KANNUR UNIVERSITY

BOARD OF STUDIES, MATHEMATICS (UG)

SYLLABUS FOR
MATHEMATICS CORE COURSE,
COMPLEMENTARY ELECTIVE COURSES
AND GENERIC ELECTIVE COURSES

CHOICE BASED CREDIT AND SEMESTER SYSTEM

(2019 ADMISSION ONWARDS)

KANNUR UNIVERSITY

VISION AND MISSION STATEMENTS

Vision

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargode and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission

- To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.
- To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.
- To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavours.
- To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.
- To build stronger community networks based on the values and principles of higher education and to ensure the region’s intellectual integration with national vision and international standards.
- To associate with the local self-governing bodies and other statutory as well as non-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

KANNUR UNIVERSITY

PROGRAMME OUTCOMES (PO)

PO 1. Critical Thinking

1.1. Acquire the ability to apply the basic tenets of logic and science to thoughts, actions and interventions.

1.2. Develop the ability to chart out a progressive direction for actions and interventions by learning to recognize the presence of hegemonic ideology within certain dominant notions.

1.3 Develop self-critical abilities and also the ability to view positions, problems and social issues from plural perspectives.

PO 2. Effective Citizenship

2.1. Learn to participate in nation building by adhering to the principles of sovereignty of the nation, socialism, secularism, democracy and the values that guide a republic.

2.2. Develop and practice gender sensitive attitudes, environmental awareness, empathetic social awareness about various kinds of marginalisation and the ability to understand and resist various kinds of discriminations.

2.3. Internalise certain highlights of the nation's and region's history. Especially of the freedom movement, the renaissance within native societies and the project of modernisation of the post-colonial society.

PO 3. Effective Communication

3.1. Acquire the ability to speak, write, read and listen clearly in person and through electronic media in both English and in one Modern Indian Language

3.2. Learn to articulate, analyse, synthesise, and evaluate ideas and situations in a well-informed manner.

3.3. Generate hypotheses and articulate assent or dissent by employing both reason and creative thinking.

PO 4. Interdisciplinarity

4.1. Perceive knowledge as an organic, comprehensive, interrelated and integrated faculty of the human mind.

4.2. Understand the issues of environmental contexts and sustainable development as a basic interdisciplinary concern of all disciplines.

4.3. Develop aesthetic, social, humanistic and artistic sensibilities for problem solving and evolving a comprehensive perspective.

PREFACE

Modern education is facing challenges to cater to the requirements of the expanding world of knowledge and information. Research studies in Basic Sciences, especially in Mathematics is to be encouraged in our country. Novel developments in the field of Mathematics are to be incorporated into the syllabus so as to cope with the challenges of ever growing field of knowledge.

The UG Board of Studies in Mathematics has designed a syllabus that familiarizes the students with the basic concepts of the subject. It helps the students to meet the current employment requirements and provides them ample scope for further study in the subject. The syllabi for Core Courses, Complementary Elective Courses and Generic Elective Courses promote self learning through assignments, seminars and project work in addition to class room learning.

The syllabus and curriculum has been prepared after concerted efforts and deliberations at various levels and it meets the programme specific outcomes. The reference materials have been recommended after a thorough study. The Board of Studies puts forward this syllabus for implementation from 2019 admission onwards. We thank all those who have helped us by giving critical suggestions for improvement.

Dr. C.P. Santhosh
Chairman
UG Board of Studies in Mathematics
Kannur University

KANNUR UNIVERSITY

PROGRAMME SPECIFIC OUTCOMES OF B.SC. MATHEMATICS PROGRAMME

PSO 1: Understand the basic concepts and tools of Mathematical logic, Set theory, Number theory, Geometry, Calculus, Algebra, Abstract structures, Linear Algebra, Analysis, Laplace transforms, Fourier series, Graph theory, and Optimization and methods of proofs.

PSO 2: Model real world problems into Mathematical problems and find solutions and understand the application of Mathematics in other Sciences and Engineering.

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KANNUR UNIVERSITY

BSc MATHEMATICS PROGRAMME

WORK AND CREDIT DISTRIBUTION STATEMENT

Semester	Course Title	Credits	Hours per week	Total Credits	Total Hours
I	English Common Course 1	4	5	20	25
	English Common Course 2	3	4		
	Additional Common Course 1	4	4		
	Core Course 1	4	4		
	First Complementary Elective Course 1	3	4		
	Second Complementary Elective Course 1	2	4		
II	English Common Course 3	4	5	20	25
	English Common Course 4	3	4		
	Additional Common Course 2	4	4		
	Core Course 2	4	4		
	First Complementary Elective Course 2	3	4		
	Second Complementary Elective Course 2	2	4		
III	English Common Course 5	4	5	17	25
	Additional Common Course 3	4	5		
	Core Course 3	4	5		
	First Complementary Elective Course 3	3	5		
	Second Complementary Elective Course 3	2	5		
IV	English Common Course 6	4	5	21	25
	Additional Common Course 4	4	5		
	Core Course 4	4	5		
	First Complementary Elective Course 4	3	5		
	Second Complementary Elective Course 4 (T+P)	6(2+4)	5		
V	Core Course 5	4	4	21	25
	Core Course 6	4	5		
	Core Course 7	4	5		
	Core Course 8	3	4		
	Core Course 9	4	5		
	Generic Elective Course	2	2		
VI	Core Course 10	4	5	21	25
	Core Course 11	4	5		
	Core Course 12	4	5		
	Core Course 13	4	5		
	Core Course 14 (Discipline Specific Elective Course)	3	5		
	Project	2	---		
Total				**120**	

CREDIT DISTRIBUTION STATEMENT

Course	Credit
English Common Course	22
Additional Common Course	16
Core Course	56
First Complementary Elective Course - Statistics	12
Second Complementary Elective Course - Physics/Computer Science	12
Generic Elective Course	2
Total	**120**

PART A

MATHEMATICS CORE COURSES
WORK AND CREDIT DISTRIBUTION

(2019 ADMISSION ONWARDS)

COURSE CODE	COURSE TITLE	SEM.	HOURS PER WEEK	CREDIT	EXAM HOURS
1B01 MAT	Set Theory, Differential Calculus and Numerical Methods	I	4	4	3
2B02 MAT	Integral Calculus and Logic	II	4	4	3
3B03 MAT	Analytic Geometry and Applications of Derivatives	III	5	4	3
4B04 MAT	Number Theory and Applications of Integrals	IV	5	4	3
5B05 MAT	Set Theory, Theory of Equations and Complex Numbers	V	4	4	3
5B06 MAT	Real Analysis I	V	5	4	3
5B07 MAT	Abstract Algebra	V	5	4	3
5B08 MAT	Differential Equations and Laplace Transforms	V	4	3	3
5B09 MAT	Vector Calculus	V	5	4	3
5D-----	Generic Elective Course	V	2	2	2
6B10 MAT	Real Analysis II	VI	5	4	3
6B11 MAT	Complex Analysis	VI	5	4	3
6B12 MAT	Numerical Methods, Fourier Series and Partial Differential Equations	VI	5	4	3
6B13 MAT	Linear Algebra	V	5	4	3
DISCIPLINE SPECIFIC ELECTIVE		VI	5	3	3
6B14A MAT	Graph Theory				
6B14B MAT	Operations Research				
6B14 C MAT	Cryptography				
6B14D MAT	Fuzzy Mathematics				
6B14E MAT	Programming in Python				
6B15 MAT	Project	VI	---	2	---

EVALUATION

ASSESSMENT	WEIGHTAGE
EXTERNAL	4
INTERNAL	1

CONTINUOUS INTERNAL ASSESSMENT

COMPONENT	WEIGHTAGE	MARKS	REAMARKS
COMPONENT1- ASSIGNMENT / SEMINAR / VIVA-VOCE	50%	6	For each course, a student has to submit one assignment/ attend one seminar/ attend one viva-voce
COMPONENT 2- TEST PAPER	50%	6	For each course, a student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.
TOTAL	100%	**12**	

- **Use of Scientific Calculators below 100 functions (that is, upto fx 99) shall be permitted for all the above courses.**

CORE COURSE 1:
SET THEORY, DIFFERENTIAL CALCULUS AND NUMERICAL METHODS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1B01 MAT	4	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand Relations and Functions
CO2	Understand limit of a function, limit laws, continuity, Inverse functions and their derivatives
CO3	Understand successive differentiation and Leibnitz theorem
CO4	Understand functions of several variables, limit and continuity, partial derivatives, chain rule, homogenous functions and Euler’s theorem on homogenous functions
CO5	Understand bisection method, Regula-falsi method and Newton-Raphson method to solve algebraic and transcendental equations

1B01 MAT:
Set Theory, Differential Calculus and Numerical Methods

Unit I - Relations and Functions (22 hours)
Relations, Types of relations, Partitions, Equivalence relation, Partial ordering relation, Functions, Composition of functions, One-to-one, onto and invertible functions, Mathematical functions, exponential function, logarithmic function (Sections 3.3, 3.6, 3.8, 3.9, 3.10 and sections 4.1 to 4.5 of Text 1).

Unit II – Limit, Continuity and Successive differentiation (18 hours)
Limit of a function and limit laws, continuity, Inverse functions and their derivatives (Sections 2.2, 2.5, 7.1 of Text 2. Proof of Theorem 10 in section 2.5 is omitted).

Successive differentiation, standard results, n^{th} derivatives, Leibnitz theorem (Sections 4.1, 4.2 of Text 3).

Unit III – Functions of several variables (22 hours)
Functions of several variables, limit and continuity, partial derivatives, chain rule (theorems without proof) (Sections 14.1, 14.2, 14.3, 14.4 of Text 2).

Homogenous functions, Euler's theorem on homogenous functions (Sections 11.8, 11.8.1 of Text 4).

Unit IV - Solution of Algebraic and Transcendental Equations (10 Hours)
Introduction to solution of algebraic and transcendental equation**,** Initial approximations,
Bisection method, Regula-falsi method, Newton-Raphson method (Sections 3.2, 3.2.1, 3.3, 3.4, 3.5 of Text 5).

Texts
1. S. Lipschutz, Set Theory and Related Topics (2nd edition), Schaum's Series
2. G.B, Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12th edition), Pearson Education
3. Higher Engineering Mathematics, B.S. Grewal (43rd edition), Khanna Publishers
4. S Narayan and P.K Mittal , Differential calculus, Revised Edition, S. Chand & Company Ltd
5. S. R. K. Iyengar and R. K. Jain, Mathematical methods (2nd edition), Narosa Publishing House.

References
1. H Anton, Bivens and Davis, Calculus, 10th edition , Willey
2. E. Kreyszig, Advanced Engineering Mathematics (10th edition), Willey

3. S. S. Sastry, Introduction to Numerical Methods (5^{th} edition), Prentice Hall of India.
4. V.N. Vedamurthy and N.Ch.S.N. Iyengar, Numerical Methods, Vikas Publishing House.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	22	**48**
II	21	
III	24	
IV	12	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 2:
INTEGRAL CALCULUS AND LOGIC

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	2B02 MAT	4	4	3	48	12	60

COURSE OUTCOME

CO	CO Statement
CO1	Understand Hyperbolic functions
CO2	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} cos^n x\, dx$ and $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$.
CO3	Understand Polar coordinates
CO4	Understand Double integrals in Cartesian and polar form.
CO5	Understand triple integrals in rectangular, cylindrical and spherical co-ordinates
CO6	Understand Substitution in multiple integrals
CO7	Understand Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule
CO8	Understand Logic and methods of proofs
CO9	Understand Propositional functions, truth set and Negation of quantified statements

2B02 MAT: Integral Calculus and Logic

Unit I – Integration of hyperbolic functions, Reduction formulae
(20 hours)

Hyperbolic functions (Section 7.7 of Text 1).

Reduction formulae, Integration of $sin^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$, Integration of $sin^p x cos^q x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$ (Sections 2.8, 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2 of Text 2)

Unit II – Multiple integrals **(20 hours)**

Polar coordinates (Sections 11.3 of Text 1).

Multiple integrals: Double and iterated integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular coordinates, triple integrals in cylindrical and spherical co-ordinates, substitution in multiple integrals (Sections 11.3, 15.1, 15.2, 15.3, 15.4, 15.5, 15.7, 15.8 of Text 1).

Unit III - Numerical integration **(12 hours)**

Numerical integration, Trapezoidal rule, Simpson's 1/3 rd rule (Sections 6.3, 6.3.1, 6.3.2 of Text 3).

Unit IV – Logic and proofs **(20 hours)**

Logic and proofs (Appendix A of Text 4).

Propositional functions and truth set, Negation of quantified statements (Section 10.11, 10.12 of Text 5).

Texts

1. G.B, Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12th edition), Pearson Education
2. S. Narayan and P.K. Mittal, Integral Calculus, S. Chand
3. S. R. K. Iyengar and R. K. Jain, Mathematical methods (2nd edition), Narosa Publishing House
4. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis (4th edition), Wiley
5. S. Lipschutz, Set Theory and Related Topics (2nd edition), Schaum's Series.

References:

1. S.S. Sastry, Introductory Methods of Numerical Analysis (5^{th} edition), PHI.
2. F.B. Hidebrand, Introduction to Numerical Analysis, TMH.
3. E. Kreyzig, Advanced Engineering Mathematics (10^{th} Edition), Wiley
4. V.N. Vedamurthy and N.Ch.S.N. Iyengar, Numerical Methods, Vikas Publishing House.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	19	**48**
II	22	
III	14	
IV	24	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 3:
ANALYTIC GEOMETRY AND APPLICATIONS OF DERIVATIVES

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3B03 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand cartesian equation of conics, eccentricity, polar equations for a conic, lines, circles
CO2	Understand Tangnts, Normals and Asymptotes
CO3	Understand Curvature, Radius of curvature ,Centre of Curvature, Circle of curvature and Evolutes of Cartesian and polar curves,
CO 4	Understand Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem and Taylors Theorem
CO5	Understand extreme values of functions, monotonic functions, first derivative test , concavity and curve sketching
CO6	Understand Indeterminate forms

3B03MAT:
Analytic Geometry and Applications of Derivatives

Unit I: Conic Sections **(25 hours)**

Conic Sections: Parabola, Ellipse, Hyperbola, Conics in Polar Co ordinates: Eccentricity, polar equations for a conic, lines, circles (Sections 11.6, 11.7 of Text 1)

Unit II: Tangnts, Normals and Asymptotes **(25 hours)**

Tangents and normals: Equation of tangent, equation of Normal, Angle of intersection of two curves, Lengths of tangents, normal.

Polar Curves: Angle between radius vector and tangent, Length of the perpendicular from pole on the tangent.

Asymptotes.

(Sections 4.6, 4.7, 4.16 of Text 2).

Unit III: Curvature and Evolutes **(15 hours)**

Curvature, Radius of curvature for Cartesian and polar curves, Centre of Curvature, Circle of curvature, Evolutes (Sections 4.10, 4.11, 4.12 of Text 2).

Unit IV: Mean Value Theorems, Extreme values of functions, Curve Sketching and Indeterminate forms **(25 hours)**

Fundamental Theorems: Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem, Taylors Theorem (without proof), Expansions of functions (Sections 4.3, 4.4 of Text 2)

Extreme values of functions, Monotonic functions and first derivative test, concavity and curve sketching, Indeterminate forms (Proof of L'Hospital's rule excluded) (Sections 4.1, 4.3, 4.4, 7.5 of Text 1).

Texts

1. G.B, Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12th edition), Pearson Education
2. Higher Engineering Mathematics, B.S. Grewal (43rd edition), Khanna Publishers.

