PARVATHANENI BRAHMAYYA

SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, VIJAYAWADA - 520 010, Andhra Pradesh

Autonomous, NAAC A+ Grade, ISO Certified Institution

Since 1975

50 Years of Educational Excellence

NAAC - SSR IV CYCLE

M.Sc. MATHEMATICS

REGULATION 20

2020-22

PROGRAMME STRUCTURE &

SYLLABUS

Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada-10.
(An Autonomous college in the jurisdiction of Krishna University)
Accredited at A+ grade by NAAC

2020 Batch M.Sc -Mathematics

List of Courses

C CODE	COURSE TITLE	CREDITS	TOTAL	CIA	SEE
	MAY -2021 FIRST SEMESTER				
20MA1T1	REAL ANALYSIS-I	4	100	30	70
20MA1T2	ORDINARY DIFFERENTIAL EQUATIONS	4	100	30	70
20MA1T3	ALGEBRA	4	100	30	70
20MA1T4	TOPOLOGY	4	100	30	70
20MA1T5	C PROGRAMMING	4	100	30	70
20MA1L1	PRACTICAL	4	100	30	70
20MA1L2	C PROGRAMMING LAB	2	100	30	70
	TOTAL	**26**	**700**	**210**	**490**
	OCTOBER-2021 SECOND SEMESTER				
20MA2T1	COMPLEX ANALYSIS	4	100	30	70
20MA2T2	NUMERICAL METHODS	4	100	30	70
20MA2T3	PARTIAL DIFFERENTIAL EQUATIONS	4	100	30	70
20MA2T4	GRAPH THOERY & ALGORITHMS	4	100	30	70
20MA2T5	LATTICE THEORY	4	100	30	70
20MA2T6	REAL ANALYSIS-II	4	100	30	70
20MA2L1	NUMERICAL METHODS LAB	3	100	30	70
	TOTAL	**27**	**700**	**210**	**490**

	MARCH-2022 THIRD SEMESTER				
20MA3T1	MEASURE & INTEGRATION	5	100	30	70
20MA3T2	PROBABILITY & STATISTICS	5	100	30	70
20MA3T3	GALOIS THEORY	5	100	30	70
20MA3T4	MATHEMATICAL METHODS	5	100	30	70
20MA3T5	ANALYTICAL NUMBER THEORY	5	100	30	70
20OE07	**PROBLEM SOLVING USING PYTHON PROGRAMMING (OPEN ELECTIVE)**	**4**	**100**	**30**	**70**
	TOTAL	**25**	**500**	**150**	**350**
	JULY-2022 FOURTH SEMESTER				
20MA4T1	RINGS & MODULES	5	100	30	70
20MA4T2	OPERATIONS RESEARCH	5	100	30	70
20MA4T3	FUNCTIONAL ANALYSIS	5	100	30	70
20MA4T4	MATHEMATICAL MODELLING	5	100	30	70
20MA4S1	SEMINAR	4	100	30	70
20MA4M1	NUMERICAL LINEAR ALGEBRA **(MOOCS)**	5	100	30	70
20OE03	**DATA VISUALIZATION (OPEN ELECTIVE)**	**4**	**100**	**30**	**70**
	TOTAL	**29**	**600**	**180**	**420**

M.Sc. MATHEMATICS I SEMESTER
C- PROGRAMMING LAB- 20MA1L2

Subject Code	20MA1L2	I A Marks	30
No. of Hours/Week	04	End Exam Marks	70
Total Number of Hours	60	Total Marks	100
Exam Hours	03	Credits	02

Objectives: This course is designed to develop the programming skills of C-language through problem solving.

LIST OF C – PROGRAMS :

1. To find factorial of a number.
2. To reverse a number.
3. To find GCD of two numbers using Euclidean algorithm.
4. To find Fibonacci numbers up to "N"
5. To find perfect numbers up to "N"
6. To find prime numbers up to "N"
7. To find sum of digits of a number.
8. To check a number palindrome or not.
9. To find the sum of squares of first ten natural numbers using function.
10. To find biggest of three numbers using function.
11. To find biggest element in an array.
12. To find the transpose of a Matrix.
13. To find the sum of the matrices.
14. To find the product of the matrices.
15. To find string length using user defined function.

M.Sc. MATHEMATICS   I SEMESTER
REAL ANALYSIS-I -20MA1T1

Subject Code	20MA1T1	I A Marks	30
No. of Lecture Hours / Week	04	End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Exam Hours	03	Credits	04

Objectives: To develop problem solving skills and knowledge on some of the basic concepts in limits, continuity, derivatives, Riemann-Stieltjes integrals and sequences of functions.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the properties of continuous & differentiable functions.
CO2	test the Riemann Stieltjes integrability of bounded functions and study its properties.
CO3	differentiate pointwise and uniform convergence of sequences of functions and illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.
CO4	understand the concept of Improper Integrals
CO5	understand the properties of Functions of several variables.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	**L3**				
CO2				**L3**	
CO3					**L4**
CO4			**L3**		
CO5	**L3**				

UNIT-I

Continuity & Differentiation: Limits of functions- continuous functions- Continuity and Compactness- Continuity and Connectedness- Discontinuities - Derivative of a Real Function- Mean value theorems- The Continuity of Derivatives- L' Hospital's rule- Derivatives of higher order- Taylor's theorem.
[4.1 to 4.27 of chapter 4 & 5.1 to 5.15 of chapter 5 of Text Book1]

UNIT-II

The Riemann - Stieltjes Integral: Definition and Existence of Integral-Properties of the integral -Integration and Differentiation –Integration of vector-valued functions - Rectifiable Curves. [Chapter-6 of Text Book-1]

UNIT-III

Sequences and Series of functions: Discussion of main problem - Uniform convergence – Uniform convergence and continuity – Uniform Convergence and Integration – Uniform Convergence and Differentiation – Equicontinuous families of functions – The Stone - Weierstrass Theorem.[7.1 to 7.26 of Text Book 1]

