Text 2).		

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning**: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Class Room Participation	3 Mark
b. Assignment	3 Mark
c. Seminar	3 Mark
d. Test Paper	6 Mark

External Assessment (60 Marks): *Duration 2 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Marks for each question**	**Ceiling of Marks**
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	**Marks**
Module 1: Set theory and Relations	12
Module 2: Logics	8
Module 3: Limits and Continuity and Derivatives	17
Module 4: Application of Derivatives and L'Hopital's Rule	15

***List of Practicals (using any software)**

- Plotting graph of functions.
- Evaluating limits by plotting of its graphs.
- Finding relative and absolute extrema by plotting of its graphs.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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. Steven R Lay, Analysis with an introduction to proof, 5th edition, Pearson, 2014
5. Ajith Kumar et al, A foundation course in Mathematics, Narosa, India, 2018
6. Kenneth H Rosen, Discrete Mathematics and it's Applications, 6th edition, Tata Mc Grawhill

SEMESTER 2

COURSE CODE –BMT2C02(CS) COMPLEMENTARY COURSE VI: Mathematics 2				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Discuss*** Mean value Theorem for integrals and Fundamental Theorem of Calculus	Understand	PSO1
CO2	***Represent*** points in polar coordinates and their graphing.	Understand	PSO1
CO3	***Represent*** a function as Power Series, Taylor Series and Maclaurin Series.	Understand	PSO1
CO4	***Utilize*** Find the derivatives and anti-derivatives of hyperbolic and inverse hyperbolic functions.	Analyse	PSO4
CO5	***Utilize*** Find the area and arc length of polar curves.	Analyse	PSO4
CO6	***Make use of*** Find the limit of sequences, convergence and divergence of series.	Apply	PSO6

TEXT	George B Thomas, Jr and Ross L Finney: CALCULUS, LPE, Ninth edition, Pearson Education.

COURSE CONTENT	
Module 1. Integration	**16 Hours**
Integration Properties of definite integrals, areas and the Mean value theorem. The Fundamental theorem (Omit Proof) (Section 4.6, 4.7). **Application of Integrals** Application of Integrals: Areas between curves, Finding Volumes by slicing, Volumes of Solids of Revolution (Disk method only), Lengths of plane curves. Areas of surfaces of revolution. (Section 5.1, 5.2, 5.3, 5.5, 5.6)	
Module 2. Hyperbolic Functions and Polar coordinates	**14 Hours**
Hyperbolic Functions- Definitions and Identities, Derivatives and Integrals, Inverse Hyperbolic Functions, Derivatives and Integrals. Polar coordinates, Graphing in Polar Coordinates, Polar equations for conic sections, Integration in Polar coordinates. (Section 6.10, 9.6, 9.7, 9.8, 9.9)	
Module 3. Sequences	**11 Hours**
Limit of Sequences of Numbers, Theorems for calculating limits of sequences (Excluding Picard's Method) (Sections 8.1, 8.2)	
Module 4. Infinite Series	**11 Hours**
Infinite series, The ratio and root test for series of nonnegative terms, Power Series, Taylor and Maclaurin Series. (Sections 8.3, 8.6, 8.8, 8.9)	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation: 3 Mark
b. Test papers I: 6 Mark
c. Assignment: 3 Mark
d. Seminar: 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1: Integration	21
Module 2: Hyperbolic Functions and Polar coordinates	12
Module 3: Sequences	9
Module 4: Infinite Series	10

***List of Practicals (using any software)**

- Finding area under a curve and verifying definite integral of a positive function and area under its graph are same.
- Obtaining surface of revolution of curves.
- Plotting of graphs of hyperbolic functions.
- Plotting of recursive sequences.
- Study the convergence of sequences through plotting.
- Calculate the sum $1 + 1/2 + 1/3 + 1/4 + \ldots + 1/n$.
- Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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*

   Glyn James: Advanced Modern Engineering Mathematics(4/e) *Pearson Education Limited (2011) ISBN: 978-0-273-71923-6*