References

1. S.L. Loney, The Elements of Coordinate Geometry, Part I, A.I.T.B.S. Publishers
2. H Anton, Bivens and Davis, Calculus (10th edition), Willey
3. E. Kreyszig, Advanced Engineering Mathematics (10th edition), Willey
4. S. Narayan and P.K. Mittal, Differential calculus (Revised Edition), S. Chant & Company Ltd.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	19	**48**
II	25	
III	10	
IV	25	
Total	79	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 4:
NUMBER THEORY AND
APPLICATIONS OF INTEGRALS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4B04 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand Division algorithm, Greatest common Divisor, Euclidean Algorithm, Diophantine equation $ax+by=c$.
CO2	Understand Primes and their distribution, fundamental theorem of arithmetic, the sieve of Eratosthenes
CO3	Understand Basic properties of congruence
CO4	Understand Picard's little theorem, Wilson's theorem and Euler's theorem
CO5	Understand Substitution and the area between curves, Arc length, Areas and length in polar co-ordinates
CO6	Understand Volumes using cross sections, volumes using cylindrical shells and areas of surfaces of revolution

4B04 MAT:
Number Theory and Applications of Integrals

Unit I - Number Theory I (22 hours)
Number theory: Division algorithm (proof omitted), Greatest common Divisor, Euclidean Algorithm, Diophantine equation $ax+by=c$, primes and their distribution, fundamental theorem of arithmetic, the sieve of Eratosthenes (Sections 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2 of Text 1).

Unit II – Number Theory II (23 hours)
Basic properties of congruence, the little theorem and pseudo primes, Wilson's theorem, Euler's theorem (Proofs of Fermat's, Wilson's and Euler's theorems excluded) (Sections 4.2, 5.2, 5.3, 7.3 of Text 1).

Unit III – Area between curves and Arc length (23hours)
Substitution and the area between curves, Arc length, Areas and length in polar co-ordinates (Sections 5.6, 6.3, 11.5 of Text 2).

Unit IV – Volumes of solids and Areas of surfaces of revolution (22 hours)
Volumes using cross sections, areas of surfaces of revolution (Sections 6.1, 6.4 of Text 2).

Texts

1. David M Burton, Elementary Number theory, 7^{th} edition, Mc Graw Hill
2. G.B, Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12^{th} edition), Pearson Education.

References

1. T.M. Apostol, Introduction to Analytic Number Theory, Springer
2. N. Koblitz, A Course in Number theory and Cryptography (2^{nd} edition), Springer
3. H Anton, Bivens and Davis, Calculus (10^{th} edition), Willey
4. S. Narayan, Integral calculus, S. Chand & Company Ltd
5. Higher Engineering Mathematics, B.S. Grewal (43^{rd} edition), Khanna Publishers.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	19	
II	20	
III	20	**48**
IV	20	
Total	**79**	

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 8 questions***	*(8 questions x Marks 2 each=16)*
Part C -	**Essay**	(7 questions x Marks 4 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 4 each=16)*
Part D -	**Long Essay**	(4 questions x Marks 6 each = 24)
	• ***Answer any 2 questions***	*(2 questions x Marks 6 each=12).*

CORE COURSE 5:
SET THEORY, THEORY OF EQUATIONS AND COMPLEX NUMBERS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5B05 MAT	4	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand finite and infinite sets, Countable and Uncountable sets, Cantor's theorem.
CO2	Understand Roots of equations, Relations connecting the roots and coefficients of an equation, Transformation of equations, The cubic equation, Character and position of roots of an equation.
CO3	Understand Descarte's rule of signs, De Gua's Rule, Limits to the roots of an equation, Rational roots of equations, Newton's method of divisors, Symmetric functions of roots of an equation, Symmetric functions involving only the difference of the roots of $f(x)=0$, Equations whose roots are symmetric functions of α,β,γ.
CO4	Understand Reciprocal equations.
CO5	Understand Cubic equation, Equation whose roots are the squares of the difference of the roots, Character of the Roots, Cardan's Solution
CO6	Understand Roots of complex numbers, General form of De Moivre's theorem, the n^{th} roots of unity, the n^{th} roots of -1, Factors of x^n-1 and x^n+1, the imaginary cube roots of unity.
CO7	Understand polar form of complex numbers, powers and roots.

5B05 MAT:
Set Theory, Theory of Equations and Complex Numbers

Unit I - Finite and Infinite Sets **(14 hours)**

Finite and infinite sets, Countable sets, Uncountable sets, Cantor's theorem (Section 1.3 of Text 1).

Unit II - Theory of equations I **(20 hours)**

Roots of equations, Relations connecting the roots and coefficients of an equation, Transformation of equations, Special cases, The cubic equation, Character and position of roots of an equation, Some general theorems, Descarte's rule of signs, Corollaries, De Gua's Rule, Limits to the roots of an equation, To find the rational roots of an equation, Newton's method of divisors, Symmetric functions of roots of an equation, Symmetric functions involving only the difference of the roots of f(x) =0, Equations whose roots are symmetric functions of α, β, γ (Sections 1 to 17 in chapter VI of Text 2).

Unit III - Theory of equations II **(20 hours)**

Reciprocal equation (Proof of theorems excluded) (Section 1 in chapter XI of Text 2)

The Cubic equation, Equation whose roots are the squares of the difference of the roots, Character of the Roots, Cardan's Solution (Section 5 of chapter VI and sections 1 to 4 of chapter XI I in Text 2).

Unit IV – Complex numbers **(18 hours)**

Quick review of a complex number, equality of complex numbers, fundamental operations, zero product, geometrical representation of complex numbers, addition and subtraction, product and quotients, conjugate numbers (Sections 1 to14 in chapter V of Text 2) [*Questions should not be included in the End Semester Examination from these topics for Quick review*].

Roots of complex numbers, General form of De Moivre's theorem, the n^{th} roots of unity, the n^{th} roots of -1, Factors of x^n -1 and x^n +1, the imaginary cube roots of unity (Sections 15 to 20 of chapter V of Text 2).

Polar form of complex numbers, powers and roots (Section 13.2 of Text 3).

Texts

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (4^{th} edition), Wiley
2. Bernard and Child, Higher Algebra, A.I.T.B.S. Publishers
3. E. Kreyszig, Advanced Engineering Mathematics (10^{th} edition), Wiley.

References

1. S.S. Sastry, Engineering Mathematics, Vol 1 (4^{th} edition), PHI
2. H.S. Hall and S.R. Knight, Higher Algebra, A.I.T.B.S. Publishers
3. B.S. Grewal, Higher Engineering Mthematics (43^{rd} edition), Khanna Publishers.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	13	**48**
II	24	
III	22	
IV	20	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 6:
REAL ANALYSIS I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5B06 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand Algebraic Properties, Order Properties and Absolute values of $\mathbb{R}$. Understand the Completeness Property of $\mathbb{R}$ and its applications to derive Archimedean Property and Density theorem.
CO2	Understand intervals in the real line.
CO3	Understand Sequences and their Limits, Limit Theorems, Monotone Sequences.
CO4	Understand Subsequences and the Bolzano-Weierstrass Theorem, The Cauchy Criterion.
CO5	Understand Infinite Series, Absolute Convergence.
CO6	Understand Comparison test, Root test, Ratio test, Integral test and Raabe's test for Absolute convergence.
CO7	Understand Alternating series test, Dirichlet's test and Abel's test for Non Absolute convergence.
CO8	Understand Continuous Functions, composition of continuous functions and continuous functions on intervals.

5B06 MAT: Real Analysis I

Unit I - The Real Numbers **(20 hours)**
Algebraic and Order Properties of $\mathbb{R}$, Absolute Value and Real Line, The Completeness Property of $\mathbb{R}$, Applications of the Supremum Property, Intervals (Sections 2.1, 2.2, 2.3, 2.4, 2.5 of the Text).

Unit II – Sequences **(30 hours)**
Sequences and their Limits, Limit Theorems, Monotone Sequences, Subsequences and the Bolzano-Weierstrass Theorem, The Cauchy Criterion (Sections 3.1, 3.2, 3.3, 3.4, 3.5 of the Text).

Unit III - Series **(20 hours)**
Introduction to Infinite Series, Absolute Convergence, Tests for Absolute Convergence, Tests for Non Absolute Convergence (Sections 3.7, 9.1, 9.2, 9.3 of the Text).

Unit IV - Continuous Functions **(20 hours)**
Continuous Functions, Combination of Continuous Functions, Continuous Functions on Intervals (Sections 5.1, 5.2, 5.3 of the Text).

Text

R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis (4^{th} edition), Wiley.

References

1. T.M. Apostol, Mathematical Analysis (2^{nd} edition), Addison-Wesley
2. W. Rudin, Principles of Mathematical Analysi (3^{rd} edition), McGraw-Hill
3. H.L. Royden, Real Analysis (3^{rd} edition), PHI
4. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Company
5. D. Chatterjee, Real Analysis, PHI.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>18</td><td rowspan="5">48</td></tr>
<tr><td>II</td><td>25</td></tr>
<tr><td>III</td><td>20</td></tr>
<tr><td>IV</td><td>16</td></tr>
<tr><td>Total</td><td>79</td></tr>
</table>

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 8 questions***	*(8 questions x Marks 2 each=16)*
Part C -	**Essay**	(7 questions x Marks 4 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 4 each=16)*
Part D -	**Long Essay**	(4 questions x Marks 6 each = 24)
	• ***Answer any 2 questions***	*(2 questions x Marks 6 each=12)*

CORE COURSE 7:
ABSTRACT ALGEBRA

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5B07 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand definition and elementary properties of Groups, Subgroups and Cyclic groups
CO2	Understand Groups of Permutations, orbits, Alternating groups and theorem of Lagrange
CO3	Understand group homomorphisms , factor Groups
CO4	Understand Fundamental Homomorphism Theorems
CO5	Understand definition and properties of rings and fields
CO6	Understand Ring homomorphisms and isomorphisms
CO7	Understand zero divisors , integral domains , characteristic of a ring and their properties

5B07 MAT: Abstract Algebra

Unit I **(27 hours)**

Groups and Subgroups - Binary Operations, Groups, Subgroups, Cyclic Groups (Sections 2, 4, 5, 6 of the Text).

Unit II **(28 hours)**

Groups of Permutations, Orbits, Cycles and the Alternating Groups, Cosets and Theorem of Lagrange (Sections 8, 9, 10 of the Text).(Proof of Theorem 9.15 omitted).

Unit III **(20 hours)**

Homomorphisms, Factor Groups (Sections 13, 14 of the Text).

Unit IV **(15 hours)**

Rings and Fields, Integral Domains (Sections 18, 19 of the Text).
(*Problems involving direct products are omitted from all sections*)

Text

J.B. Fraleigh, A First Course in Abstract Algebra (7^{th} edition), Pearson.

References

1. I.N. Herstein, Topics in Algebra (2^{nd} edition), Wiley
2. M. Artin, Algebra, Prentice Hall
3. D. Chaterjee, Abstract Algebra (2^{nd} edition), PHI
4. J.A. Gallian, Contemporary Abstract Algebra, Narosa
5. P.B. Bhatacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2^{nd} edition), Cambridge University Press.

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	27	
II	26	
III	16	**48**
IV	10	
Total	**79**	

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 8 questions***	*(8 questions x Marks 2 each=16)*
Part C -	**Essay**	(7 questions x Marks 4 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 4 each=16)*
Part D -	**Long Essay**	(4 questions x Marks 6 each = 24)
	• ***Answer any 2 questions***	*(2 questions x Marks 6 each=12).*

CORE COURSE 8:
DIFFERENTIAL EQUATIONS AND LAPLACE TRANSFORMS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5B08 MAT	4	3	3	48	12	60

COURSE OUTCOMES

CO1	Understand Separable ODEs, Exact ODEs, Linear ODEs, Bernoulli equation and methods to solve these ODEs
CO2	Understand the theorem of Existence and Uniqueness of solutions of first and second order ODEs
CO3	Understand Homogeneous Linear ODEs of Second Order and solve homogeneous linear ODEs of second order with constant coefficients and Euler-Cauchy equation
CO4	Understand Nonhomogeneous ODEs and solve by variation of parameters
CO5	Understand Laplace Transform and inverse Laplace Transformation
CO6	Understand The first and The second shifting theorems and their applications
CO7	Understand the methods to find Laplace transforms of derivatives and integrals of functions
CO8	Understand the method of differentiating and integrating Laplace transform
CO9	Solve ordinary differential equations and integral equations using Laplace transform

5B08 MAT:
Differential Equations and Laplace Transforms

Unit I - First Order ODEs **(25Hours)**

First Order ODEs: Basic concepts (Modelling excluded), Separable ODEs(Modelling excluded), Exact ODEs. Integrating factors, Linear ODEs, Bernoulli equation (except Population Dynamics), Orthogonal Trajectories, Existence and uniqueness of solutions (Sections 1.1, 1.3, 1.4, 1.5, 1.6, 1.7 in Chapter 1of the Text).

Unit II – Second-Order Linear ODEs **(22 Hours)**

Second-Order Linear ODEs: Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Differential Operators, Euler-Cauchy Equations, Statement of Existence and Uniqueness theorem for initial value problems, linear independence of solutions, Wronskian, general solution, Nonhomogeneous ODEs, Method of undetermined coefficients, Solution by Variation of Parameters (Sections 2.1, 2.2, 2.3, 2.5, 2.6, 2.7, 2.10 in Chapter 2 of the Text).

Unit III - Laplace Transforms **(25 hours)**

Laplace Transform, Inverse Transform, Linearity. s-Shifting, Transforms of Derivatives and Integrals. ODEs, Unit Step Function. t-Shifting, Short Impulses, Dirac's Delta Function, Partial Fractions, Convolution, Integral Equations, Differentiation and Integration of Transforms (Sections 6.1 to 6.6 in Chapter 6 of the Text).

Texts

E. Kreyzig, Advanced Engineering Mathematics, 10th Edition, John Wiley

References

1. S.L. Ross, Differential Equations, 3rd Edition, Wiley.
2. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, 3rd Edition, Wiley and Sons
3. E.A. Coddington, An Introduction to Ordinary Differential Equtions, Printice Hall
4. W.E. Boyce and R.C. Diprima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	30	**48**
II	28	
III	21	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 9:
VECTOR CALCULUS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5B09 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand lines and planes in space
CO2	Understand curves in space, their tangents, normal, curvature, tangential and normal curvature of acceleration
CO3	Understand Directional derivatives and gradient vectors, tangent planes and differentials. Solve extreme value problems using Lagrange multipliers
CO4	Understand Partial derivatives with constrained variables and Taylor's formula for two variables
CO5	Understand Line integrals. Solve for work, circulation and flux using line integrals
CO6	Understand path independence conservative fields and potential functions
CO7	Understand Green's theorem and solve problems using Green's theorem
CO8	Understand Surface area and surface integrals
CO9	Understand Stoke's theorem and solve problems using Stoke's theorem
CO10	Understand Divergence theorem and solve problems using Divergence theorem

5B09 MAT: Vector Calculus

Unit I – Geometry of space and motion in space (25 Hours)

Lines and planes in space, curves in space and their tangents, arc length in space, curvature and normal vector of a curve, tangential and normal components of acceleration (Sections 12.5, 13.1, 13.3, 13.4, 13.5 of the Text).

Unit II - Partial derivatives (25 Hours)

Directional derivatives and gradient vectors, Tangent planes and differentials, Extreme values and saddle points, Lagrange multipliers, Partial derivatives with constrained variables, Taylor's formula for two variables (Sections 14.5, 14.6, 14.7, 14.8, 14.10 of the Text).

Unit III – Integration in vector fields I (20 Hours)

Line integrals, Vector fields and line integrals: work, circulation, flux, Path independence, conservative fields and potential functions, Green's theorem in the plane (Sections 16.1, 16.2, 16.3, 16.4 of the Text).

Unit IV - Integration in vector fields II (20 Hours)

Surfaces and area, surface integrals, Stokes' theorem (theorem without proof) (paddle wheel interpretation of $\nabla\times\mathbf{F}$ is excluded), the Divergence Theorem (theorem without proof) (Gauss' law: one of the four great laws of Electromagnetic Theory, continuity equation of hydrodynamics, unifying the integral theorems are excluded) (Sections 16.5, 16.6, 16.7, 16.8 of the Text).