UNIT-IV

Improper Integrals: Introduction – Integration of unbounded Functions with Finite limits of Integration – Comparison Tests for Convergence at a of $\int_a^b f dx$ - Infinite range of Integration – Integrand as a Product of Functions. [Chapter-11 of Text Book-2]

UNIT-V

Functions of several variables: Explicit and Implicit Functions - Continuity - Partial Derivatives – Differentiability – Partial Derivatives of Higher Order – Differentials of Higher order- Functions of Functions – Change of variables – Taylor's Theorem – Extreme Values: Maxima and Minima – Functions of Several Variables. [Chapter-15 of Text Book-2]

PRESCRIBED BOOKS:

1. "**Principles of Mathematical Analysis"**, Walter Rudin, Student Edition 1976, McGraw-Hill International.
2. " **Mathematical Analysis",** S.C. Malik and Savita Aurora, Fourth edition, New Age International Publishers.

REFERENCE BOOK:

"**Mathematical Analysis"** Tom. M. Apostol, second Edition, Addison Wesley Publishing Company.

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA
(An Autonomous college in the jurisdiction of Krishna University)
M. Sc. Mathematics
First Semester
REAL ANALYSIS - I -20MA1T1

Time: 3 Hours **Max. Marks : 70**

1. Answer all questions. **(10 X 2=20)**

a) Let $f(x) = (1/x), x \neq 0$
$= 0, x = 0.$
Discuss the continuity of this function on R. (CO1)

b) Let f be a differentiable function on (a, b). Then prove that f is continuous on (a, b). (CO1)

c) Define Riemann-Stieltjes integral. (CO2)

d) State Fundamental theorem of calculus. (CO2)

e) Define Uniform convergence of sequence of functions. (CO3)

f) Discuss the Equicontinuous family of functions. (CO3)

g) Define Beta function. (CO4)

h) Examine the convergence of $\int_0^1 \frac{dx}{\sqrt{1-x}}$ (CO4)

i) Define Explicit and Implicit functions. (CO5)

j) Define extreme value of a function. (CO5)

Answer all questions.All questions carry equal marks. **(5X10=50)**

2\. a) Show that a mapping f of a metric space X into a metric space Y is continuous if and only if $f^{-1}(V)$ is open in X, for every open set V in Y. (CO1)

(OR)

b) State and Prove Taylor's theorem. (CO1)

3\. a) If f is monotonic on [a, b] and if α is continuous on [a, b] then show that $f \in R(\alpha)$. (Assume that α is monotonic). (CO2)

(OR)

b) If γ^1 is continuous on [a, b] then show that γ is rectifiable and $\wedge(\gamma) = \int_a^b |\gamma^1(t)| dt$.
(CO2)

P.T.O.

4. a) If $\{f_n\}$ is sequence of continuous functions on E and if $f_n \to f$ uniformly on E, then show that f is continuous on E. (CO3)

(OR)

b) State and prove Stone – Weierstrass theorem. (CO3)

5. a)Show that the improper integral $\int_0^1 \frac{dx}{(x-a)^n}$ converges if and only if n<1. (CO4)

(OR)

b) Show that if f and g are positive and $f(x) \leq g(x)$, for all x in [a, X] and $\int_a^\infty g(x)dx$ converges, then $\int_a^\infty f(x)dx$ converges. (CO4)

6. a) State and prove Schwarz's theorem. (CO5)

(OR)

b) Find the maxima and minima of the function $f(x, y)=x^3+y^3-3x-12y+20$.(CO5)

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M.Sc. MATHEMATICS I SEMESTER
ORDINARY DIFFERENTIAL EQUATIONS - 20MA1T2

Subject Code	20MA1T2	I A Marks	30
No. of Lecture Hours / Week	04	End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Exam Hours	03	Credits	04

Objectives : To learn various methods for finding solutions of an ordinary differential equation and to study the characteristics of solutions of differential equations.

COURSE OUTCOME	**Upon successful completion of this course, students will be able to:**
CO1	formulate and solve linear differential equations of first and second order.
CO2	solve linear differential equations of order n with constant/variable coefficients.
CO3	determine the power series solutions of differential equations and study the properties of Legendre and Bessel functions.
CO4	solve the Systems of Linear Differential Equations.
CO5	find the approximate solutions and understand the concept of Existence and Uniqueness of solutions.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1			L4		
CO2					L4
CO3	L3				
CO4	L3				
CO5					L4

UNIT-I

Linear Equation of the first order: Introduction**,** Linear equations of the first order, The equation $y' + ay = 0$, The equation $y' + ay = b(x)$, The general linear equations of the first order, Linear Equations with constant coefficients, The homogeneous equation of order n, Initial value problems for nth order equations.
[Chapter 1 of Text Book(1) and Sections 7, 8 of Chapter 2 of Text book(1)]

UNIT-II

Linear Equations with Constant Coefficients: The non - homogeneous equation of order n, A special method for solving the non homogeneous equation.
Linear equations with variable coefficients: Introduction, Initial value problems for the homogeneous equations, Solution of the homogeneous equations, The Wronskian and linear independence.
[Sections 10,11 of Chapter 2 and Sections 1,2,3,4 of Chapter 3 of Text book(1)]

UNIT-III:

Solutions in Power series: Introduction– Second order Linear Equations with Ordinary points – Legendre equation and Legendre Polynomials – Second order equations with regular singular points – Properties of Bessel functions.
[Sections 3.1 to 3.5 of Chapter 3 of Text Book(2)]

UNIT-IV:

Systems of Linear Differential Equations: Introduction - Systems of first order equations - Model of arms competitions between two nations - Existence and uniqueness theorem - Fundamental Matrix - Non homogeneous linear systems - Linear systems with constant coefficients.[Sections 4.1 to 4.7 of Chapter 4 of Text Book (2)]

UNIT-V:

Existence and Uniqueness of solutions: Introduction – Successive approximations – Picard's theorem. [Sections 5.1 to 5.4 of chapter 5 of Text Book(2)]

PRESCRIBED BOOKS :

1. Earl.A. Coddington "*An Introduction to Ordinary Differential Equations*" , PHI.
2. S.G. Deo, V. Lakshmi kantham and V. Raghavendra "*Text Book of Ordinary Differential Equations,* Second edition, Tata McGraw Hill Pub., New Delhi, 1997.