SEMESTER 3

COURSE CODE –BMT3C03(CS) COMPLEMENTARY COURSE VII: Mathematics 3				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Solve*** a system of linear equations using matrix theory.	Apply	PSO6
CO2	***Compute*** Find limits, continuity and differentiability of functions of several variables.	Apply	PSO6
CO3	***Explain*** Work on the idea of limit, continuity, and derivative of vector-valued functions.	Understand	PSO1
CO4	***Understand*** the concept of gradient and directional derivative and their geometrical interpretation	Understand	PSO1
CO5	***Make use of*** Find the rank and inverse of a matrix using elementary row transformations.	Apply	PSO6
CO6	***Utilize*** Find the characteristic roots values and the corresponding characteristic vectors of a matrix	Analyse	PSO4
CO7	***Analyse*** Work on the idea of limit, continuity, and derivative of vector-valued functions.	Analyse	PSO4
CO8	***Determine*** Find limits, continuity and differentiability of functions of several variables.	Evaluate	PSO4

CO9	***Judge*** Verify Cayley Hamilton Theorem and understand its applications.	Evaluate	PSO4
CO10	***Use*** partial derivatives to find the tangent plane and normal line to a point on a surface.	Apply	PSO6
CO11	***Determine*** continuity, differentiability, analyticity of a complex function.	Evaluate	PSO4
CO12	***Develop*** Perform basic mathematical operations with complex numbers in cartesian and polar forms.	Create	PSO5

TEXT 1	George B Thomas, Jr and Ross L Finney: CALCULUS, LPE, Ninth edition, Pearson Education.
TEXT 2	Frank Ayres JR: Matrices, Schaum's Outline Series, TMH Edition
TEXT 3	Erwin Kreyszig: Advanced Engineering Mathematics, Eighth Edition, Wiley, India.

COURSE CONTENT		
Module 1. Matrices	**TEXT 2**	**16 Hours**
Rank of a Matrix, Non-Singular and Singular matrices, Elementary Transformations, Inverse of an elementary Transformations, Row Canonical form, Normal form. Systems of Linear equations: Homogeneous and Non-Homogeneous Equations, Characteristic equation of a matrix; Characteristic roots and characteristic vectors. Cayley Hamilton Theorem (statement only) and simple applications (relevant sections of Text 2).		
Module 2. Functions of Several Variables	**TEXT 1**	**13 Hours**
Functions of Several Variables, Limits and Continuity, Partial Derivatives, differentiability, Chain rule (Sections 12.1, 12.2, 12.3, 12.4, 12.5 of the Text 1)		

Module 3. Vector Differential Calculus	TEXT 3	22 Hours
A quick Review of vector algebra, Inner product and vector product in $\mathbb{R}^2$ and $\mathbb{R}^3$. Vector and scalar functions and Fields, Derivatives, Curves, Tangents, Arc Length, Gradient of a scalar field; Directional Derivative, Divergence of a vector field, Curl of a Vector Field. (Sections 8.1, 8.2, 8.3, 8.4, 8.5, 8.9, 8.10, 8.11 of Text 3) (Sections 9.1, 9.2, 9.4, 9.5, 9.6, 9.7, 9.9, 9.10 of Text (2))		
Module 4. Complex Analysis	**TEXT 3**	**14 Hours**
A Quick Review: Complex Numbers, Complex Plane, Polar Form of Complex Numbers, Powers and Roots. Derivatives, Analytic functions, Cauchy-Riemann Equations, Laplace's Equation (All proofs omitted) (Section 12.1, 12.2, 12.3, 12.4, 13.1, 13.2, 13.3, 13.4 (statements only) of the Text 3).		

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT
Internal Assessment (15 Marks) e. Classroom participation: 3 Mark

f. Test papers I:	6 Mark
g. Assignment:	3 Mark
h. Seminar:	3 Mark

External Assessment (60 Marks) *Duration: 2 Hours, No of Questions:21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Matrices	15
Module 2: Functions of Several Variables	12
Module 3: Vector Differential Calculus	20
Module 4: Complex Analysis	13

***List of Practicals (using any software)**

- Matrix operation (addition, multiplication, inverse, transpose).
- Reorganizing systems of linear equations into matrix form and solving.
- Calculating the eigen values and eigen vectors of a matrix.
- Evaluating limits by plotting of graphs of multi-variable functions.