Text

G.B, Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12th edition), Pearson Education

References

1. E. Kreyzig, Advanced Engineering Mathematics (10th Edition), Wiley
2. H. F. Davis and A. D. Snider, Introduction to Vector Analysis (6th Edition), Universal Book Stall, New Delhi.
3. F. W. Bedford and T. D. Dwivedi, Vector Calculus, McGraw Hill Book Company
4. S.S. Sastry, Engineering Mathematics , Vol 2 (4th edition), PHI
5. B.S. Grewal, Higher Engineering Mathematics (43rd edition), Khanna Publishers.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	22	**48**
II	25	
III	18	
IV	14	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 10:
REAL ANALYSIS II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	6B10 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand Uniform Continuity, Monotone and Inverse Functions
CO2	Understand Riemann Integral and Riemann-integrable Functions
CO3	Understand Fundamental Theorem of Calculus
CO4	Understand Improper Integrals
CO5	Understand Beta and Gamma Functions and their properties.
CO6	Understand Transformations of Gamma Function and Duplication formula
CO7	Understand Pointwise and Uniform Convergence of sequence of functions and Interchange of Limits
CO8	Understand Series of Functions
CO9	Understand the concept of Metric Spaces

6B10 MAT: Real Analysis II

Unit I – Uniform continuity and Monotone functions (20 hours)
Uniform Continuity, Monotone and Inverse Functions (Sections 5.4, 5.6 of Text 1).

Unit II – Riemann Integral (25 hours)
Riemann Integral, Riemann Integrable functions (proof of Additivity theorem is excluded), The Fundamental Theorem of Calculus (Lebesgue's Integrability Criterion and proof of Composition Theorem are excluded) (Sections 7.1,7.2, 7.3 of Text 1).

Unit III - Improper Integrals and Beta and Gamma Functions (25 hours)
Improper Integrals (Section 8.7 of Text 2).

Beta and Gamma Functions – Definitions, Properties of Beta and Gamma Functions, Transformations of Gamma Function, Some Important Deductions, Duplication formula (Sections 7.1, 7.2, 7.3, 7.4, 7.5 of Text 3).

Unit IV – Sequence and Series of Functions and Metric spaces (20 hours)
Pointwise and Uniform Convergence, Interchange of Limits, Series of Functions (Sections 8.1, 8.2, 9.4 of Text 1).

Metric Spaces – Definition, examples, neighbourhood of a point (Relevant topics from section 11.4 of the Text).

Texts

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis (4^{th} edition), Wiley
2. G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12^{th} edition), Pearson Education
3. S. Narayan and P.K. Mittal, Integral Calculus (11^{th} edition), S. Chand Publishers.

References

1. T.M. Apostol, Mathematical Analysis (2^{nd} edition), Addison-Wesley
2. W. Rudin, Principles of Mathematical Analysi (3^{rd} edition), McGraw-Hill
3. H.L. Royden, Real Analysis (3^{rd} edition), PHI
4. B.S. Grewal, Higher Engineering Mthematics (43^{rd} edition), Khanna Publishers
5. S.S. Sastry, Engineering Mathematics, Vol 2 (4^{th} edition), PHI
6. D. Chatterjee, Real Analysis, PHI.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	15	**48**
II	22	
III	24	
IV	18	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 11:
6B11 MAT: COMPLEX ANALYSIS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	**6B11 MAT**	**5**	**4**	**3**	**48**	**12**	**60**

COURSE OUTCOMES

CO1	Understand Analytic Function, Cauchy–Riemann Equations. Laplace's Equation.
CO2	Understand Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarithmic functions and General Power of complex numbers
CO3	Understand line integral in the complex plane ,Cauchy's integral theorem , Cauchy's integral formula and derivatives of analytic functions
CO4	Understand convergence of Sequences and Series of complex functions
CO5	Understand power series, functions given by power series, Taylor series, Maclaurin's Series and Laurent Series
CO6	Understand singularities and zeros of complex functions
CO7	Understand residue integration method and integrate real integrals

6B11 MAT: Complex Analysis

Unit I – Complex Functions and Analyticity (24 hours)
Complex Functions, Limit, Continuity, Derivative, Analytic Function, Cauchy–Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Euler's Formula, Logarithm, General Power, Principal Value (Sections 13.3, 13.4, 13.5, 13.6, 13.7 of the Text).

Unit II – Complex Integration (24 hours)
Line Integral in the Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Functions (Sections 14.1, 14.2, 14.3, 14.4 of the Text).

Unit III – Power Series, Taylor Series (20 hours)
Sequences, Series, Convergence, Power Series, Functions given by Power Series, Taylor and Maclaurin's Series (Proof of Taylor's theorem excluded) (Sections 15.1, 15.2, 15.3, 15.4 of the Text).

Unit IV - Laurent Series, Residue Integration (22 hours)
Laurent Series (Proof of Laurent's Theorem excluded), Singularities and Zeros, Infinity, Residue Integration Method (Sections 16.1, 16.2, 16.3 of the Text).

Text

E. Kreyzig, Advanced Engineering Mathematics, 10th Edition, John Wiley.

References

1. J.W. Brown and R.V. Churchil, Complex Variables and Applications (7^{th} edition), McGraw-Hill
2. S.S. Sastry, Engineering Mathematics, Vol 2 (4^{th} edition), PHI
3. W. Rudin, Real and Complex Analysis (3^{rd} edition), Tata McGraw-Hill
4. L.V. Ahlfors, Complex Analysis (3^{rd} edition), McGraw-Hill
5. J.B. Conway, Functions of One Complex Varible (2^{nd} edition), Springer
6. S. Ponnusamy, Foundations of Complex Analysis (2^{nd} edition), Narosa.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>21</td><td rowspan="5">48</td></tr>
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<tr><td>III</td><td>18</td></tr>
<tr><td>IV</td><td>20</td></tr>
<tr><td>Total</td><td>79</td></tr>
</table>

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 8 questions***	*(8 questions x Marks 2 each=16)*
Part C -	Essay	(7 questions x Marks 4 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 4 each=16)*
Part D -	**Long Essay**	(4 questions x Marks 6 each = 24)
	• ***Answer any 2 questions***	*(2 questions x Marks 6 each=12).*

CORE COURSE 12:
NUMERICAL METHODS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	6B12 MAT	5	4	3	48	12	60

COURSE OUTCOMES

CO1	Understand Interpolation techniques: Interpolation with unevenly spaced points, Langrange interpolation, Newton's divided differences interpolation, Finite difference operators and finite differences, Newton's interpolation formulae and Central difference interpolation.
CO2	Understand Numerical differentiation using difference formulae
CO3	Understand Picard's method, Solution by Taylor series method, Euler method and Runge- Kutta methods.
CO4	Understand Fourier Series: Arbitrary period, Even and Odd Functions, Half-Range Expansions and Fourier Integrals.
CO5	Understand Partial Differential eqations, Solution by Separating Variables.
CO6	Understand the use of Fourier Series in solving PDE: D'Alembert's Solution of the Wave Equation. Characteristics and solving Heat Equation by Fourier Series.
CO7	Understand Laplacian in Polar Coordinates

6B12 MAT:
Numerical Methods, Fourier series and Partial Differential Equations

Unit I- Interpolation **(25 Hours)**

Interpolation with unevenly spaced points, Langrange interpolation, Newton's divided differences interpolation, Finite difference operators and finite differences, Newton's interpolation formulae, Central difference interpolation. (Sections 4.2, 4.2.1, 4.2.3, 4.3.1, 4.3.2, 4.3.3 of Text 1).

Unit II - Numerical Solution of Differential Equations **(25 Hours)**

Introduction, Picard's method, Solution by Taylor series method, Euler method, Runge-Kutta methods (Sections 7.1, 7.2, 7.3, 7.4, 7.5 of Text 1).

Unit III - Fourier Series **(20 Hours)**

Fourier Series, Arbitrary period, Even and Odd Functions, Half-Range Expansions, Fourier Integrals (Sections 11.1, 11.2, 11.7 of Text 2).

Unit IV – Partial Differential Equations **(20 Hours)**

Basic Concepts, Solution by Separating Variables. Use of Fourier Series, D'Alembert's Solution of the Wave Equation. Characteristics, Heat Equation: Solution by Fourier Series (Steady two-dimensional Heat problems, Laplace's equation, unifying power of methods, Electro statistics and Elasticity are excluded), Laplacian in Polar Coordinates (circular membrane, Bessel's equation are excluded). (Sections 12.1, 12.3, 12.4, 12.6, 12.10 of Text 2).

Texts

1. S. R. K. Iyengar and R. K. Jain, Mathematical methods, Narosa Publishing House
2. E. Kreyzig, Advanced Engineering Mathematics (10th edition), John Wiley.

References

1. V.N. Vedamurthy and N.Ch.S.N. Iyengar, Numerical Methods, Vikas Publishing House
2. S.S. Sastry, Introductory Methods of Numerical Analysis (5th edition), PHI
3. B.S. Grewal, Higher Engineering Mathematics (43rd edition), Khanna Publishers
4. S.S. Sastry, Engineering Mathematics , Vol 2 (4th edition), PHI

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	24	**48**
II	24	
III	16	
IV	15	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)

- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

CORE COURSE 13:
LINEAR ALGEBRA

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	**6B13 MAT**	**5**	**4**	**3**	**48**	**12**	**60**

COURSE OUTCOMES

CO1	Understand the concept of Vector spaces, subspaces, linear combinations ad system of equations.
CO2	Understand the concept of Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets and solves problems.
CO3	Understand the concept of Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation.
CO4	Understand Rank of a matrix, Elementary transformations of a matrix, Invariance of rank through elementary transformations, Normal form, Elementary matrices.
CO5	Understand the concept System of linear homogeneous equations Null space and nullity of matrix, Range of a matrix, Systems of linear non homogeneous equations.
CO6	Understand Eigen values, Eigen vectors, Properties of Eigen values, Cayley-Hamilton theorem.

6B13 MAT: Linear Algebra

Unit I – Vector Spaces (20 Hours)

Introduction, Vector spaces, Subspaces, Linear Combinations and Systems of Linear Equations (Sections 1.1, 1.2, 1.3 of Text 1).

Unit II – Bases and Dimension (20 Hours)

Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets (Sections 1.5, 1.6, 1.7 of Text 1).

Unit III - Linear Transformations, Matrices (25 Hours)

Linear Transformations, Null Spaces, and Ranges (Proof of Theorem 2.3 excluded), The Matrix Representation of a Linear Transformation (Sections 2.1, 2.2 of Text 1) (Operations of Linear Transformations and related theorems are excluded).

Introduction, Rank of a matrix, Elementary transformations of a matrix, Invariance of rank through elementary transformations, Elementary transformations of a matrix do not alter its rank, Multiplication of the elements of a row by a non zero number does not alter the rank, Addition to the elements of a row the products by a number of the corresponding elements of a row does not alter the rank, Reduction to normal form (Proof of theorem excluded), Elementary Matrices, Elementary Transformations and elementary matrices, Employment of only row (column) transformations, The rank of a product, A Convenient method for computing the inverse of a non singular matrix by elementary row transformations (Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13 of Text 2).

Unit IV - System of linear equations, Eigen values and Eigen vectors (25 Hours)

Introduction, System of linear homogeneous equations, Null space and nullity of matrix, Sylvester's law of nullity, Range of a matrix, Systems of linear non homogeneous equations (Sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6 of Text 2)

Eigen values, eigen vectors, Properties of eigen values, Cayley-Hamilton theorem(without proof). (Sections 2.13, 2.14, 2.15 of Text 3)

Texts

1. S.H. Friedberg, A. J. Insel and L.E. Spence, Linear Algebra (4^{th} edition), PH Inc
2. S. Narayan and Mittal, A Text Book of Matrices (Revised edition), S. Chand

3. B.S. Grewal, Higher Engineering Mathematics (41st edition), Khanna Publishers.

References

1. R. Larson and D.C. Falvo, Elementary Linear Algebra (6th edition), Houghton Mifflin Harcourt Publishing Company
2. J.R. Kirkwood and B.H. Kirkwood, Elementary Linear Algebra, CRC Press
3. S. Kumaresan, Linear Algebra – A Geometrical approach, Prentice Hall of India
4. S. Axler, Linear Algebra Done Right (3rd edition), Springer
5. K. Hoffman and R. Kunze, Linear Algebra (2nd edition), PHI.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	18	**48**
II	17	
III	22	
IV	22	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - Essay (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

DISCIPLINE SPECIFIC ELECTIVE COURSES

Discipline specific elective courses are:

1. **6B14A MAT: GRAPH THEORY**
2. **6B14B MAT: OPERATIONS RESEARCH**
3. **6B14C MAT: CRYPTOGRAPGY**
4. **6B14D MAT: FUZZY MATHEMATICS**
5. **6B14E MAT: PROGRAMMING IN PYTHON.**

One of the above courses is to be chosen as Discipline Specific Elective Course.

DISCIPLINE SPECIFIC ELECTIVE COURSE 1: GRAPH THEORY

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	**6B14A MAT**	**5**	**3**	**3**	**48**	**12**	**60**

COURSE OUTCOMES

CO1	Understand a graph, subgraph ,different types of graphs and their properties
CO2	Understand and represent graph as matrix
CO3	Understand a path, cycle, trees, bridges and their properties
CO4	Understand cut vertices and connectivity of graphs
CO5	Understand Eulerian graphs, Hamiltonian graphs, The Chinese Postman Problem and The Travelling Salesman Problem.
CO6	Understand planar graphs, Euler's formula, The Platonic bodies and Kuratowski's Theorem
CO7	Model real world problems using the concept of graphs
CO8	Solve real world problems using the concept of graphs

6B14A MAT: Graph Theory

Unit I - An Introduction to Graphs **(20 hours)**

The Definition of a graph, Graphs as models, More definitions, Vertex Degrees, Sub graphs , Matrix representation of graphs (Theorems omitted).
(Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.7 of the Text).

Unit II - Trees and connectivity **(25 hours)**

Paths and Cycles, Definition of trees and simple properties, Bridges, spanning trees, Cut vertices and connectivity.
(Sections 1.6, 2.1, 2.2, 2.3, 2.6 of the Text).

Unit III - Euler Tour and Hamiltonian cycles **(22 hours)**

Euler tours (Excluding Fleury's algorithm), The Chinese Postman Problem, Hamiltonian Graphs, The Travelling salesman Problem (Algorithm Omitted).
(Sections 3.1, 3.2, 3.3, 3.4 of the Text).

Unit IV - Planar Graphs **(23 hours)**

Plane and planar Graphs, Euler's formula, The platonic bodies, Kuratowski's theorem (Proof of Theorem 5.13 and 5.14 are omitted).
(Sections 5.1, 5.2, 5.3, and 5.4).

Text

J. Clark and D.A. Holton, A First Look at Graph Theory, Allied Publishers.

References

1. R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory (2nd edition), Springer.
2. J.A. Bondy and U.S.R. Murthy, Graph Theory with Aplications, Macmillan
3. F. Harary, Graph Theory, Narosa
4. K.R. Parthasarathy, Basic Graph Theory, Tata-McGraw Hill.
5. G. Chartrand and P. Zhang, Introduction to Graph Theory, Tata McGraw Hill

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	19	**48**
II	21	
III	19	
IV	20	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - Essay (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

DISCIPLINE SPECIFIC ELECTIVE COURSE 2:
6B14B MAT: OPERATIONS RESEARCH

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	**6B14B MAT**	**5**	**3**	**3**	**48**	**12**	**60**

COURSE OUTCOMES

CO1	Understand convex sets, convex functions, their properties, local and global extrema and quadratic forms
CO2	Understand LPP, formulate and solve using graphical method
CO3	Understand General LPP, canonical and standard forms of LPP
CO4	Understand simplex method and solve LPP
CO5	Understand basic solution, degenerate solution, basic feasible solution, optimum basic feasible solution , fundamental properties of solution and simplex method
CO6	Understand primal-dual pair, formulation of dual and duality theorems
CO7	Understand LP formulation of transportation problem and its solution
CO8	Understand Mathematical formulation of Assignment problem and Hungarian Assignment method
CO9	Understand problem of sequencing , Processing ‘n’ jobs through ‘2’ machines, Processing ‘n’ jobs through ‘k’ machines
CO10	Understand basic terms in Game theory, The Maximin-Minimax Principle, Solution of game with saddle point, Solution of 2x2 game without saddle point, Graphic solution of 2xn and mx2 games and Arithmetic method for nxn Games.