REFERENCE BOOKS :

1. G.F. Simmons, *Differential equations with Applications and Historical Notes*, Second Edition , Tata Mc Graw Hill, (2003).
2. D. Somasundaram, "*Theory of Ordinary Differential Equations*", Narosa Publications, 2001.

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An autonomous college in the jurisdiction of Krishna University)

M. Sc. Mathematics

First Semester

ORDINARY DIFFERENTIAL EQUATIONS – 20MA1T2

Time: 3 hours **Max. Marks: 70**

1. **Answer all questions.** **(10x2=20)**

a) Solve y' – 2y = 1 (CO1, L5)

b) Solve y' + e^x y = $3e^x$ (CO1, L5)

c) Write the characteristic polynomial of y''' – 3y'' + 3 y' – y = 0 (CO2, L6)

d) Define homogeneous and non-homogeneous differential equations with examples. (CO2, L1)

e) Express f (t) = 1 + t + t^2 in terms of Legendre series. (CO3, L4)

f) Show that $P_n(1) = 1$ and $P_n(-1) = (-1)^n$. (CO3, L3)

g) Define fundamental matrix of the system of linear differential equations. (CO4, L5)

h) State Existence theorem for first order linear differential equation. (CO4, L2)

i) State Lipschitz condition. (CO5. L3)

j) Compute first two successive approximations of the equation x' = x, x(0) = 1 (CO5, L6)

Answer all questions. All questions carry equal marks. **(5X10=50)**

2. a) State and prove Existence theorem. (CO1, L3)

(OR)

b) Consider the equation y''' – 4y' = 0. Compute three linearly independent solutions and Wronskian of the solutions. Also find the solution Φ satisfying Φ(0) = 0, Φ'(0) = 1, Φ''(0) = 0. (CO1, L5)

3.a) Compute the solution of the equation y''' + y'' + y' + y = 1, satisfying

ψ(0) = 0, ψ' (0) = 1 and ψ'' (0) =0. (CO2, L6)

(OR)

b) Find two linearly independent solutions of the equation

$y^{11} + \frac{1}{x}\, y^{1} - \frac{1}{x^2} y = 0.$ (CO2, L5)

(P.T.O.)

4 a) Show that the Legendre polynomials are given by

$P_n(t) = \frac{1}{2^n\, n!} \frac{d^n}{dt^n} (t^2 - 1)^n$ (CO3, L3)

(OR)

b) Show that $\frac{d}{dt}[t^p J_p(t)] = t^p J_{p-1}(t)$

and $\frac{d}{dt}[t^{-p} J_p(t)] = -t^{-p} J_{p+1}(t)$ (CO3, L5)

5 a) Find the fundamental matrix for x' = Ax where $A = \begin{bmatrix} 3 & -2 \\ -2 & 3 \end{bmatrix}$ (CO4, L4)

(OR)

b) Determine e^{At} for the system x' = Ax where $A = \begin{bmatrix} 1 & 1 & 1 \\ 0 & -2 & 3 \\ 0 & 1 & 0 \end{bmatrix}$ (CO4, L6)

6. a) State and prove Picard's theorem. (CO5, L4)

(OR)

b) Find the first three successive approximations of the equation $x^1 = e^x$, $x(0) = 0$.

(CO5, L3)

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M.Sc. MATHEMATICS I SEMESTER
ALGEBRA - 20MA1T3

Subject Code	20MA1T3	I A Marks	30
No. of Lecture Hours / Week	04	End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Exam Hours	03	Credits	04

Objectives: To acquire knowledge on the basic concepts of Group theory and Ring theory.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the properties of groups and homomorphisms.
CO2	Study permutation groups and Cayley's theorem.
CO3	Study the applications of Sylow's theorems.
CO4	understand the properties of ideals in Rings, quotient rings, integral domains and fields.
CO5	illustrate the properties of Euclidean rings and polynomial rings.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	**L2**				
CO2					**L3**
CO3				**L2**	
CO4			**L3**		
CO5	**L2**				

UNIT-I

Group Theory: Definition of a Group, Some Examples of Groups, Some Preliminary Lemmas, Subgroups, A Counting Principle, Normal Subgroups and Quotient Groups, Homomorphisms, Automorphisms. [Sections 2.1 to 2.8 of the prescribed book]

UNIT-II

Group Theory Continued: Cayley's theorem, Permutation groups, Another counting principle. [Sections 2.9 to 2.11 of the prescribed book]

UNIT-III

Group Theory Continued: Sylow's theorem, direct products, finite abelian groups.
[Sections 2.12 to 2.14 of the prescribed book]

UNIT-IV

Ring Theory: Definition and Examples of Rings, Some special classes of Rings, Homomorphisms, Ideals and quotient Rings, More Ideals and quotient Rings, The field of quotients of an Integral domain. [Sections 3.1 to 3.6 of the prescribed book]

UNIT-V

Ring Theory Continued: Euclidean rings, A particular Euclidean ring, Polynomial Rings, Polynomials over the rational field, Polynomial Rings over Commutative Rings.
[Sections 3.7 to 3.11 of the Prescribed book].

PRESCRIBED BOOK:

Topics in Algebra, I.N. Herstein, Second Edition, Wiley Eastern Limited, New Delhi, 1988.

REFERENCE BOOKS:

1. "Basic Abstract Algebra", Bhattacharya P.B., Jain S.K., Nagpaul S.R., Second Edition, Cambridge Press.
2. “Abstract Algebra”, David S Dummit and Richard M Foote, Wiley Publications, Third Edition.
3. “Introduction to Rings and Modules”, C. Musili, Narosa Publications.