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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

SEMESTER 4

COURSE CODE –BMT4C04(CS) **COMPLEMENTARY COURSE VIII**: Mathematics 4				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	Learn the major classifications of differential equations.	Understand	PSO1
CO2	Learn the conditions for the existence of solution of first and second order initial value problems.	Understand	PSO1
CO3	Learn to solve the first order differential equations that are of linear, separable, exact, and Bernoulli's forms. .	Understand	PSO1
CO4	Find the orthogonal trajectories of family of curves.	Analyse	PSO4
CO5	Familiar with the theory and method of solving second order linear homogeneous and non-homogeneous equations with constant coefficients.	Analyse	PSO4
CO6	Learn the method of reduction of order to find a second solution of linear second order equation by reducing to linear first order equation.	Apply	PSO2

CO7	Learn the method of solution of Euler Cauchy equations.	Understand	PSO1
CO8	Determine the Laplace Transform and inverse Laplace Transform of a function.	Apply	PSO2
CO9	Learn the linearity and shifting theorems	Understand	PSO1
CO10	Acquire the knowledge of solving a differential equation using the Laplace method.	Evaluate	PSO4
CO11	Understand periodic functions and their Fourier series expansion	Understand	PSO1
CO12	Approximate the integral using the Trapezoidal rule and Simpson's rule.	Apply	PSO2
CO13	Learn the basic concepts of partial differential equations	Understand	PSO1

TEXT	Erwin Kreyszig: Advanced Engineering Mathematics, Eighth Edition, Wiley, India

COURSE CONTENT	
Module 1. Ordinary Differential Equations	**20 Hours**
Basic concepts and ideas, Geometrical meaning of y' = f (x, y), Direction Fields, Separable Differential Equations. Exact Differential Equations; Integrating Factors, Linear Differential Equations; Bernoulli Equation, Orthogonal Trajectories of Curves. (Sections 1.1, 1.2, 1.3, 1.5, 1.6, 1.8)	
Module 2. Linear Differential equations of Second and Higher order	**20 Hours**
Linear Differential equations of Second and Higher order: Differential Operators, Euler-Cauchy Equation, Wronskian, Nonhomogeneous Equations, Solutions by Undetermined Coefficients, Solution by variation of Parameters.	

(Sections 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10).	
Module 3. Laplace Transforms and Fourier Series	**24 Hours**
Laplace Transforms: Laplace Transform, Inverse Transform, Linearity, Shifting, Transforms of Derivatives of Integrals, Differential Equations. Unit step Function, Second Shifting Theorem. (Sections 5.1, 5.2, 5.3 – Excluding Proofs). Fourier Series: Periodic Functions, Trigonometric Series, Fourier Series, Even and Odd functions, Half-range Expansions. (Sections 10.1, 10.2, 10.4 – Excluding Proofs)	
Module 4. Numerical Integration and Partial Differential Equations	**8 Hours**
Numerical Integration: Trapezoidal Rule, Simpson's Rule. (Section 4.9). Partial differential Equations: Basic Concepts. (Section 11.1).	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning**: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT
Internal Assessment (15 Marks)

a. Class Room Participation:	3 Mark
b. Assignment:	3 Mark
c. Seminar:	3 Mark
d. Test Paper 1:	6 Mark

External Assessment (60 Marks): *Duration: 2 Hours, No. of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**12**	**12**	**2**	**20**
Paragraph	**7**	**7**	**5**	**30**
Essay	**2**	**1**	**10**	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Ordinary Differential Equations	17
Module 2: Linear Differential equations of Second and Higher order	17
Module 3: Laplace Transforms and Fourier Series	20
Module 4: Numerical Integration and Partial Differential Equations	6

***List of Practicals (using any software)**

- Plotting of first and second order solutions of ordinary differential equations.
- Finding the Laplace transforms of some functions.
- Approximating definite integral by using Simpson's rule and Trapezoidal rule

* Practical shall be conducted during extra hours. Questions should not be asked from this part.

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