6B14B MAT: Operations Research

Unit I - Linear Programming Problem (30 hours)

Convex sets and their properties, Convex Functions, Local and Global Extrema, Quadratic Forms.

Linear Programming Problem – Mathematical formulation, Graphical solution, General Linear Programming Problem , Slack and Surplus Variables, Canonical and standard form of LPP, Insights into the simplex method.

Basic Solution, Degenerate Solution, Basic Feasible Solution, Associated cost vector, Improved basic Feasible solution, Optimum Basic Feasible Solution, Fundamental Properties of solution (Proof of theorems omitted), Simplex method – The computational Procedure, The Simplex Algorithm.

General Primal-Dual Pair, Formulating a dual problem (Sections 0:13, 0:15, 0:16, 0:17, 2:1, 2:2, 2:3, 2:4, 3:1, 3:2, 3:4, 3:5, 3:6, 4:1, 4:2, 4:3, 5:1, 5:2, 5:3of the Text).

Unit II - Transportation Problem (25 hours)

LP formulation of the Transportation Problem, Existence of solution in T.P, Duality in Transportation problem, The Transportation Table, Loops in Trasportation Tables, Triangular basis in a T.P (proof of theorem Omitted), Solution of a Trasportation problem, North-west corner Method, Least –Cost Method, VAM, Test For Optimality, Degeneracy in TP, MODI Method.

(Sections 10:1,10:2,10:3,10:4,10:5,10:6,10:7,10:8,10:9,10:10,10:12,10:13 of the Text)

Unit III - Assignment Problem and Sequencing Problem (20 hours)

Assignment Problem: Mathematical Formulation of Assignment Problem, Hugarian Assignment Method.

Sequencing Problem: Problem of sequencing, Basic terms used in sequencing, Processing ‘n’ jobs through ‘2’ machines, Processing ‘n’ jobs through ‘k’ machines, Maintenance Crew Scheduling.

(Sections 11:1, 11:2, 11:3, 12:1, 12:2, 12:3, 12:4, 12:5, 12:7 of the Text)

Unit IV - Games and Strategies (15 hours)

Two-person Zero-sum Games, Basic terms in Game theory, The Maximin-Minimax Principle, Solution of game with saddle point, Solution of 2x2 game without saddle point, Graphic solution of 2xn and mx2 games, Dominance Property, Modified Dominance Property, Arithmetic Method for nxn Games. (Proofs of all theorems in this unit are omitted).

(Sections 17:1, 17:2, 17:3, 17:4, 17:5, 17:6, 17:7, 17:8 of the Text)

Text

K. Swarup, P.K.Gupta and M. Mohan, Operations Research (18^{th} edition), Sulthan Chand and Sons.

References

1. J.K. Sharma, Operations Research - Theory and Applications, McMillan
2. H.A. Thaha, Operations Research, An Introduction (8^{th} edition), Prentice Hall
3. G. Hadley, Linear Programming, Oxford & IBH Publishing Company.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	25	**48**
II	22	
III	18	
IV	14	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - Essay (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

DISCIPLINE SPECIFIC ELECTIVE COURSE 3: CRYPTOGRAPHY

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	**6B14C MAT**	**5**	**3**	**3**	**48**	**12**	**60**

COURSE OUTCOMES

CO1	Understand Simple Cryptosystems namely, The Shift Cipher, The Substitution Cipher, The Affine Cipher, The Vigenere Cipher, The Hill Cipher, The Permutation Cipher and Stream Ciphers
CO2	Understand basics of Shannon's Theory, Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings and Entropy, Properties of Entropy, Spurious Keys and unicity Distance, Product Cryptosystems.
CO3	Understand The Euclidean Algorithm, The Chinese Remainder Theorem
CO4	Understand Legendre and Jacobi Symbols and quadratic residues
CO5	Understand The RSA System and Factoring (25 Hours): Introduction to Public-key Cryptography, The RSA Cryptosystem, Implementing RSA, Primality Testing, The Solovay-Strassen Algorithm, The Miller Rabin Algorithm, Square roots modulo *n*.

6B14C MAT: Cryptography

Unit I - Some Simple Cryptosystems **(20 Hours)**
Introduction, The Shift Cipher, The Substitution Cipher, The Affine Cipher, The Vigenere Cipher, The Hill Cipher, The Permutation Cipher, Stream Ciphers (Section 1.1 of Chapter 1 in the Text).

Unit II - Shannon's Theory **(25 Hours)**
Introduction, Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings and Entropy, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystems (Chapter 2 in the Text).

Unit III - More on Number Theory **(20 Hours)**
The Euclidean Algorithm, The Chinese Remainder Theorem, Other Useful Facts (Proof of Lagrange's theorem omitted), Legendre and Jacobi Symbols (Sections 5.2 and 5.4.1 of Chapter 5 in the Text).

Unit IV - The RSA System and Factoring **(25 Hours)**
Introduction to Public-key Cryptography, The RSA Cryptosystem, Implementing RSA, Primality Testing, The Solovay-Strassen Algorithm, The Miller Rabin Algorithm, Square roots modulo *n* (Sections 5.1, 5.3, 5.4.2, 5.4.3, 5.5 of Chapter 5in the Text).

Text

Douglas R. Stinson, Cryptography: Theory and Practice- Third Edition, CRC Press, 2006.

References:

1. David M. Burton, Elementary Number Theory- Seventh Edition, Mc Graw Hill
2. William Stallings, Cryptography and Network Security Principles and Practices- Fourth Edition, Prentice Hall
3. Christof Paar-Jan Pelzl, Understanding Cryptography- A Text for Students and Practitioners, Springer.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	19	**48**
II	21	
III	19	
IV	20	
Total	**79**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

DISCIPLINE SPECIFIC ELECTIVE COURSE 4:
FUZZY MATHEMATICS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	6B14D MAT	5	3	3	48	12	60

COURSE OUTCOMES

CO1	Understand Fuzzy Subsets, L-fuzzy Sets, Visual representation of a Fuzzy Subset, Operations on Fuzzy Subsets, Empty Fuzzy Subset 0
CO2	Understand Universal Fuzzy Subset, Disjoint Fuzzy Subsets, Disjunctive Sum
CO3	Understand α Level Set, Properties of Fuzzy Subsets of a Set, Algebraic Product and Sum of Two Fuzzy Subsets, Properties Satisfied by Addition and Product
CO4	Understand Cartesian Product of Fuzzy Subsets
CO5	Understand Fuzzy Relations, Binary Fuzzy Relations, Binary Relations on a Single Set, Fuzzy Equivalence Relations
CO6	Understand Fuzzy Subgroup, Fuzzy Subgroupoids
CO7	Understand The Lattice of Fuzzy Subgroups, Fuzzy Subgroup, Fuzzy Subrings

6B14D MAT: Fuzzy Mathematics

Unit I - Fuzzy Subsets and Fuzzy Mappings I (25 hours)
Introduction, Fuzzy Subsets, L-fuzzy Sets, Visual Representation of a Fuzzy Subset, Operations on Fuzzy Subsets, Empty Fuzzy Subset 0 and Universal Fuzzy Subset, Disjoint Fuzzy Subsets, Disjunctive Sum (Sections 1.1, 1.2, 1.5, 1.6, 1.7, 1.7.1, 1.7.2, 1.8 of Text 1).

Unit II - Fuzzy Subsets and Fuzzy Mappings II (23 hours)
α Level Set, Properties of Fuzzy Subsets of a Set, Algebraic Product and Sum of Two Fuzzy Subsets, Properties Satisfied by Addition and Product, Cartesian Product of Fuzzy Subsets (Sections 1.9, 1.10, 1.11, 1.12, 1.13 in Text 1. Proof of theorems in Section 1.13 omitted).

Unit III - Fuzzy Relations (22 hours)
Crisp and Fuzzy Relations, Binary Fuzzy Relations, Binary Relations on a Single Set, Fuzzy Equivalence Relations (Sections 5.1, 5.3, 5.4, 5.5 of Text 2).

Unit IV - Fuzzy Groups and Fuzzy Rings (20 hours)
Introduction, Fuzzy Subgroup, Fuzzy Sub groupoids, The Lattice of Fuzzy Subgroups, Fuzzy Subgroup, Fuzzy Sub rings (Section 3.1, 3.2, 3.2.1, 3.2.2, 3.3.2, 3.5 except Theorems 3.5.2, 3.5.3, 3.5.4, 3.5.5 in Text 1).

Texts

1. S. Nanda and N.R. Das, Fuzzy Mathematical Concepts, Narosa Pub. House
2. G.J. Klir and B Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications.

References

1. K.H. Lee, First Course on Fuzzy Theory and Applications, Springer-Verlag
2. H.J. Zimmermann, Fuzzy Set Theory-And Its Applications (2nd revised edition), Allied Publishers Limited.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>21</td><td rowspan="5">48</td></tr>
<tr><td>II</td><td>20</td></tr>
<tr><td>III</td><td>19</td></tr>
<tr><td>IV</td><td>19</td></tr>
<tr><td>Total</td><td>79</td></tr>
</table>

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

DISCIPLINE SPECIFIC ELECTIVE COURSE 5: PROGRAMMING IN PYTHON

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
VI	6B14E MAT	5	3	3	48	12	60

COURSE OUTCOMES

CO1	Understand the basics of Python Variables, Indentation in Python, Input, Output and Import Functions Operators
CO2	Understand Pythan programming for numbers, Dictionaries and Mathematical functions
CO3	Understand Flow Control, if, if..else, if ,.else, Loops – for loop, Range Function, while, Section 3.3 Nested Loop, Break and Continue Statements in Pythan
CO4	Understand Data visualization – The Matplot lib Module, Plotting mathematical functions, Famous Curves, 2D plot using colors, Mesh grids, 3D Plots using Pthan
CO5	Understand Pythan programming for Solving equations using Newton-Raphson's Method , Bisection Method , Method of false position, Trapezoidal rule of Numerical Integration , Simpson's Three Eighth rule of Numerical Integration, Euler's Modified Method to solve first order differential equation , Runge-Kutta Method of Order 4, Lagrange's Method for Interpolation.

6B14E MAT: Programming in Python

Unit I **(30 Hours)**

Features of Python, Variables, Indentation in Python, Input, Output and Import Functions, Operators, Numbers, List, Tuples, Set, Dictionaries, Mathematical Functions (Sections 1.1, 1.5, 1.7, 1.11, 1.12, 2.1, 2.3, 2.5, 2.6 of Text 1. 1.12.4 and 1.12.7 omitted).

Unit II **(18 hours)**

Flow Control, if, if..else, Loops – for loop, Range Function, while, Nested Loop, Break and Continue Statements (Section 3.1, 3.2, 3.3, 3.4 of Text 1).

UNIT III **(20 Hours)**

Data visualization – The Matplot lib Module, Plotting mathematical functions, Famous Curves, 2D plot using colors, Mesh grids, 3D Plots. (Relevant sections from Text 2).

Practicals (10 Programmes) **(22 Hours)**

1. Solution of Ax =B using Doolittle method
2. Newton-Raphson’s Method
3. Bisection Method
4. Method of false position
5. Trapezoidal rule of Numerical Integration
6. Simpson’s Three Eighth rule of Numerical Integration
7. Euler’s Modified Method to solve first order differential equation
8. Runge-Kutta Method of Order 4
9. Lagrange’s Method for Interpolation
10. Taylor Series Method for initial value problems.

Texts

1. Dr. Jeeva Jose, Taming Python by Programming, Khanna Publications
2. B.P. Ajith Kumar, Python for Education – Learning Mathematics and Physics using Python and writing them in Latex (Free download from www.iuac.res.in/phoenix).

Reference

J. Kiusalaas, Numerical methods in Engineering with Python, Cambridge University Press.

Marks including choice

Unit	Marks in End Semester Examination*	
	Aggregate Marks	Maximum Marks
I	25	**48**
II	14	
III	16	
IV	24	
Total	**79**	48

No End Semester Practical Examination shall be conducted for this course.

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 8 questions*** *(8 questions x Marks 2 each=16)*

Part C - **Essay** (7 questions x Marks 4 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 4 each=16)*

Part D - **Long Essay** (4 questions x Marks 6 each = 24)
- ***Answer any 2 questions*** *(2 questions x Marks 6 each=12).*

6B15 MAT: PROJECT

A student of B.Sc. Mathematics should compulsorily do a project work on a topic of his/her choice and prepare a project dissertation for completing the B.Sc. Mathematics Pogramme. The project work should satisfy the following criteria.

1. The topic of study should not be a part of the existing syllabus. But it can be an extension of a topic of the syllabus.
2. After the completion of the study, the student shall submit a project dissertation to the university in typed form.
3. The dissertation should have at least 15 pages excluding the page of table of contents.
4. The dissertation can be prepared using any typesetting software like LaTeX, MS Word or Libre Office Writer.
5. The project work can be done individually if the student so wishes. It can be done as a group having maximum 3 students.
6. The dissertation should contain a Title Page, Certificate from the Project Guide/Supervisor countersigned by the Head of the Department, Table of Contents, Preface/Introduction and References.

Evaluation of the project work and dissertation

1. **Internal Evaluation**
   Internal evaluation of the project has the following components.

Sl. No.	Components	Percentage of marks allotted	Marks allotted
1	Relevance of the topic and references	20	1.4
2	Layout	10	0.7
3	Content	20	1.4
4	Presentation and Viva-voce*	50	3.5
	Total	**100**	**7**

*Presentation and Viva-voce are to be conducted individually even if the project is done as a group.

2. **External Evaluation**

External evaluation of the project has the following components.

Sl. No.	Components	Percentage of marks	Marks allotted
1	Relevance and depth of the topic and layout	25	7
2	Seminar presentation*	25	7
3	Viva-voce*	50	14
Total		**100**	**28**

*Viva-voce and Seminar presentation are to be conducted individually even if the project is done as a group.

The student should get a minimum of 40% of the aggregate marks and 40% separately for End Semester examination and 10% for CE for pass in the project.