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M. Sc. Mathematics

First Semester

ALGEBRA-20MA1T3

Time: 3 Hours **Max Marks: 70**

1. Answer all questions **(10X 2 = 20)**

(a) If G is a finite group and a ϵ G then prove that $a^{o(G)} = e$. (CO1, L1)
(b) Define a subgroup and give an example. (CO1, L2)
(c) Define a Sylow subgroup. (CO2, L3)
(d) State Cauchy's theorem. (CO2, L3)
(e) State Sylow's theorem. (CO3, L4)
(f) Define direct product of groups. (CO3, L2)
(g) Define an ideal and maximal ideal of a ring R. (CO4, L3)
(h) Define integral domain with an example. (CO4, L3)
(i) Define Euclidean Ring. (CO5, L2)
(h) Define an irreducible polynomial over a field F. (CO5, L2)

Answer all questions. All questions carry equal marks. **(5X10 = 50)**

2. a) If H and K are finite subgroups of G of orders o(H) and o(K) respectively, then show that $o(HK) = o(H)o(K) / o(H \cup K)$. (CO1, L2)

(OR)

b) State and prove the fundamental theorem of homomorphism in groups. (CO1, L3)

3. a) Show that every group is isomorphic to a subgroup of A(S), for some appropriate S. (CO2, L3)

(OR)

b) State and prove Cauchy's theorem. (CO2, L4)

4. a) Show that any two Sylow subgroups of a group G are conjugate. (CO3, L4)

(OR)

b) Show that If G and G^1 are isomorphic abelian groups, then show that G(s) and $G^1(s)$ are isomorphic, for every integer s. (CO3, L3)

(P.T.O.)

5. a) If U is an ideal of a ring R, then show that R/U is a ring and is a homomorphic image of R. (CO4, L4)

(OR)

b) If R is a commutative ring with unity and M is an ideal of R, then prove that M is maximal iff R/M is a field. (CO4, L5)

6. a) Prove that J[i], the ring of Gaussian integers is a Euclidean ring. (CO5, L5)

(OR)

b) State and prove Gauss Lemma. (CO5, L4)

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M.Sc. MATHEMATICS I SEMESTER
TOPOLOGY-20MA1T4

Subject Code	20MA1T4	I A Marks	30
No. of Lecture Hours / Week	04	End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Exam Hours	03	Credits	04

Objectives : To generalize the concepts of distance, open sets, closed sets in real line and to learn concepts in Metric Spaces, Topological Spaces, compact spaces and connected spaces.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the basic concepts of metric spaces and completeness.
CO2	discuss the properties of topological spaces, open bases and subbases.
CO3	understand the properties of compact spaces and Ascoli's theorem.
CO4	differentiate T_1 and Hausdorff spaces , describe Urysohn's lemma, Tietze extension theorem.
CO5	understand the concepts of connected spaces, components of a space and totally disconnected spaces.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	**L2**				
CO2			**L2**		
CO3					**L2**
CO4	**L4**				
CO5			**L2**		

UNIT-I

Metric Spaces: The Definition and some examples, Open sets, Closed sets, Convergence, Completeness and Baire's theorem. [Sections 9 to 12 of chapter 2 of the Prescribed book]

UNIT-II

Topological spaces : The Definition and some examples, Elementary concepts, Open bases and Open subbases. [Sections 16 to 18 of chapter 3 of the Prescribed book]

UNIT-III
Compactness: Compact spaces, Products of spaces, Tychonoff's theorem and Locally Compact spaces, Compactness for Metric Spaces, Ascoli's theorem.
[Sections 21 to 25 of chapter 4 of the Prescribed book]
UNIT-IV

Separation: T_1 spaces and Hausdorff spaces, Completely regular spaces and normal spaces, Urysohn's Lemma and the Tietze extension theorem.
[Sections 26 to 28 of chapter 5 of the Prescribed book]

UNIT-V

Connectedness: Connected spaces, The components of a space, Totally disconnected spaces. [sections 31 to 33 of chapter 6 of the Prescribed book]

PRESCRIBED BOOK: "Introduction to Topology and Modern Analysis", G.F. Simmons, Mc. Graw Hill Book Company , New York International student edition.

REFERENCE BOOKS:

1. " Topology", James R Munkers, Second Edition, Pearson Education.
2. "General Topology", John L Kelly, Springer, 2005.

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M. Sc. Mathematics

First Semester

TOPOLOGY –20MA1T4

Time: 3 Hours **Max. Marks : 70**

1. Answer all questions **(10X2=20)**

a) Define Metric space. (CO1, L1)

b) Define Convergent sequence and Cauchy sequence in a metric space. (CO1, L2)

c) Define Topological space. (CO2, L1)

d) Show that $\bar{A} = A \cup D(A)$. (CO2, L3)

e) Define a Compact space. (CO3, L2)

f) State Ascoli's theorem. (CO3, L2)

g) Define Hausdorff space. (CO4, L2)

h) Define Normal space. (CO4, L4)

i) Define Connected space. (CO5, L2)

j) Show that every discrete space is totally disconnected. (CO5, L5)

Answer all questions. All questions carry equal marks. **(5X10=50)**

2. a) Let X be a metric space. Then prove that (i) Any finite intersection of open sets is open. (ii) Each open sphere is an open set. (CO1, L2)

(OR)

b) State and prove the Cantor's intersection theorem. (CO1, L3)

3. a) State and Prove Lindelof's theorem. (CO2, L3)

(OR)

b) Show that every separable metric space is second countable. (CO2, L4)

4. a) State and Prove Tychonoff's Theorem. (CO3, L3)

(OR)

b) Show that every sequentially compact metric space is compact. (CO3, L2)

5. a) State and prove Urysohn's lemma. (CO4, L4)

(OR)

b) Show that every compact Hausdorff space is normal. (CO4, L5)

(P.T.O.)