PART B

MATHEMATICS
COMPLEMENTARY ELECTIVE COURSES

FOR

BSc PHYSICS, CHEMISTRY, STATISTICS, ELECTRONICS, COMPUTER SCIENCE AND BCA PROGRAMMES

WORK AND CREDIT DISTRIBUTION

(2019 ADMISSION ONWARDS)

1. BSc PHYSICS PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-PH	MATHEMATICS FOR PHYSICS I	I	4	3	3
2C02 MAT-PH	MATHEMATICS FOR PHYSICS II	II	4	3	3
3C03 MAT-PH	MATHEMATICS FOR PHYSICS III	III	5	3	3
4C04 MAT-PH	MATHEMATICS FOR PHYSICS IV	IV	5	3	3

2. BSc CHEMISTRY PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-CH	MATHEMATICS FOR CHEMISTRY I	I	4	3	3
2C02 MAT-CH	MATHEMATICS FOR CHEMISTRY II	II	4	3	3
3C03 MAT-CH	MATHEMATICS FOR CHEMISTRY III	III	5	3	3
4C04 MAT-CH	MATHEMATICS FOR CHEMISTRY IV	IV	5	3	3

3. BSc STATISTICS PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-ST	MATHEMATICS FOR STATISTICS I	I	4	3	3
2C02 MAT-ST	MATHEMATICS FOR STATISTICS II	II	4	3	3
3C03 MAT-ST	MATHEMATICS FOR STATISTICS III	III	5	3	3
4C04 MAT-ST	MATHEMATICS FOR STATISTICS IV	IV	5	3	3

4. BSc ELECTRONICS PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-EL	MATHEMATICS FOR ELECTRONICS I	I	4	3	3
2C02 MAT-EL	MATHEMATICS FOR ELECTRONICS II	II	4	3	3
3C03 MAT-EL	MATHEMATICS FOR ELECTRONICS III	III	5	3	3
4C04 MAT-EL	MATHEMATICS FOR ELECTRONICS IV	IV	5	3	3

5. BSc COMPUTER SCIENCE PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-CS	MATHEMATICS FOR COMPUTER SCIENCE I	I	4	3	3
2C02 MAT-CS	MATHEMATICS FOR COMPUTER SCIENCE II	II	4	3	3
3C03 MAT-CS	MATHEMATICS FOR COMPUTER SCIENCE III	III	5	3	3
4C04 MAT-CS	MATHEMATICS FOR COMPUTER SCIENCE IV	IV	5	3	3

6. BCA PROGRAMME

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
1C01 MAT-BCA	MATHEMATICS FOR BCA I	I	4	4	3
2C02 MAT-BCA	MATHEMATICS FOR BCA II	II	4	4	3
3C03 MAT-BCA	MATHEMATICS FOR BCA III	III	4	4	3
4C04 MAT-BCA	MATHEMATICS FOR BCA IV	IV	4	4	3

EVALUATION

ASSESSMENT	WEIGHTAGE
EXTERNAL	4
INTERNAL	1

INTERNAL ASSESSMENT

COMPONENT	WEIGHTAGE	MARKS	REAMARKS
COMPONENT1- ASSIGNMENT / SEMINAR / VIVA-VOCE	50%	5	For each course, a student has to submit one assignment/ attend one seminar/ attend one viva-voce
COMPONENT 2- TEST PAPER	50%	5	For each course, a student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.
TOTAL	100%	**10**	

- **Use of Scientific Calculators below 100 functions (that is, upto fx 99) shall be permitted for all the above courses.**

MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc PHYSICS PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR PHYSICS I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT - PH	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand the concept of Differentiation and successive differentiation.
CO2	Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem,.
CO3	Understand the Taylor's theorem , expansions of functions – Maclaurin's series, expansion by use of known series
CO4	Understand the Matrices and System of Equations, Linear Transformations
CO5	Understand Rank of a matrix, elementary transformations, normal form of a matrix, inverse of a matrix, solution of linear system of equations.
CO6	Understand Linear transformations, orthogonal transformation, vectors – linear dependence
CO7	Understand Derivative of arc, curvature, Polar coordinates, Cylindrical and Spherical co-ordinates

1C01 MAT-PH: Mathematics for Physics I

Unit I - Differential Calculus - Differentiation and successive differentiation (18 hours)

Text: Differential Calculus, Shanti Narayan and P. K. Mittal

Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. (*Questions should not be asked in the End Semester Examinations from the above sections for quick review*) (Relevant portions from sections 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10).

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two functions (Sections 4.1, 4.2)

Unit II - Differential Calculus – Applications of differential Calculus (18 hours)

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series, Indeterminate forms - form 0/0, form ∞/∞, form reducible to 0/0 form - form 0.∞, form ∞-∞, forms 0^0,1^∞, ∞^0 . (Sections 4.3, 4.4, 4.5)

Unit III - Linear Algebra – Matrices and System of Equations, Linear Transformations (20 hours)

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence

(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV - Curvature and Geometry **(16 hours)**

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Derivative of arc, curvature (radius of curvature only for Cartesian curve y=f(x)), centre of curvature

(Sections 4.9, 4.10, 4.11, 4.12)

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Polar coordinates, Cylindrical and spherical co-ordinates

(Section 11.3, relevant portions from section 15.7).

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai.
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company.
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	18	**40**
II	16	
III	18	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:
MATHEMATICS FOR PHYSICS II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	**2C02 MAT - PH**	**4**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand partial derivatives, homogeneous functions, Euler's theorem, total derivative, differentiation of implicit functions, change of variables
CO2	Understand Integration and Integration by Successive Reduction , Integration of Trigonometric Functions
CO3	Comprehend Applications of Integration
CO4	Comprehend Eigen values, Eigen vectors, properties of Eigen values,
CO5	Understand Cayley- Hamilton theorem, Diagonal form, similarity of matrices, powers of a matrix, canonical form, nature of a quadratic form

2C02 MAT-PH: Mathematics for Physics II

Unit I - Differential Calculus – Partial Differentiation (18 hours)
Text: Differential Calculus, Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Integral Calculus - Integration and Integration by Successive Reduction (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Quick review of basics of Integration (*Questions should not be asked in the End Semester Examinations from the above sections for quick review*)
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)
Text: Integral Calculus, Santhi Narayanan and P.K. Mittal
Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $sin^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$, Integration of $sin^p x cos^q x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit III - Integral Calculus – Applications of Integration (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Substitutions and the area between curves, volumes using cross sections, arc length, areas of surfaces of revolution, areas and length in polar coordinates
(Section 5.6, 6.1, 6.3, 6.4, 11.5)

Unit IV - Linear Algebra – Eigen Values and Cayley Hamilton Theorem (18 hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices,

powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form.
(Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18).

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai.
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company.
4. Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
5. Calculus (10^{th} edition), Anton, Bivens, Davis, Wiley-India

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	16	
III	16	
IV	18	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR PHYSICS III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3C03 MAT - PH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand the concept of Multiple Integrals and solves problems
CO2	Understand Vector Differentiation
CO3	Understand Laplace Transforms and its Applications
CO4	Understand Fourier Series and Half range expansions

3C03 MAT-PH: Mathematics for Physics III

Unit I - Integral Calculus – Multiple Integrals (26 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates, substitutions in multiple integrals
(Sections 15.1, 15.2, 15.3, 15.4, 15.5, 15.8)

Unit II - Vector Calculus – Vector Differentiation (22 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Lines and planes in space, curves in space and their tangents, curvature and normal vector of a curve, tangential and normal components of acceleration, directional derivatives and gradient vectors.
(Sections 12.5, 13.1, 13.3 to 13.5, 14.5)

Unit III - Laplace Transforms and its Applications **(24 hours)**

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Laplace Transforms: Laplace Transform, Linearity, first shifting theorem (*s*-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (*t*- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.

(Chapter 6 Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9)(Proofs are omitted)

Unit IV - Fourier Series **(18 hours)**

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Fourier Series Fourier series, arbitrary period, , Even and Odd functions, Half-range Expansions. (Proofs are omitted)

(Chapter 11 Sections 11.1, 11.2)

References

1. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
2. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
3. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
4. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	18	**40**
II	16	
III	18	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 7 questions***	*(7 questions x Marks 2 each=14)*
Part C -	Essay	(7 questions x Marks 3 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 3 each=12)*
Part D -	**Long Essay**	(4 questions x Marks 5 each = 20)
	• ***Answer any 2 questions***	*(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR PHYSICS IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT - PH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Wave Equation, Solution by Separating Variables, D-Alembert’s solution of the wave equation.
CO2	Understand Heat Equation and Solution by Fourier Series
CO3	Understand Line integrals , path independence, conservative fields and potential functions, Green’s theorem in the plane
CO4	Understand Surface area, surface integrals, Stoke’s theorem, Divergence theorem
CO5	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO6	Understand Numerical Solutions of Ordinary Differential Equations by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.

4C04 MAT-PH: Mathematics for Physics IV

Unit I - Partial differential Equations (20 hours)

Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.

Basic Concepts, Modeling: Vibrating String, Wave Equation,
Solution by Separating Variables, Use of Fourier Series, D-Alembert's solution of the wave equation, Heat Equation, Solution by Fourier Series.
(Chapter 12 sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6)
(*Excluding* steady two dimensional heat problems and Laplace equation of 12.5).

Unit II - Vector Calculus – Vector Integration (22 hours)

Text: Thomas' Calculus (12^{th} edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Line integrals (mass, moment and moment of inertia are excluded), vector fields and line integrals: work, circulation and flux, path independence, conservative fields and potential functions, Green's theorem in the plane (Proof of Green's theorem is excluded)
(Sections 16.1, 16.2,16.3,16.4)

Unit III - Vector Calculus – Vector Integration (24 hours)

Text: Thomas' Calculus (12^{th} edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Surfaces and area, surface integrals, Stoke's theorem, the divergence theorem and unified theory (Gauss's Law: One of the four great laws of Electromagnetic Theory, continuity equation of Hydrodynamics, Unifying the integral theorems are excluded) (Proofs of all theorems are excluded)
(Sections16.5, 16.6, 16.7, 16.8)

Unit IV - Numerical Analysis (24 hours)

Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry PHI Learning.

Numerical Integration: Numerical Integration, Trapezoidal Rule, Simpson's 1/3- Rule
(Chapter 6 Sections 6.4, 6.4.1, 6.4.2)

Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
(Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

References

1. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
2. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
3. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
4. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
5. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>16</td><td rowspan="5">40</td></tr>
<tr><td>II</td><td>16</td></tr>
<tr><td>III</td><td>16</td></tr>
<tr><td>IV</td><td>18</td></tr>
<tr><td>Total</td><td>66</td></tr>
</table>

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 7 questions***	*(7 questions x Marks 2 each=14)*
Part C -	**Essay**	(7 questions x Marks 3 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 3 each=12)*
Part D -	**Long Essay**	(4 questions x Marks 5 each = 20)
	• ***Answer any 2 questions***	*(2 questions x Marks 5 each=10).*

MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc CHEMISTRY PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR CHEMISTRY I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT-CH	4	3	3	40	10	50

Course outcomes

CO1	Understand Successive differentiation and Leibnitz's theorem for the nth derivative of the product of two functions
CO2	Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem and Cauchy's mean value theorem.
CO3	Understand Taylor's theorem, expansions of functions – Maclaurin's series, expansion by use of known series and Taylor's series.
CO4	Understand the method of finding limits of Indeterminate forms.
CO5	Understand Polar, Cylindrical and Spherical co-ordinates.
CO6	Understand Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix and partition method of finding the inverse.
CO7	Understand solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations.
CO8	Understand Linear transformations, orthogonal transformation and linear dependence of vectors.
CO9	Understand methods of curve fitting, graphical method, laws reducible to the linear law, principles of least squares, method of least squares and apply the principle of least squares to fit the straight line $y=a+bx$, to fit the parabola $y=a+bx+cx^2$, to fit $y=ax^b$, $y=ae^{bx}$ and $xy^n=b$

1C01 MAT-CH: Mathematics For Chemistry I

Unit I - Differential Calculus - Differentiation and successive differentiation (18 hrs)

Text: Differential Calculus, Shanti Narayan and P.K. Mittal

Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. *(Questions should **not** be asked in the End Semester Examinations from the above sections for quick review)* (Relevant portions from sections 4.3,4.4,4.5,4.6,4.7, 4.8,4.9,4.10)

Text: Higher Engineering Mathemaics (41^{st} edition), B.S. Grewal, Khanna Pub.

Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two functions (Sections 4.1, 4.2)

UnitII : Differential Calculus – Applications of Differentiation (18 hrs)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series, Indeterminate forms - form 0/0, form ∞/∞, forms reducible to 0/0 form - form $0.\infty$, form $\infty-\infty$, forms $0^0, 1^\infty, \infty^0$.

Unit III Linear Algebra – Matrices and System of Equations, Linear Transformations (20 hrs)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equatios in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence
(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV Curve Fitting (16 hrs)

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Introduction, graphical method, laws reducible to the linear law, principles of least squares, method of least squares, to fit the straight line y=a+bx, to fit the parabola $y=a+bx+cx^2$ (Sections 24.1, 24.2, 24.3, 24.4, 24.5)

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
6. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	16	
III	20	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 1 question*** *(2 questions x Marks 5each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:
MATHEMATICS FOR CHEMISTRY II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	2C02 MAT-CH	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Functions of two or more variables, limits and continuity.
CO2	Understand partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions and change of variables.
CO3	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals $\int_0^{\frac{\pi}{2}} sin^n x\,dx$, $\int_0^{\frac{\pi}{2}} cos^n x\,dx$ and $\int_0^{\frac{\pi}{2}} sin^p x\,cos^q x dx$.
CO4	Understand Substitutions and the area between curves, arc length, areas and length in polar coordinates.
CO5	Understand Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form and triple integrals in rectangular co-ordinates.
CO6	Understand Eigen values, Eigen vectors, properties of Eigen values, Cayley- Hamilton theorem, reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form and nature of a quadratic form

2C02 MAT-CH: Mathematics for Chemistry II

Unit I - Differential Calculus – Partial Differentiation (18 hours)
Text: Differential Calculus, Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Integral Calculus - Integration and Integration by Successive Reduction (18 hours)
Text: Thomas' Calculus (12^{th} edition), Maurice D. Weir and Joel Hass, Pearson India Education Services
Quick review of basics of Integration **(Questions should not be asked in the End Semester Examinations from the above sections for quick review)**
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)

Text: Integral Calculus, Santhi Narayanan and P.K. Mittal
Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $sin^n x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$,Integration of $sin^p x cos^q x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit III - Integral Calculus – Applications of Integration and Multiple Integrals (20 hours)
Text: Thomas' Calculus (12^{th} edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Substitutions and the area between curves, arc length, polar coordinates, areas of surfaces of revolution, areas and length in polar coordinates (Section 5.6, 6.3, 11.3, 11.5).

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates (Sections 15.1, 15.2, 15.3, 15.4, 15.5).

Unit IV - Linear Algebra – Eigen Values **(16 hours)**

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form (Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18.)

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	16	
III	20	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

Answer any 2 questions *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR CHEMISTRY III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3C03 MAT-CH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Ordinary differential equations, Geometrical meaning of $y' = f(x, y)$ and Direction Fields.
CO2	Understand Methods of solving Differential Equations: Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs and Bernoulli Equation.
CO3	Understand Orthogonal Trajectories, Existence and Uniqueness of Solutions.
CO4	Understand Second order ODEs, Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian, Nonhomogeneous ODEs and Solution by variation of Parameters
CO5	Understand Laplace Transform, Linearity, first shifting theorem, Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem, Convolution, Integral Equations, Differentiation and integration of Transforms and to solve special linear ODE's with variable coefficients and Systems of ODEs
CO6	Understand Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions.

3CO3 MAT-CH: Mathematics for Chemistry III

Unit I - First Order Ordinary Differential Equations (25 hrs)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig.

Basic concepts, Geometrical meaning of $y' = f(x, y)$. Direction Fields (numerical method by Euler is excluded), Separable ODEs (modelling is excluded) , Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics is excluded).
(Sections 1.1, 1.2, 1.3, 1.4, 1.5)

Unit II: Second Order Ordinary Differential Equations (20 hrs)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of Theorems only, proofs omitted), Nonhomogeneous ODEs, Solution by variation of Parameters.
(Sections 2.1 to 2.10 *except* 2.4, 2.8 and 2.9)

Unit III: Laplace Transforms and its Applications (25 hrs)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Laplace Transform, Linearity, first shifting theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (t- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.
(Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9 (Proofs are omitted))

Unit IV Fourier Series (20 hrs)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions. (Proofs are omitted)
(Sections 11.1, 11.2)

References

1. Higher Engineering Mathematics (41st edition), B .S. Grewal, Khanna Pub.

2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley
3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Text of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>19</td><td rowspan="5">40</td></tr>
<tr><td>II</td><td>16</td></tr>
<tr><td>III</td><td>18</td></tr>
<tr><td>IV</td><td>13</td></tr>
<tr><td>Total</td><td>66</td></tr>
</table>

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR CHEMISTRY IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT-CH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Partial Differential Equations, Modeling, Vibrating String, Wave Equation..
CO2	Solve PDE by Separating Variables, by use of Fourier Series, D-Alembert’s solution of the wave equation and Heat Equation.
CO3	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO4	Understand Numerical methods to find Solutions of Ordinary Differential Equations: Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
CO5	Understand volumes of solid using cross sections and areas of surfaces of revolution

4C04 MAT-CH: Mathematics for Chemistry IV

Unit I - Partial differential Equations (30 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Basic Concepts, Modeling: Vibrating String, Wave Equation, Solution by Separating Variables, Use of Fourier Series, D-Alembert's solution of the wave equation, Heat Equation, Solution by Fourier Series.

(sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6) (*Excluding* steady two dimensional heat problems and Laplace equation of 12.5).

Unit II - Numerical Analysis (30 hrs)

Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry, PHI Learning

Numerical Integration - Trapezoidal Rule, Simpson's 1/3-Rule

(Sections 6.4, 6.4.1, 6.4.2)

Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.

(Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

Unit III - Group Theory

Text: Group Theory in Chemistry, M.S. Gopinathan and V. Ramakrishnan, Vishal Pub. Co. (30 hrs)

Symmetry elements and symmetry operations: Identity, rotation, reflection, improper rotation and inversion.

Group theory - Definition of group, order of a group, classes and similarity transformations, point group classifications, subgroups- group multiplication table. Matrix representation of symmetry operations – rotation, reflection, identity.

(Sections 1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 3.2).

References

1. Higher Engineering Mathematics (41st edition), B .S. Grewal, Khanna Pub.
2. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.
3. Molecular Symmetry and Group Theory, Robert L. Carter, Wiley.
4. Chemical Applications of Group Theory (3rd edition), F. Albert Cotton, Wiley

5. Group Theory and Symmetry in Chemistry, Gurudeep Raj, Ajay Bhagi and Vinod Jain, Krishna Prakashan Media.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	22	**40**
II	22	
III	22	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - Essay (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc STATISTICS PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR STATISTICS I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT-ST	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Differentiation and Successive Differentiation
CO2	Understand Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two Sections
CO3	Understand Applications of Differentiation
CO5	Understand Matrices and System of Equations, Linear Transformations
CO6	Understand Lines and planes in space, curves in space and their tangents, curvature and normal vector of a curve, tangential and normal components of acceleration, directional derivative, gradient vectors, divergence and curl

1C01 MAT-ST: Mathematics for Statistics I

Unit I- Differential Calculus - Differentiation and Successive Differentiation (16 hours)

Text: Differential Calculus, Shanti Narayan and P.K. Mittal

Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. **(Questions should not be asked in the End Semester Examinations from the above sections for quick review).** Relevant portions from sections 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10

Text: Higher Engineering Mathemaics (41^{st} edition), B.S. Grewal, Khanna Pub.

Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the n^{th} derivative of the product of two functions.

(Sections 4.1, 4.2)

Unit II- Differential Calculus – Applications of Differentiation (20 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series.

Indeterminate forms - form 0/0, form ∞/∞, forms reducible to 0/0 form - form $0.\infty$, form $\infty-\infty$, forms 0^0, 1^∞, ∞^0

(Sections 4.3, 4.4, 4.5)

Unit III- Linear Algebra - Matrices and System of Equations, Linear Transformations (20 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Rank of a matrix, elementary transformation of a matrix, equivalent matrices elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equatios in *n* unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence

(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV- Vector Differential Calculus **(16 hours)**

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Lines and planes in space, curves in space and their tangents, curvature and normal vector of a curve, tangential and normal components of acceleration, directional derivatives and gradient vectors (Sections 12.5, 13.1, 13.3, 13.4, 13.5, 14.5)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Divergence and curl (Sections 9.8 and 9.9)

Reference

1. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
2. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand
3. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
4. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
5. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**40**
II	20	
III	17	
IV	12	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:
MATHEMATICS FOR STATISTICS II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	2C02 MAT-ST	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Partial Differentiation: Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables
CO2	Understand Integration and Integration by Successive Reduction, Integration of Trigonometric Functions
CO3	Understand Applications of Integration and Multiple Integrals
CO4	Understand Eigen Values and Eigen vectors, Cayley-Hamilton Theorem

2C02 MAT-ST: Mathematics for Statistics II

Unit I- Differential Calculus - Partial Differentiation (17 hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II- Integral Calculus – Integration and Integration by Successive Reduction (17 hours)
Text: Integral Calculus, Santhi Narayanan and P.K. Mittal, S. Chand
Quick review of basics of Integration *(Questions should **not** be asked in the End Semester Examinations from the above sections for quick review)*
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)

Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $sin^n x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$, Integration of $sin^p x cos^q x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit III Integral Calculus – Applications of Integration and Multiple Integrals (20 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services, 2016
Substitutions and the area between curves, arc length, areas and length in polar coordinates (Section 5.6, 6.3, 11.5)

Multiple Integrals- Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates, triple integrals in cylindrical and spherical co-ordinates, substitutions in multiple integrals
(Sections 15.1, 15.2, 15.3, 15.4, 15.5, 15.7, 15.8)

Unit IV
Linear Algebra – Eigen Values and Cayley-Hamilton Theorem (18 hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form
(Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18)

Reference

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
3. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**40**
II	17	
III	20	
IV	12	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR STATISTICS III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3C03 MAT-ST	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Geometrical meaning of First order ordinary differential equation $y' = f(x, y)$. Direction Fields , Separable ODEs , Exact ODEs, Linear ODEs, Bernoulli Equation
CO2	Understand Homogeneous Linear ODEs of second order, Differential Operators, Euler-Cauchy Equation, Wronskian solution by variation of Parameters
CO3	Understand Laplace Transform, first shifting theorem ,Transforms of Derivatives and Integrals, unit step Function, Convolution, General Formulas, Table of Laplace Transforms
CO4	Understand Fourier series, arbitrary period, , Even and Odd functions, Half-range Expansions

3C03 MAT-ST: Mathematics for Statistics III

Unit I- First Order Ordinary Differential Equations (24 hours)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig , Wiley

Basic concepts, Geometrical meaning of $y'=f(x, y)$. Direction Fields (numerical method by Euler excluded), Separable ODEs (modelling is excluded), Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics is excluded)
Chapter 1 Sections 1.1, 1.2, 1.3, 1.4, 1.5

Unit II- Second Order Ordinary Differential Equations (24 hours)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley

Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of Theorems only, proofs are omitted), Nonhomogeneous ODEs, Solution by variation of Parameters.
Sections 2.1 to 2.10 except 2.4, 2.8 and 2.9

Unit III- Laplace Transforms and its Applications (24 hours)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley

Laplace Transform, Linearity, first shifting theorem (*s*-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (*t*- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.
Chapter 6 Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9 (Proofs of theorems are omitted)

Unit IV Fourier Series (18 hours)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley

Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions. (Proofs are omitted)
Chapter 11 Sections 11.1, 11.2

References

1. Higher Engineering Mathematics (41^{st} edition), B .S. Grewal, Khanna Pub.

2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley
3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	18	**40**
II	16	
III	18	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR STATISTICS IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT-ST	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Partial Differential Equations ,Basic Concepts, solution by separation of variables
CO2	Understand Solution of Algebraic and Transcendental Equation : Bisection Method, Method of false position, Newton-Raphson Method
CO3	Understand Finite differences , forward differences, Backward differences, Interpolation, Divided differences and their properties
CO4	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO5	Understand Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta method
CO6	Understand Volume and Surface Area of Revolution

4C04 MAT-ST: Mathematics for Statistics IV

Unit I- Partial Differential Equations (18 hours)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
Basic Concepts, solution by separation of variables, use of Fourier series
Sections 12.1, 12.3

Unit II- Numerical Analysis (28 hours)
Text: Introductory Methods of Numerical Analysis (5th edition), S.S. Sastry, PHI Learning.
Solution of Algebraic and Transcendental Equation: Introduction**,** Bisection Method, Method of false position, Newton-Raphson Method
Chapter 2 Sections 2.1, 2.2, 2.3 and 2.5
Finite Differences and Interpolation: Introduction, finite differences **- f**orward differences, Backward differences, Interpolation with unevenly spaced points Newton's formulae for interpolation, Interpolation with unevenly spaced points - Langrange's interpolation formula, Divided differences and their properties, Newton's general interpolation formula
Sections 3.1, 3.3, 3.3.1, 3.3.2, 3.6, 3.9, 3.9.1, 3.10, 3.10.1

Unit III- Numerical Analysis (26 hours)
Text: Introductory Methods of Numerical Analysis (5th edition), S.S. Sastry, PHI Learning
Numerical Integration **-** Trapezoidal Rule, Simpson's 1/3-Rule
Chapter 6 Sections 6.4, 6.4.1, 6.4.2
Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
Sections 8.1, 8.2, 8.4, 8.4.2, 8.5

Unit IV- Integral Calculus – Volume and Surface Area of Revolution (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Volumes using cross sections, areas of surfaces of revolution.
Sections 6.1, 6.4

References

1. Higher Engineering Mathematics (41st edition), B .S. Grewal, Khanna Pub
2. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.
3. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
4. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	13	**40**
II	20	
III	20	
IV	13	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc ELECTRONICS PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR ELECTRONICS I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT-EL	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand functions of two or more variables, limits, continuity, partial derivatives,.
CO2	Understand homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables
CO3	Understand lines , planes curves in space , their tangents, curvature and normal, tangential and normal components of acceleration, directional derivatives and gradient vectors.
CO4	Understand Rank of a matrix, elementary transformation of a matrix, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse,
CO5	Understand Cramer's rule, matrix inversion method to find solution of linear system of equations
CO6	Understand Rouche's theorem, procedure to test the consistency of a system of equations
CO7	Understand linear transformations, orthogonal transformation,
CO8	Understand linear dependence and independence.
CO9	Understand Probability distributions and curve fitting

1C01 MAT-EL: Mathematics for Electronics I

Unit I - Differential Calculus (16 hours)

Text: Differential Calculus, Shanti Narayan and P.K. Mittal

Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. *(Questions should not be asked in the End Semester Examinations from the above sections for quick review)*
(Relevant portions from sections 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10)

Text: Differential Calculus, Higher Engineering Mathematics (41^{th} edition), B.S. Grewal, Khanna Pub

Partial Differentiation: Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Vector Differentiation and Geometry (16 hours)

Text: Thomas' Calculus (12^{th} edition), Maurice D. Weir and Joel Hass, Pearson India Education Services

Lines and planes in space, curves in space and their tangents, curvature and normal vector of a curve, tangential and normal components of acceleration, directional derivatives and gradient vectors.
(Sections 12.5, 13.1, 13.3, 13.4, 13.5, 14.5)

Unit III: Linear Algebra – Matrices and System of Equations, Linear Transformations (25 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub

Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear

homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence
(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV: Probability distributions and curve fitting (15 hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Introduction, graphical method, laws reducible to the linear law, principles of least squares, method of least squares, to fit the straight line y=a+bx, to fit the parabola $y=a+bx+cx^2$, fitting of $y=ax^b$, $y=ae^{bx}$, $xy^n=b$
(Sections 24.1, 24.2, 24.3, 24.4, 24.5)
Random variable, Discrete probability distribution, continuous probability distribution, expectation, variance, r^{th} moment, mean deviation from mean.
(Sections 26.7, 26.8, 26.9, 26.10)

References

1. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
2. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
3. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand and Co.
4. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
5. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
6. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
7. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>16</td><td rowspan="5">40</td></tr>
<tr><td>II</td><td>16</td></tr>
<tr><td>III</td><td>20</td></tr>
<tr><td>IV</td><td>14</td></tr>
<tr><td>Total</td><td>66</td></tr>
</table>

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(10 questions x Marks 2 each = 20)
	• ***Answer any 7 questions***	*(7 questions x Marks 2 each=14)*
Part C -	**Essay**	(7 questions x Marks 3 each = 21)
	• ***Answer any 4 questions***	*(4 questions x Marks 3 each=12)*
Part D -	**Long Essay**	(4 questions x Marks 5 each = 20)
	• ***Answer any 2 questions***	*(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:

MATHEMATICS FOR ELECTRONICS II

<table>
<tr><th rowspan="2">SEMESTER</th><th rowspan="2">COURSE CODE</th><th rowspan="2">HOURS PER WEEK</th><th rowspan="2">CREDIT</th><th rowspan="2">EXAM HOURS</th><th colspan="3">MARKS</th></tr>
<tr><th>END SEM EXAM</th><th>INTERNAL</th><th>TOTAL</th></tr>
<tr><td>II</td><td>2C02 MAT-EL</td><td>4</td><td>3</td><td>3</td><td>40</td><td>10</td><td>50</td></tr>
</table>

COURSE OUTCOMES

CO1	Understand the reduction formulae to integrate powers of trigonometric functions
CO2	Understand the method to find area between curves, arc length both in Polar and Cartesian coordinates
CO3	Understand the method of evaluating multiple integrals
CO4	Understand the concept of eigen values and eigen vectors, properties of eigen values and Cayley- Hamilton theorem
CO5	Understand reduction to diagonal form and reduction of quadratic form to canonical form.
CO6	Understand line integrals in vector fields and Green's theorem in the plane
CO7	Understand Surfaces and area, surface integrals, Stoke's theorem, the divergence theorem and unified theory

2C02 MAT-EL: Mathematics for Electronics II

Unit I - Integral Calculus – Integration and Integration by Successive Reduction (18 hours)

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services, 2016

Quick review of basics of Integration (*Questions should **not** be asked in the End Semester Examinations from the above sections for quick review*)

Text: Integral Calculus, Santhi Narayanan and P.K. Mittal

Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $\cos^n x$ where n is a positive integer, Integration of $\sin^p x \cos^q x$ where p, $q$are positive integers, Integration of $\tan^n x$ and $\cot^n x$ where n is a positive integer, Integration of $\sec^n x$ where n is a positive integer.
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit II - Integral Calculus – Applications of Integration and Multiple Integrals (18 hours)

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services

Substitutions and the area between curves, arc length, Polar coordinates, areas and length in polar coordinates
(Section 5.6, 6.3, 11.3, 11.5)

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates.
(Sections 15.1, 15.2, 15.3, 15.4, 15.5)

Unit III Linear Algebra (18 hours)

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form
(Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18)

Unit IV Vector Calculus – Vector Integration (18 hours)

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services

Line integrals (mass, moment and moment of inertia excluded), vector fields and line integrals: work, circulation and flux, path independence, conservative fields and potential functions, Green's theorem in the plane.
(Sections 16.1, 16.2, 16.3, 16.4)
Surfaces and area, surface integrals, Stoke's theorem (theorem without proof) (paddle wheel interpretation of $\nabla\times\mathbf{F}$ is excluded), the Divergence Theorem (theorem without proof) (Gauss' law: one of the four great laws of Electromagnetic Theory, continuity equation of hydrodynamics and unifying the integral theorems are excluded).
(Sections 16.5, 16.6, 16.7, 16.8 of the Text).

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
3. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
4. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
5. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
6. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.

Marks including choice

Unit	Marks in End Semester Examination: Aggregate Marks	Marks in End Semester Examination: Maximum Marks
I	16	**40**
II	16	
III	18	
IV	16	
Total	**66**	

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(10 questions x Marks 2 each = 20)
	• ***Answer any 7 questions***	*(7 questions x Marks 2 each=14)*
Part C -	**Essay**	(7 questions x Marks 3 each = 21)
	• ***Answer any 4 questions***	*(4 questions x Marks 3 each=12)*
Part D -	**Long Essay**	(4 questions x Marks 5 each = 20)
	• ***Answer any 2 questions***	*(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:
MATHEMATICS FOR ELECTRONICS III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	**3C03 MAT-EL**	**5**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand Separable ODEs, Exact ODEs, Linear ODEs, Bernoulli equation and methods to solve these ODEs
CO2	Understand Homogeneous Linear ODEs of Second Order and solve homogeneous linear ODEs of second order with constant coefficients and Euler-Cauchy equation
CO3	Understand Nonhomogeneous ODEs and solve by variation of parameters
CO4	Understand Laplace Transform and inverse Laplace Transformation
CO5	Understand The first and The second shifting theorems and their applications
CO6	Understand the methods to find Laplace transforms of derivatives and integrals of functions
CO7	Understand the method of differentiating and integrating Laplace transform
CO8	Understand convolution, convolution theorem and applications of convolution Theorem
CO9	Solve ordinary differential equations and integral equations using Laplace transform
CO10	Understand Fourier series and Fourier Transform

3C03 MAT-EL: Mathematics for Electronics III

Unit I - First Order Ordinary Differential Equations (26 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig

Basic concepts, Geometrical meaning of $y' = f(x,y)$. Direction Fields (numerical method by Euler excluded), Separable ODEs (modelling excluded) Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics excluded) (Sections 1.1, 1.2, 1.3, 1.4, 1.5)

Unit II - Second Order Ordinary Differential Equations (22 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of Theorems only, proofs omitted), Nonhomogeneous ODEs, Solution by variation of Parameters.
(Sections 2.1 to 2.10 *except* 2.4, 2.8 and 2.9)

Unit III - Laplace Transforms and its Applications (24 hrs)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Laplace Transforms: Laplace Transform, Linearity, first shifting theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (t- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.
(Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9 (Proofs omitted))

Unit IV Fourier Series and Fourier Transforms (18 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions. (Proofs are omitted) (Sections 11.1, 11.2)

Fourier integral, Fourier cosine and sine transform (discrete only), Inverse transform (Sections 11.7, 11.8, 11.9. Convolution is excluded).

References

1. Higher Engineering Mathematics (41st edition), B .S. Grewal, Khanna Pub.
2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley
3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	19	**40**
II	16	
III	17	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

Answer any 2 questions *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR ELECTRONICS IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT-EL	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Partial Differential equations, its solution by Separating Variables and the use of Fourier Series in solving PDE
CO2	Understand LPP, formulate and solve using graphical method
CO3	Understand General LPP, canonical and standard forms of LPP
CO4	Understand simplex method and solve LPP
CO5	Understand basic solution, degenerate solution, basic feasible solution, optimum basic feasible solution , fundamental properties of solution and simplex method
CO6	Understand LP formulation of transportation problem and method to solve
CO7	Understand the concept of Numerical Integration , Trapezoidal Rule, Simpson's 1/3 Rule
CO8	Understand Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta methods to solve ordinary differential equations.

4C04 MAT-EL: Mathematics for Electronics IV

Unit I - Partial differential Equations (20 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Basic Concepts, solution by separation of variables, use of Fourier series
(Sections 12.1, 12.3)

Unit II - Linear Programming (25 hrs)

Text: Operations Research (18th thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Mathematical formulation of daily life situations – simple cases only (Questions should be avoided for end semester examination) Canonical and standard form, Graphical solution method, Simplex method – computational procedure (Proof of theorems excluded)
(Sections 2.1, 2.2, 2.3, 2.4, 3.2, 4.3)

Unit III Linear Programming (20 hrs)

Text: Operations Research (18th thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Transportation problem – introduction, transportation table, loops, solution to a Transportation Problem, finding an initial basic feasible solution, transportation algorithm (MODI method) (Proofs of theorems are excluded)
(Sections 10.5, 10.6, 10.8, 10.9, 10.13)

Unit IV Numerical Analysis (25 hrs)

Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry, PHI Learning

Numerical Integration- Trapezoidal Rule, Simpson's 1/3 -Rule.
(Sections 6.4, 6.4.1, 6.4.2)
Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods. (Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	12	**40**
II	19	
III	16	
IV	19	
Total	**66**	

References

1. Higher Engineering Mathematics (41^{st} edition), B .S. Grewal, Khanna Pub
2. Linear Programming, G. Hadley, Oxford & IBH Publishing Company, New Delhi.
3. Operations Research, S. Kalavathy, Vikas Pub.
4. Mathematical Methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

MATHEMATICS
COMPLEMENTARY ELECTIVE COURSES FOR BSc COMPUTER SCIENCE PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR COMPUTER SCIENCE I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT-CS	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Successive differentiation and Leibnitz's theorem for the nth derivative of the product of two functions
CO2	Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem and Cauchy's mean value theorem.
CO3	Understand Taylor's theorem, expansions of functions – Maclaurin's series, expansion by use of known series and Taylor's series.
CO4	Understand the method of finding limits of Indeterminate forms.
CO5	Understand Polar, Cylindrical and Spherical co-ordinates.
CO6	Understand Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix and partition method of finding the inverse.
CO7	Understand solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations.
CO8	Understand Linear transformations, orthogonal transformation and linear dependence of vectors.
CO9	Understand methods of curve fitting, graphical method, laws reducible to the linear law, principles of least squares, method of least squares and apply the principle of least squares to fit the straight line $y = a+bx$, to fit the parabola $y=a+bx+cx^2$, to fit $y = ax^b$, $y =ae^{bx}$ and $xy^n=b$

1C01 MAT-CS: Mathematics for Computer Science I

Unit I Differential Calculus – Differentiation and Successive Differentiation (18 Hours)
Text: Differential Calculus, Shanti Narayan and P.K. Mittal
Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. *(Questions should not be asked in the End Semester Examinations from the above sections for quick review)(*Relevant portions from sections 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10)

Text: Higher Engineering Mathemaics (41rd edition), B.S. Grewal,
Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two
Sections 4.1, 4.2

Unit II: Differential Calculus – Applications of Derivatives (22 Hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series, Indeterminate forms - form 0/0, form ∞/∞, form reducible to 0/0 form - form $0.\infty$, form ∞-∞, forms $0^0, 1^\infty, \infty^0$ (Sections 4.3, 4.4, 4.5).

Unit III Linear Algebra - Matrices and System of Equations, Linear Transformations (20 Hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equatios in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence
Sections 2.8, 2.9, 2.10, 2.11, 2.12, 2.13

Unit IV Fitting of Curves

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Introduction, graphical method, laws reducible to the linear law, principles of least squares, method of least squares, to fit the straight line y=a+bx, to fit the parabola $y=a+bx+cx^2$

Sections 24.1, 24.2, 24.3, 24.4, 24.5

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
6. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	18	**40**
II	20	
III	18	
IV	10	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVECOURSE 2:

MATHEMATICS FOR COMPUTER SCIENCE II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	**2C02 MAT-CS**	**4**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand Functions of two or more variables, limits and continuity.
CO2	Understand partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions and change of variables.
CO3	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} cos^n x\, dx$ and $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$.
CO4	Understand Substitutions and the area between curves, arc length, areas and length in polar coordinates.
CO5	Understand Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form and triple integrals in rectangular co-ordinates.
CO6	Understand Eigen values, Eigen vectors, properties of Eigen values, Cayley- Hamilton theorem, reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form and nature of a quadratic form

2C02 MAT-CS: Mathematics for Computer Science II

Unit I Differential Calculus – Partial Differentiation
Text: Differential Calculus, Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Partial Differentiation: Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
Sections 5.1, 5.2, 5.4, 5.5, 5.6

Unit II Integral Calculus – Integration and Integration by Successive Reduction
Text: Integral Calculus, Santhi Narayanan and P.K. Mittal, S. Chand and Co.

Quick review of basics of Integration (*Questions should **not** be asked in the End Semester Examinations from the above sections for quick review*)
Sections 8.1, 8.2, 8.3, 8.4, 8.5
Integration of Trigonometric Functions: Integration of $sin^n x,$ where *n* is a positive integer, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$,Integration of $sin^p x cos^q x,$evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\; cos^q x dx$, integration of $tan^n x$, integration of $cot^n x,$ integration of $sec^n x$, integration of $cosec^n x$
Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2

Unit III Integral Calculus – Applications of Integration and Multiple Integrals
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services
Substitutions and the area between curves, arc length, Polar coordinates, areas and length in polar coordinates
Section 5.6, 6.3, 11.3, 11.5

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates
Sections 15.1, 15.2, 15.3, 15.4, 15.5

Unit IV Linear Algebra - Eigen Values and Cayley-Hamilton Theorem

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal

Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form

Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18.

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	17	**40**
II	20	
III	17	
IV	12	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR COMPUTER SCIENCE III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	**3C03 MAT-CS**	**5**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand Ordinary differential equations, Geometrical meaning of $y' = f(x, y)$ and Direction Fields.
CO2	Understand Methods of solving Differential Equations: Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs and Bernoulli Equation.
CO3	Understand Orthogonal Trajectories, Existence and Uniqueness of Solutions.
CO4	Understand Second order ODEs, Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian, Non homogeneous ODEs and Solution by variation of Parameters
CO5	Understand Laplace Transform, Linearity, first shifting theorem, Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem, Convolution, Integral Equations, Differentiation and integration of Transforms and to solve special linear ODE's with variable coefficients and Systems of ODEs
CO6	Understand Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions.
CO7	Understand Partial Differential Equations and to solve PDEs by separation of variables and by use of Fourier series.

3C03 MAT-CS: Mathematics for Computer Science III

Unit I First Order Ordinary Differential Equations
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, 2015
Basic concepts, Geometrical meaning of $y'=f\ (x,\ y)$. Direction Fields (numerical method by Euler excluded), Separable ODEs (modelling excluded) Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics excluded) Chapter 1 Sections 1.1, 1.2, 1.3, 1.4, 1.5

Unit II: Second Order Ordinary Differential Equations
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley, 2015
Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of Theorems only, proofs omitted), Non homogeneous ODEs, Solution by variation of Parameters.
Sections 2.1 to 2.10 *except* 2.4, 2.8 and 2.9

Unit III: Laplace Transforms and its Applications
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
Laplace Transforms: Laplace Transform, Linearity, first shifting theorem (*s*-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (*t*- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.
Chapter 6 Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9 (Proofs omitted)

Unit IV Fourier Series and Partial Differential Equations
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions. (Proofs omitted)
Chapter 11 Sections 11.1, 11.2

Partial Differential Equations - Basic Concepts, solution by separation of variables, use of Fourier series Sections 12.1, 12.3

References

1. Higher Engineering Mathematics (41st edition), B .S. Grewal, Khanna Pub.

2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley
3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	18	**40**
II	15	
III	15	
IV	18	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - Essay (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY COURSE 4:
MATHEMATICS FOR COMPUTER SCIENCE IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	**4C04 MAT-CS**	**5**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand the concept of a graph, graphs as models, vertex degrees, sub graphs, paths and cycles, matrix representation of graphs, trees and connectivity – definition and simple properties.
CO2	Understand Linear Programming Problems, their canonical and standard forms.
CO3	Understand Methods to solve LPP : Graphical solution method and Simplex method
CO4	Understand Transportation problems, transportation table, loops. Solve a Transportation Problem by finding an initial basic feasible solution and then by using the transportation algorithm known as MODI method.
CO5	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO6	Understand Numerical methods to find Solutions of Ordinary Differential Equations: Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.

4C04 MAT-CS: Mathematics for Computer Science IV

Unit I

Text: A First Look at Graph Theory, John Clark and Derek Allan Holton, Allied Pub.

The definition of a graph, graphs as models, More definitions (problems on isomorphism excluded), vertex degrees, subgraphs, paths and cycles, matrix representation of graphs, trees and connectivity – definition and simple properties (Proofs of theorems 2.1, 2.2, 2.3, 2.5 and that of corollary 2.4 are excluded) (Problems involving proofs are excluded)

Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.1

Unit II Linear Programming

Text: Operations Research (18^{th} thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Mathematical formulation of daily life situations – simple cases only (Questions should be avoided for end semester examination from this topic)

Canonical and standard form, Graphical solution method, Simplex method – computational procedure (Proofs of theorems are excluded)

Sections 2.1, 2.2, 2.3, 2.4, 3.2, 4.3

Unit III Linear programming

Text: Operations Research (18^{th} thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Transportation problem – introduction, transportation table, loops, solution to a Transportation Problem, finding an initial basic feasible solution, transportation algorithm (MODI method)

(Proofs of theorems excluded)

Sections 10.5, 10.6, 10.8, 10.9, 10.13

Unit IV Numerical Analysis

Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry PHI Learning

Numerical Integration-

Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule

Chapter 6 Sections 6.4, 6.4.1, 6.4.2

Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.

Sections 8.1, 8.2, 8.4, 8.4.2, 8.5

References

1. Introduction to Graph Theory, F. Harary, Narosa Pub.
2. Graph Theory with Applications, J.A. Bondy and U.S.R.Murty, Macmillan
3. Linear Programming, G. Hadley, Oxford & IBH Publishing Company, New Delhi.
4. Operations Research, S. Kalavathy, Vikas Pub.
5. Mathematical Methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	18	
III	16	
IV	16	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

MATHEMATICS
COMPLEMENTARY ELECTIVE COURSES FOR BCA PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR BCA I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	**1C01 MAT-BCA**	**4**	**4**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO 1	Understand differentiation, derivative of functions namely constant function, trigonometric function, inverse trigonometric functions, y = log x, hyperbolic functions and parametrically defined function, Logarithmic differentiation and derivative of implicitly defined functions.
CO 2	Understand Successive differentiation and Leibnitz's theorem for the nth derivative of the product of two functions.
CO 3	Understand Basics of Boolean Algebra: Definition, duality and basic theorems.
CO 4	Understand Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix and partition method of finding the inverse.
CO 5	Understand solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations.
CO 6	Understand Linear transformations, orthogonal transformation and linear dependence of vectors.

1C01 MAT-BCA: Mathematics for BCA I

Unit I - Differential Calculus – Differentiation

Text: Differential Calculus, Shanti Narayan and P.K. Mittal

Basics of differentiation – Derivative of a constant function, some general theorems on derivation (theorems without proof), derivatives of trigonometric functions, derivatives of inverse trigonometric functions, derivative of $y = \log x$, hyperbolic functions, derivation of parametrically defined functions, logarithmic differentiation, derivation of implicitly defined functions.
(Sections 4.2, 4.3 except 4.3.5, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10)

Unit II - Differential Calculus– Successive Differentiation

Text: Higher Engineering Mathemaics (41^{st} edition), B.S. Grewal

Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two functions
(Sections 4.1, 4.2)

Unit III - Boolean Algebra

Text: Set Theory and Related Topics, S. Lipschitz, Schaum's Series

Introduction, basic definition, duality, basic theorems
(Sections 11.1, 11.2, 11.3, 11.4)

Unit IV - Linear Algebra - Matrices and System of Equations, Linear Transformations

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal

Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equatios in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence
(Sections 2.7, 2.8,2.9, 2.10, 2.11, 2.12)

References

1. Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley
2. Calculus (10^{th} edition), Anton, Bivens, Davis, Wiley-India
3. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co

4. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
5. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	15	**40**
II	17	
III	13	
IV	21	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:
MATHEMATICS FOR BCA II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	**2C02 MAT-BCA**	**4**	**4**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand Functions of two or more variables, limits and continuity.
CO2	Understand partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions and change of variables.
CO3	Understand basics of integration, Integration by parts, trigonometric integrals, trigonometric substitutions and integration of rational functions by partial fractions.
CO4	Understand Polar co-ordinates.
CO5	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} cos^n x\, dx$ and $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$.
CO6	Understand Double and Iterated Integrals over rectangles, double integrals over general regions and triple integrals in rectangular co-ordinates.
CO7	Understand Eigen values, Eigen vectors, properties of Eigen values, Cayley- Hamilton theorem, reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form and nature of a quadratic form

2C02 MAT-BCA: Mathematics for BCA II

Unit I- Differential Calculus - Partial Differentiation
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Integral Calculus – Integration and Integration by Successive Reduction
Text: Integral Calculus, Santhi Narayanan and P.K. Mittal, S. Chand
Basics of Integration – Integration by parts, trigonometric integrals, trigonometric substitutions, integration of rational functions by partial fractions
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)
Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer,
Integration of $sin^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$,Integration of $sin^p x cos^q x$,evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$ (Derivation of formulae omitted)
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1)

Unit III Integral Calculus – Multiple Integrals
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services, 2016
Polar co-ordinates, Double and Iterated Integrals over rectangles, double integrals over general regions, triple integrals in rectangular co-ordinates
(Sections 11.3, 15.1, 15.2, 15.5)

Unit IV - Linear Algebra - Eigen Values and Cayley-Hamilton Theorem (22 hrs)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal
Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof),reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form,
(Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18)

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
3. A Textbook of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co
4. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
5. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	16	
III	16	
IV	18	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:
MATHEMATICS FOR BCA III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	**3C03 MAT-BCA**	**4**	**4**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand Ordinary differential equations, Geometrical meaning of $y' = f(x, y)$ and Direction Fields.
CO2	Understand Methods of solving Differential Equations: Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs and Bernoulli Equation.
CO3	Understand Second order ODEs, Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian and Nonhomogeneous ODEs.
CO4	Understand Laplace Transform, Linearity, first shifting theorem, Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem, Convolution, Integral Equations, Differentiation and integration of Transforms and to solve special linear ODE's with variable coefficients and Systems of ODEs
CO5	Understand Fourier series, arbitrary period and Even and Odd functions

3C03 AMT-BCA: Mathematics for BCA III

UnitI - First Order Ordinary Differential Equations (22 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley, 2015

Basic concepts, Geometrical meaning of $y'=f(x, y)$. Direction Fields (numerical method by Euler excluded), Separable ODEs (modelling excluded) Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics excluded

(Sections 1.1, 1.2, 1.3, 1.4, 1.5)

Unit II - Second Order Ordinary Differential Equations (16 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley, 2015

Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of theorems only, proof omitted), Nonhomogeneous ODEs.