6. a) Prove that the product of any non-empty class of connected spaces is connected. (CO5, L5)

(OR)

b) Let X be a Hausdorff space. If X has an open base whose sets are also closed, then show that X is totally disconnected. (CO5, L4)

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M.Sc. MATHEMATICS I SEMESTER
C PROGRAMMING - 20MA1T5

Subject Code	20MA1T5	I A Marks	30
No. of Lecture Hours / Week	04	End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Exam Hours	03	Credits	04

Objectives: This course is designed to provide basic the concepts of C-language including flow charts, algorithms, pointers, functions, structures and simple applications.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the basic concepts of C programming.
CO2	implement the algorithms and draw flowcharts for solving Mathematical problems.
CO3	work with arrays and character strings of complex objects within the framework of functional model.
CO4	write C programs with pointers and functions.
CO5	create C programs for simple applications using Structures, unions and understand file operations.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	**L4**				
CO2			**L4**		
CO3					**L3**
CO4				**L4**	
CO5					**L3**

UNIT-I
Over view of C – Constants, variables and Data types - Operators and Expressions.
[Chapters 2, 3& 4 of the prescribed book]

UNIT-II
Managing Input and output operations - Decision making and branching - Decision making and Looping.[Chapters 5, 6 & 7 of the prescribed book]

UNIT-III
Arrays - Handling of character strings.[Chapters 8 & 9 of the prescribed book]

UNIT-IV
User defined functions – Pointers.
[Chapters 10&11 of the prescribed book]

UNIT-V

Structures and Unions - File management in C.
[Chapter 12 and 13 of the prescribed book]

PRESCRIBED BOOK:

"**C Programming and Data Structures"** E. Balaguruswamy, Second Edition, Tata McGraw- Hill Publishing Company.(Refer 4th edition also)

REFERENCE BOOKS:

1."**Computing Fundamentals and C Programming**", E. Balaguruswamy , McGrawHill, 2008.
2."**Programming in C"** D. Ravichandran, 1998, New Age International.
3."**C and Data Structures"** Ashok N. Karthane, Pearson Education.

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M. Sc. Mathematics

First Semester

C PROGRAMMING -20MA1T5

Time: 3 Hours **Max.Marks:70**

1. Answer all questions **(10x2=20)**

(a) Write history of C programming language. (CO1, L2)
(b) Write some features of C programming language. (CO1, L1)
(c) Explain increment and decrement operators with examples. (CO2, L2)
(d) Explain data types in C. (CO2, L3)
(e) Explain single dimensional arrays. (CO3, L2)
(f) Explain any string function with example. (CO3, L3)
(g) Write uses of functions. (CO4, L4)
(h) What is pointer? Write uses of pointers. (CO4, L2)
(i) Write a program to print 1 to n numbers. (CO5, L5)
(j) Write the uses of structures in C. (CO5, L3)

Answer all questions. All questions carry equal marks **(5X10=50)**

2\. a) Briefly explain structure of C program with example. (CO1, L2)

(OR)

b) Write a program in C to check whether the given number is even or odd and draw flowchart. (CO1, L5)

3\. a) Write a program to check whether the given number is palindrome. (CO2, L6)

(OR)

b) Explain Simple if, if-else, nested if statements with example programs. (CO2, L4)

4\. a) Write a program in C for the addition of two matrices using arrays. (CO3, L5)

(OR)

b) Explain the following with example programs.

i) strupr ii) strlen iii) strrev (CO3, L3)

(P.T.O.)

5. a) Write a program in C to find biggest of three numbers using function. (CO4, L6)

(OR)

b) Explain the terms (i) call by reference (ii) call by value with examples. (CO4, L3)

6. a) Write the differences between structures and unions. (CO5, L3)

(OR)

b) What is a file? Explain how the file open and file close functions handled in C.

(CO5, L2)

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010

Reaccredited at 'A+' level by NAAC

Autonomous & ISO 9001:2015 Certified

Title of the Course: NUMERICAL METHODS LAB

Semester : II

Course Code	20MA2L1	Course Delivery Method	Blended Mode
Credits	4	CIA Marks	30
No. of Lecture Hours / Week	4	Semester End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Objectives: The objective of this course is to develop the computational skills of the students to solve various mathematical problems by numerical techniques using C programming.

LIST OF PROGRAMS:

1. Bisection method.
2. False position method (Regula-Falsi Method).
3. Newton -Raphson method.
4. Secant method.
5. Gauss elimination method.
6. Gauss-Jordan method.
7. Gauss- Seidal method.
8. Lagrange's method.
9. Difference table method.
10. Trapezoidal method.
11. Simpson's 1/3 rule.
12. Simpson's 3/8 rule.
13. Euler's method.
14. Taylor Series method.
15. Runge -Kutta method.
16. Modified Euler's method.

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Siddhartha Nagar, Vijayawada – 520 010
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Title of the Course: COMPLEX ANALYSIS
Semester : II

Course Code	20MA2T1	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Course Objectives:
The main objective of the course is to learn the basic properties of complex numbers, analytical functions, differentiation and integration of complex valued functions.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the concept of continuity for complex valued functions and use the Cauchy-Riemann equations to find the derivative of a complex valued function
CO2	apply Cauchy integral formula to evaluate complex contour integrals.
CO3	find power series representations of analytic functions.
CO4	classify singularities and evaluate complex integrals using the residue theorem.
CO5	understand Rouche's theorem and Linear Transformations.