(Sections 2.1 to 2.9 *except* 2.4, 2.8)

Unit III - Laplace Transforms and its Applications (20 hrs)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley, 2015

Laplace Transform, Linearity, first shifting theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (t- Shifting), Convolution, Integral Equations,Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Laplace Transform, General Formulas, Table of Laplace Transforms.

(Chapter 6 Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.8, 6.9 (Proofs omitted))

Unit IV Fourier Series (14 hours)

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley, 2015

Fourier series, arbitrary period, Even and Odd functions.(Proofs omitted)

(Chapter 11 Sections 11.1, 11.2 (half range expansions excluded))

References

1. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley

3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>20</td><td rowspan="5">40</td></tr>
<tr><td>II</td><td>16</td></tr>
<tr><td>III</td><td>16</td></tr>
<tr><td>IV</td><td>14</td></tr>
<tr><td>Total</td><td>66</td></tr>
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Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - Essay (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR BCA IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	**4C04 MAT-BCA**	**4**	**4**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO 1	Understand principle of counting, permutations, combinations, basic terminology.
CO 2	Understand the meaning of probability, probability and set notations, random experiment, sample space, event, axioms, notations, addition law of probability, theorem of total probability, independent events and multiplication law of probability
CO 3	Understand LPP, canonical and standard form, Graphical solution method, Simplex method and computational procedure.
CO 4	Understand Network routing problems: introduction, network flow problem, minimal spanning tree problem and shortest route problems.
CO 5	Understand Numerical Integration, Trapezoidal Rule and Simpson's 1/3-Rule.
CO 6	Understand Numerical methods to find Solutions of Ordinary Differential Equations: Solution by Euler's method and Runge-Kutta methods.
CO 7	Understand volumes of solid using cross sections and areas of surfaces of revolution

4C04 AMT-BCA: Mathematics for BCA IV

Unit I- Probability (18 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Probabiliy – introduction, principle of counting, permutations, combinations, basic terminology, definition of probability, statistical definition of probability, probability and set notations, random experiment, sample space, event, axioms, notations, addition law of probability or theorem of total probability (proof excluded), independent events, multiplication law of probability.
(Sections 26.1, 26.2, 26.3, 26.4, 26.5)

Unit II- Linear Programming (24 hours)

Text: Operations Research (18^{th} thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Mathematical formulation of daily life situations – simple cases only *(Questions should be avoided for end semester examination from this section).*

Canonical and standard form, Graphical solution method, Simplex method – computational procedure (Proof of theorems excluded)
(Sections 2.1, 2.2, 2.3, 2.4, 3.2, 4.3)

Unit III - Linear programming (14 hours)

Text: Operations Research (18^{th} thoroughly revised edition), Kantiswaroop, P.K. Gupta and Manmohan, Sultan Chand & Sons.

Network routing problems – introduction, network flow problem, minimal spanning tree problem, shortest route problems (algorithm omitted)
(Sections 24.1, 24.2, 24.3, 24.4)

Unit IV - Numerical Analysis (16 hours)
Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastri PHI Learning, 2015
Numerical Integration: Trapezoidal Rule, Simpson's 1/3- Rule
(Sections 6.4, 6.4.1, 6.4.2)

Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods. (Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

References

1. Introduction to Probablity and Statistics, S. Lipschutz, J. Schiller, Schaum's Outline series
2. Linear Programming, G. Hadley, Oxford & IBH Publishing Company, New Delhi.
3. Operations Research, S. Kalavathy, Vikas Pub.
4. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub
5. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	20	
III	14	
IV	16	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - Essay (7 questions x Marks 3 each = 21)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

PART C

MATHEMATICS GENERIC ELECTIVE COURSES

WORK AND CREDIT DISTRIBUTION

(2019 ADMISSION ONWARDS)

Any *one* Generic Elective Course from the following five courses can be chosen.

COURSE CODE	COURSE TITLE	SEMESTER	HOURS PER WEEK	CREDIT	EXAM HOURS
5D01 MAT	**HISTORY OF MATHEMATICS**	**V**	2	2	2
5D02 MAT	**QUANTITATIVE ARITHMETIC AND REASONING**	**V**	2	2	2
5D03 MAT	**LINEAR PROGRAMMING**	**V**	2	2	2
5D04 MAT	**GRAPH THEORY**	**V**	2	2	2
5D05 MAT	**BUSINESS MATHEMETICS**	**V**	2	2	2

EVALUATION

ASSESSMENT	WEIGHTAGE
EXTERNAL	4
INTERNAL	1

INTERNAL ASSESSMENT

COMPONENT	WEIGHTAGE	MARKS	REAMARKS
COMPONENT1- ASSIGNMENT / SEMINAR / VIVA-VOCE	50%	2.5	For each course, a student has to submit one assignment/ attend one seminar/ attend one viva-voce
COMPONENT 2- TEST PAPER	50%	2.5	For each course, a student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.
TOTAL	100%	**5**	

GENERIC ELECTIVE COURSE 1:
HISTORY OF MATHEMATICS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5D01 MAT	2	2	2	20	5	25

COURSE OUTCOMES

CO1	Understand the history of Early Number Systems and Symbols.
CO2	Understand the history of Mathematics in Early Civilizations.
CO3	Understand the history of the Beginnings of Greek Mathematics
CO4	Understand the Euclidean Geometry, Euclid's Foundation for Geometry, Euclid's Proof of the Pythagorean Theorem
CO5	Understand Infinity of Primes, Measurement of the Earth , Archimedes, The Ancient World's Genius, contributions of Hardy and Ramanujan, Examination, The Rejuvenation of English Mathematics

5D01 MAT: History of mathematics

Unit I **(18 hours)**
Early Number Systems and Symbols, Mathematics in Early Civilizations (section 1.2, 1.3, 2.1 to 2.5)

Unit II **(18 hours)**
The Beginnings of Greek Mathematics, The Alexandrian School:Euclid, Hardy and Ramanujan, The Tripos Examination, The Rejuvenation of English Mathematics, A Unique Collaboration: Hardy and Littlewood, India's Prodigy, Ramanujan (section 3.1, 3.2, 4.1 to 4.5, 13.1)

Text

David M Burton, The History of Mathematics – An Introduction, Seventh Edition, Mc Graw Hill.

References

1. Luke Hodgkin, A History of Mathematics from Mesopotamia to modernity, Oxford University Press.
2. Katz, Victor J., A History of Mathematics: An Introduction (3rd edition), Addison-Wesley
3. Berlinghoff, William P., and Fernando Q. Gouvêa, Math Through the Ages: A Gentle History for Teachers and Others, Expanded Edition, Oxton House and MAA

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**20**
II	16	
Total	**33**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 6 questions*** *(6 questions x Marks 2 each=12)*

Part C - **Essay** (2 questions x Marks 4 each = 8)

- ***Answer any 1 question*** *(1question x Marks 4 each=4)*

GENERIC ELECTIVE COURSE 2:

QUANTITATIVE ARITHMETIC AND REASONING

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5D02 MAT	2	2	2	20	5	25

COURSE OUTCOMES

CO1	Understand average, Problems on ages, Profit and loss and solves problems
CO2	Understand Profit and loss, Ratio and proportion, Chain rule
CO3	Comprehend Time and work, Time and distance and solves problems
CO4	Comprehend Problems on trains, Boats and streams, Calendar, Clocks

5D02 MAT: Quantitative Arithmetic and Reasoning

Unit I **(18 hours)**

Average, Problems on ages, Profit and loss, Ratio and proportion, Chain rule (Chapters 6, 8, 11, 12, 14 of the Text).

Unit II **(18 hours)**

Time and work, Time and distance, Problems on trains, Boats and streams, Calendar, Clocks (Chapters 15, 17, 18, 19, 27, 28 of the Text).

Text

R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**20**
II	16	
Total	**33**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 6 questions*** *(6 questions x Marks 2 each=12)*

Part C - **Essay** (2 questions x Marks 4 each = 8)

- ***Answer any 1 question*** *(1question x Marks 4 each=4)*

- **Use of Calculators shall *<u>not</u>* be permitted for this course.**

GENERIC ELECTIVE COURSE 3:
LINEAR PROGRAMMING

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5D03 MAT	2	2	2	20	5	25

COURSE OUTCOMES

CO1	Understand General linear programming problem – canonical and standard forms of L.P.P, Solutions and fundamental properties of solutions of LPP.
CO2	Understand Graphical solution method, Simplex method, Duality in linear programming, Formulating a dual problem.
CO3	Understand General transportation problem, the transportation tables, Loops in transportation table and solves transportation problem
CO4	Understand Degeneracy in transportation problem, Transportation algorithm (MODI method) and solves problems

5D03 MAT: Linear Programming

Unit I - Linear programming **(20 hours)**

Formulation of LPP from daily life situations (simple cases only and there should not be any question from this topic in the End Semester Examination). General linear programming problem – canonical and standard forms of L.P.P, Graphical solution method, Simplex method. (Sections 2.1, 2.2, relevant topics from 2.3 and 2.4, 3.2, 3.4, 3.5, 4.1, 4.3 of the Text. Proofs of all theorems are omitted).

Unit II - Transportation problems **(16 hours)**

General transportation problem, the transportation tables, Loops in transportation table, Solution of a transportation problem, Finding an initial basic feasible solution, Degeneracy in transportation problem, Transportation algorithm (MODI method). (Sections 10.1, 10.2, 10.5, 10.6, 10.9, 10.12, 10.13of the Text. Proofs of all theorems are omitted)

Text

K. Swarup, P.K. Gupta and M. Mohan, Operations Research (18th edition), Sulthan Chand and Sons.

References

1. J. K. Sharma, Operations Research Theory and Applications. McMillan
2. G. Hadley, Linear Programming, Oxford & IBH Publishing Company
3. H. A. Thaha, Operations Research, An Introduction (8th edition), Prentice Hall

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**20**
II	16	
Total	**33**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions* x *Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 6 questions*** *(6 questions* x *Marks 2 each=12)*

Part C - **Essay** (2 questions x Marks 4 each = 8)

- ***Answer any 1 question*** *(1question* x *Marks 4 each=4).*

- **Use of Scientific Calculators below 100 functions (that is, upto fx 99) shall be permitted for this courses.**

GENERIC ELECTIVE COURSE 4:

GRAPH THEORY

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5D04 MAT	2	2	2	20	5	25

COURSE OUTCOMES

CO1	Understand how to transform daily life problems into Graph Theoretical (Mathematical) Models
CO2	Understand the evolution of Graph Theory as a subject
CO3	Understand the representation of Chinese Postman Problem, Marriage Problem, Travelling Salesman Problem and Personnel Assignment Problem
CO4	Understand the concepts of planar graphs and Jordan curve
CO5	Comprehend Problem of colouring maps and Graph Colouring

5D04 MAT: Graph Theory

Unit I **(18 hours)**

1. Representing a telephone network so as to identify vulnerability to accidental disruption
2. Representing a set of jobs and a set of people so as to assign jobs to qualified persons
3. Representing a salesman's destinations in such a way that a shortest round trip through all destinations can be found out
4. Representing supply lines of electricity, gas and water so that each house gets the supply and the lines do not cross

5. Representing radio frequencies to assign frequencies to radio or TV broadcasting companies so that the frequencies do not interfere with each other
6. Representing the air route between cities so as to find out the cheapest route between cities
7. Konigsberg bridge problem
8. Checking whether it is possible to draw a closed figure without lifting pencil from the paper – Euler graph
9. Finding the shortest path for a postman to start from his Post Office, deliver the letters and return to the Post Office – Chinese Postman Problem.

   (Relevant portions from sections 1.2, 3.1, 3.2)

Unit II **(18 hours)**

10. Finding the path of minimum total distance for a travelling salesman involving a number of towns – Travelling Salesman Problem
11. Representing the problem of getting a set of boys married with a set of girls in such a way that a boy is married to his girlfriend – Marriage problem
12. Representing the problem of assigning qualified teachers to a set of classes – Personnel Assignment Problem
13. The problem whether we can join points inside a continuous non self intersecting curve whose origin and terminus coincide with a point exterior to it – Jordan curve theorem
14. The fact that there are only five regular polyhedra
15. The problem of colouring maps – Graph Colouring
16. Representing the streets of a city in such a way that one can drive from any part of the city to any other part

(Relevant portions from Sections 3.4, 4.2, 4.3, 5.1, 5.3, 6.1, 6.6, 7.4 of the Text)

(Necessary concepts may be introduced by the teacher to supplement the content. However, Theorems and their proofs are not included in the syllabus. The syllabus is meant only to give an idea of the applications of the subject Graph Theory in real life problems).

Text

A First Look at Graph Theory, John Clark and Derek Allan Holton, Allied Pub., 1995

References

1. R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory (2^{nd} edition), Springer.

2. J.A. Bondy and U.S.R. Murthy, Graph Theory with Aplications, Macmillan
3. F. Harary, Graph Theory, Narosa
4. K.R. Parthasarathy, Basic Graph Theory, Tata-McGraw Hill.
5. G. Chartrand and P. Zhang, Introduction to Graph Theory, Tata McGraw Hill.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	17	**25**
II	16	
Total	**33**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each* = *4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 6 questions*** *(6 questions x Marks 2 each=12)*

Part C - **Essay** (2 questions x Marks 4 each = 8)

- ***Answer any 1 question*** *(1question x Marks 4 each=4).*

GENERIC ELECTIVE COURSE 5:
BUSINESS MATHEMATICS

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
V	5D05 MAT	2	2	2	20	5	25

COURSE OUTCOMES

CO1	Understand the concept of Limit and continuity, methods of finding limits definition, Differentiation- rules of differentiation, Parametric function logarithmic differentiation.
CO2	Understand the Successive differentiation, Local maximum and local minimum and solves problems
CO3	Understand the Rules of integration, Some standard results, Consumer's surplus, Producer's surplus, Consumer's surplus
CO4	Understand rate of interest, Continuous compounding, Compound interest, Present valve, interest and discount, Rate of discount, Equation of value, Depreciation and solves problems

5D05 MAT: Business Mathematics

Unit I **(18 hours)**

Functions, Limit and continuity: Constants and variables, functions, Limit of a function, methods of finding limits definition, Differentiation- rules of differentiation, Parametric function logarithmic differentiation, Successive differentiation, Local maximum and local minimum, (except concavity, convexity and points of inflexion), solved examples. (Sections 3.1 to 3.2, 3.6, 4.1, 4 .3, 4.4, 4.7,4.8, 5.2,5.3)

Unit II **(18 hours)**

Integral Calculus: Rules of integration, Some standard results, Consumer's surplus, Producer's surplus, Consumer's surplus under pure competition, Consumer's surplus under monopoly. Nominal rate of interest, Effective rate of interest, Continuous compounding, Compound interest, Present valve, interest and discount, Rate of discount, Equation of value, Depreciation. (Sections 6.1 to 6.2, 6.4, 7.2to 7.5, 8.1 to 8.9)

Text

B. M. Aggarwal, Business Mathematics and Statistics, Ane Books Pvt. Ltd.

References

1. A. C. Chiang and K. Wainwright, Fundamental Methods of Mathematical Economics
2. Knut Sydestar and Peter Hummond with Arne Storm, Essential Mathematics for Economic Analysis, Fourth Edition, Pearson

Marks including choice

Unit	**Marks in End Semester Examination**	
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Part A - **Short answer** (5 questions x Mark 1each = 5)

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Part C - **Essay** (2 questions x Marks 4 each = 8)

- ***Answer any 1 question*** *(1question* x *Marks 4 each=4).*

- **Use of Scientific Calculators below 100 functions (that is, upto fx 99) shall be permitted for this course.**