UNIT-I

Analytic Functions: Continuity- Derivatives- Differentiation Formulas-Cauchy-Riemann Equations-Sufficient conditions for Differentiability-Polar Coordinates- Analytic Functions-Harmonic Functions. [Sec 18 to 26 of Chapter 2 of the Prescribed Text Book [1]]

UNIT-II

Integrals: Derivatives of functions w(t)-Definite integrals of functions w(t)- Contours- Contour Integrals- Cauchy-Goursat theorem- Proof of the theorem- Simply Connected Domains- Multiply Connected Domains- Cauchy Integral Formula- An extension of Integral Formula- Some Consequences of the extension- Liouville's Theorem and the Fundamental Theorem of Algebra.
[Sec 37 to Sec 41 and Sec 46 to Sec 53 of chapter 4 of the Prescribed Text Book [1]]

UNIT-III

Series: Convergence of Sequences- Convergence of Series-Taylor's series – Proof of Taylor's theorem- Examples- Laurent's series – Proof of Laurent's Series- Examples.
[Sec 55 to 62 of Chapter-5 of the Prescribed Text Book [1]]

UNIT-IV

Residues and Poles: Isolated singular points- Residues – Cauchy's residue theorem- Residue at Infinity- the three types of isolated singular points - Residues at poles, Zero's of analytic function- Zeros and Poles- Evaluation of improper integrals.
[Sec 68 to 76 of chapter 6 and sec 78, 79 of chapter 7 of the Prescribed Text Book [1]]

UNIT-V

Argument principle- Rouche's theorem- Linear Transformations: The transformation w=1/z - Mappings by 1/z - Linear fractional transformations - The transformation w=sin z.
[Sec 86 &87 of chapter7, sec 90 to 93, 96 of chapter 8 of the Prescribed Text Book [1]]

Prescribed Text Book:

1. "Complex Variables and Applications", James Ward Brown, Ruel V. Churchill, McGraw- Hill International Editions, Eighth Edition.

Reference Books:
1. "Complex analysis for Mathematics and Engineering", John H. Mathews and Russel W, Howell, Narosa Publishing house.
2. "Complex Variables", H. S. Kasana, Prentice Hall of India.

Course has Focus on : Foundation

Websites of Interest: 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA
(An autonomous college in the jurisdiction of Krishna University)
M. Sc. Mathematics
Second Semester

COMPLEX ANALYSIS– 20MA2T1

Time: 3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Check the differentiability of $f(z) = \bar{z}$ (CO1, L5)
b) Define an entire function. (CO1, L2)
c) Define a contour. (CO2, L1)
d) Define simply connected domain and multiply connected domain. (CO2, L2)
e) Expand the function in a series, $f(z) = 1 / z^2 (1 + z)$. (CO3, L4)
f) Show that the series of complex numbers converges,then the n^{th} term converges to 0. (CO3, L3)
g) Find the residue of the function $f(z) = 2z / (z + 4)(z - 1)^2$ at $z = 1$. (CO4, L6)
h) Define three types of isolated singular points. (CO4, L3)
i) Define Argument principle. (CO5, L2)
j) Define Mobius transformation. (CO5, L3)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. a) Suppose that the complex function $f(z) = u + iv$ is differentiable at $z_0=x_0+iy_0$,then prove that the first order partial derivatives of 'u' and 'v' are exist and satisfies C – R equations $u_x = v_y$, $u_y = -v_x$ at (x_0,y_0). (CO1, L2)

(OR)

b) Find a harmonic conjugate $v(x, y)$ of $u(x, y) = e^x (x \cos y - y \sin y)$. (CO1, L5)

3. a) State and Prove Cauchy-Goursat Theorem. (CO2, L3)

(OR)

b) State and Prove Cauchy Integral formula. (CO2, L2)

Turn Over

4. a) State and prove Taylor's theorem. (CO3, L3)

(OR)

b) State and prove Laurent's theorem. (CO3, L5)

5. a) State and prove Cauchy's residues theorem. (CO4, L2)

(OR)

b) Using residue theorem, evaluate the improper integral $\int_0^\infty \frac{x^2}{x^6+1}dx$ (CO4, L6)

6. a) State and prove Rouche's Theorem. (CO5, L3)

(OR)

b) Discuss the transformation w = 1/z (CO5, L5)

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Title of the Course: NUMERICAL METHODS
Semester : II

Course Code	20MA2T2	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Course Objectives:
This Course introduces various Numerical methods for solving Mathematical problems that arise in Science and Engineering and helps to choose, develop and apply the appropriate Numerical techniques for the Mathematical problems.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	solve first and second order Transcendental and Polynomial Equations using different iteration methods.
CO2	solve System of Linear Algebraic Equations and Eigen Value Problems.
CO3	compare the viability of different approaches to the numerical solution of problems arising in interpolation and approximation.
CO4	evaluate a derivative at a value using an appropriate numerical method and calculate the value of a definite integral.
CO5	derive and apply numerical methods like single step methods, multistep methods to solve the linear system of equations.

UNIT-I:

Transcendental and Polynomial Equations: Introduction - Bisection method - Iteration methods based on first degree equation - Secant method – Regula-Falsi method - Newton Raphson method - Iteration method based on second degree equation – Muller method, Chebyshev method- Rate of convergence of Secant method - Newton Raphson method.
[Above topics from Chapter-2 of the Prescribed Book [1]]

UNIT-II:

System of Linear Algebraic Equation and Eigen Value Problems: Introduction - Direct methods - Gauss Elimination Method- Gauss – Jordan Elimination Method - Triangularisation method - Iteration Methods- Jacobi iteration Method - Gauss-Seidel Iteration Method - Eigen values and Eigen vectors. [Above topics from Chapter-3 of the Prescribed Book [1]]

UNIT-III:

Interpolation and Approximation: Introduction - Lagrange Interpolation – Newton's Divided Difference Interpolation - Finite Difference Operators - Interpolating Polynomials using finite differences- Gregory- Newton forward difference interpolation- Gregory- Newton Backward difference interpolation - Hermite interpolation - Approximation: Least Square approximation.
[Above topics from Chapter-4 of the Prescribed Book [1]]

UNIT-IV:

Numerical Differentiation and Integration: Introduction – Numerical differentiation: Methods based on Interpolation- Methods based on finite differences.
Numerical Integration: Trapezoidal rule – Simpson's rule - Composite integration methods.
[Above topics from Chapter-5 of the Prescribed Book [1]]

UNIT-V:

Numerical solutions to Ordinary Differential Equations – Euler Method – Backward Euler Method – Midpoint Method- Runge- Kutta methods: Euler - Cauchy Method- Modified Euler-Cauchy Method- Runge-Kutta second order method - Runge-Kutta fourth order method. [Above topics from Chapter- 6 of the Prescribed Book [1]]

PRESCRIBED BOOK :

1. "Numerical Methods for Scientific and Engineering Computation", M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International, 6th Edition.

REFERENCE BOOK:

"An Introduction to Numerical Analysis" Kendall E. Atkinson.

Course has Focus on : Foundation

Websites of Interest: 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An Autonomous college in the jurisdiction of Krishna University)

M. Sc. Mathematics

Second Semester

NUMERICAL METHODS -20MA2T2

Time: 3 Hours **Max. Marks : 70**

1. Answer all questions. **(10x2=20)**

a) Explain bisection method. (CO1, L1)

b) Write Regula-Falsi Formula. (CO1, L2)

c) Write the condition for Gauss Elimination Method fails. (CO2, L3)

d) Define Eigen value and Eigen vector of a matrix. (CO2, L2)

e) Prove that $\Delta = E - 1$ (CO3, L2)

f) Find the third difference with arguments 2,4,9,10 of the function $f(x) = x^3 - 2x$ (CO3, L5)

g) Write Newton's backward interpolation Formula. (CO4, L3)

h) Write Simpson's 1/3 formula. (CO4, L2)

i) Solve the differential equation $y' = t + y$ with $y(1) = 0$, by Taylor series method to obtain y(1.2)with h=0.1. (CO5, L5)

j) Write second order Runge - Kutta formula. (CO5, L2)

Answer all questions. All questions carry Equal Marks. **(5x10 = 50)**

2 .a)Use Newton-Raphson method to obtain a root, correct to 3 decimal places of the equation $x + \log x = 2$. (CO1, L5)

(OR)

b) Find a root of the equation $(x) = x^3 - 4x - 9 = 0$, using the bisection method in four stages. (CO1, L4)

3 .a)Solve the equations 10x+2y+z=9, 2x+3y-2z = -44, 2x+3y+10z=22 by using Gauss –Seidal method. (CO2, L3)

(OR)

b)Solve the system of linear equations $x_1+x_2+x_3=1$, $4x_1+3x_2-x_3=6$, $3x_1+5x_2+3x_3=14$, by triangulation method. (CO2,L5)

4 .a)The values of x and y are given as below:

x	5	6	9	11
f(x)	12	13	14	16

Find the value of y at x=10 by using Lagrange's interpolation formula. (CO3, L5)

(OR) **(P.T.O.)**

b) Given the following values of f(x) and $f^1(x)$.

x	f(x)	$f^1(x)$
-1	1	-5
0	1	1
1	3	7

Estimate the values of f(−0.5) and $f^1(0.5)$ using Hermite interpolation. (CO3, L4)

5 . a) The following data for f(x) =x^4 is given (CO4, L5)

x	0.4	0.6	0.8
f(x)	0.0256	0.1296	0.4096

Find $f^1(0.8)$ and $f^{11}(0.8)$ using quadratic interpolation.

(OR)

b) (i)Evaluate $\int_{-2}^{2} \frac{x}{5+2x} dx$ by using Trapezoidal rule with 5 ordinates.

(ii) Evaluate $\int_{0}^{2} \frac{dx}{x^3+x+1}$ by using Simpson's 1/3 rule with h=0.25 (CO4, L3)

6 a) Solve the initial value problem $y^1=-y^2$, with y(1)=1 using Euler method and compute y(1.2) using h=0.1. (CO5, L6)

(OR)

b) Solve $u^1=-2tu^2$ with u(0)=1 and h=0.2 on the interval [0, 0.4]using the fourth order classical Runge-Kutta method. (CO5, L6)

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Siddhartha Nagar, Vijayawada – 520 010
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Title of the Course: PARTIAL DIFFERENTIAL EQUATIONS
Semester : II

Course Code	20MA2T3	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Course Objectives: The objective of the course is to find the solutions of first and second order partial differential equations and to study some applications of partial differential equations.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	Formulate and classify first order and second order partial differential equations
CO2	Solve the first order linear and non linear equations using different methods
CO3	Solve the wave equation with different initial and boundary conditions and can apply these solutions to physical problems
CO4	Solve the Laplace equation with different initial and boundary conditions and can apply these solutions to physical problems
CO5	Find Riemann Volterra solution of one dimensional wave equation

UNIT-I

First Order PDE's - Introduction - Methods of solution of $dx/P=dy/Q=dz/R$ - Orthogonal trajectories of a system of curves on a surface - Pfaffian Differential forms and equations - Solution of Pfaffian Differential Equations in three variables – Partial Differential equations- Origins of first order Partial Differential Equations- Cauchy's problem for first order equations.

[Sections 3 to 6 of Chapter 1, Sections 1 to 3 of Chapter 2 of the Prescribed Book [1]]

UNIT-II

Partial differential equations of the First order: Linear Equations of the first order - Integral Surfaces passing through a given curve- Surfaces orthogonal to a given system of Surfaces - Non Linear PDE of the first order - Cauchy's method of characteristics - Compatible systems of first order equations - Charpit's Method- Special types of first order equations - Solutions satisfying given conditions- Jacobi's Method.
[Sections 4 to 13 of Chapter 2 of the Prescribed Book [1]]

UNIT-III

Partial differential equations of the second order: The origin of second order equations - Linear partial differential equations with constant coefficients - Equations with variable coefficients - The solution of linear hyperbolic equations - Separation of variables - Monge's Method.[Sections 1, 4, 5 , 8, 9, 11 of Chapter 3 of the Prescribed Book [1]]

UNIT-IV

Laplace's Equation: Elementary solutions of Laplace's Equation - Families of equipotential surfaces - Boundary value problems - Separation of a variables - Problems with axial symmetry - Kelvin's Inversion theorem. [Sections 2 to 7 of Chapter 4 of the Prescribed Book[1]]

UNIT-V

The wave equation: Elementary solutions of the one dimensional form - The Riemann Volterra solution of one dimensional wave equation. [Problematic approach is Preferred]
[Sections 1 to 3 of Chapter 5 of the Prescribed Book [1]]

PRESCRIBED BOOK:
1. "**Elements of partial differential equations",** I. N. Sneddon, McGraw-Hill International Edition, Mathematics series.

REFERENCE BOOK:
1. "**An Elementary Course in Partial differential equations",** T. Amaranath, Second Edition, Narosa Publishing House.

Course has Focus on : Foundation

Websites of Interest: 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA
(An autonomous college in the jurisdiction of Krishna University)
M. Sc. Mathematics
Second Semester

PARTIAL DIFFERENTIAL EQUATIONS – 20MA2T3

Time: 3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Define orthogonal trajectories of a system of curves on the given surface. (CO1, L1)
b) Define Pfaffian differential equation. (CO1, L2)
c) State the necessary and sufficient condition for the integrability of Pfaffian differential equation. (CO2, L2)
d) Define compatible systems of a partial differential equations. (CO2, L3)
e) Define Wave equation and Laplace equation (CO3, L2)
f) Define Greens function. (CO3, L3)
g) State two types of boundary value problems for Laplace equations. (CO4, L2)
h) Classify Second order PDE's and give an example. (CO4, L5)
i) Define Helmholtzs equation. (CO5, L2)
j) Write Riemann-Volterra solution for one dimensional wave equation. (CO5, L3)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. a) If there exists a relation between two functions u(x, y) and v(x, y) not involving x or y explicitly, then show that $\partial(u,v)/\partial(x,y) = 0$ (CO1, L3)

(OR)

b) Verify that the equation $(z+y)+z(z+x)dy-2xy$ dz = 0 is integrable and find its primitive. (CO1, L5)

3. a) Explain the charpit's method of solving the equation f(x,y,z,p,q) =0. Using this method, find a complete integral of the equation $(p^2+q^2)y=qz$. (CO2, L5)

(OR)

b) Find a complete integral of p^2x+q^2y= z using Jacobi's method. (CO2, L6)

(P.T.O.)

4. a) Solve the equation $r+s-2t = ex+y$ with usual notation. (CO3, L5)

(OR)

b) Solve the equation $r+4s+t+rt-s^2 = 2$ using Monge's method. (CO3, L5)

5. a) A rigid sphere of radius a is placed in a stream of fluid whose velocity in the undisturbed state is V. Determine the velocity of the fluid at any point of the disturbed stream. (CO4,L6)

(OR)

b) State and Prove Kelvin's inversion theorem. (CO4, L6)

6 a) Derive D'Alembert's solution of the one-dimensional wave equation. (CO5, L2)

(OR)

b) If ψ is determined by the differential equation $a^2 (\partial^2\psi/\partial x^2)+b^2\psi=\partial^2\psi/\partial y^2$ where a and b are constants and by the conditions $y = 0, \psi = f(x)$, $\partial\psi/\partial y=g(x)$, then find ψ using Riemann-Volterra Method. (CO5, L3)

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Siddhartha Nagar, Vijayawada – 520 010
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Title of the Course: GRAPH THEORY AND ALGORITHMS
Semester : II

Course Code	20MA2T4	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Course Objectives: The objective of this course is to understand some important classes of graph theoretic problems, properties of trees, matching, connectivity and learn some algorithms for graphs.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the basic concepts in graphs and characterize Eulerian circuits and Hamiltonian cycles
CO2	find minimal spanning tree and shortest paths
CO3	learn matching in a graph and solve assignment problem
CO4	characterize 2-connected graphs and learn various algorithms
CO5	understand planar graphs and coloring of graphs.

UNIT-I

Fundamental Concepts: What is a Graph: The Definition- Graphs as Models- Matrices and Isomorphism- Decomposition and Special graphs; Paths, cycles and trails : connection in graphs, bipartite graphs, Eulerian Circuits; Vertex degrees and counting: Directed Graphs; Hamiltonian Cycles - Necessary and Sufficient conditions.

[Sections 1.1, 1.2, 1.3, 1.4 of chapter 1and Section 7.2 of chapter 7 of Prescribed Book [1]]

UNIT-II

Trees and distance : Properties of Trees; Spanning trees in Graphs; Kruskal and Prim algorithms with proofs of correctness; Shortest paths - Dijkstra's algorithm, BFS and DFS algorithms, Application to Chinese postman problem; Trees in Computer science - rooted trees, binary trees, Huffman's Algorithm.

[Sections 2.1, 2.2, 2.3 of chapter 2 of Prescribed Book [1]]

UNIT-III

Matchings: Maximum Matchings- Hall's matching condition- Maximum bipartite matching - Augmenting path algorithm; Weighted bipartite matching - Hungarian algorithm and solving the assignment problem; Tutte's theorem.

[Sections 3.1, 3.2, 3.3 of Chapter 3 of Prescribed Book [1]]

UNIT-IV

Connectivity and Paths: Connectivity; 2-connected graphs; Menger's theorem; Network flow problems - Ford-Fulkerson labelling algorithm, Max-flow Min-cut Theorem.

[Sections 4.1, 4.2, 4.3 of chapter 4 of Prescribed Book [1]]

UNIT-V

Coloring of Graphs: Definition and Examples; Upper Bounds- Greedy coloring algorithm- Brooks' theorem; Graphs with large chromatic number; Extremal problems and Turan's theorem.

Planar Graphs: Planar graphs; Dual graphs; Euler's formula; Preparation for Kuratowski's Theorem; Coloring of Planar Graphs-Five Color Theorem; Four Color Problem.

[Sections 5.1, 5.2 of Chapter 5 & Sections 6.1, 6.2, 6.3 of chapter 6 of Prescribed Book [1]]

PRESCRIBED BOOK : [1] “Introduction to Graph Theory”, Douglas B. West, Second Edition, Prentice Hall, 2001.

REFERENCE BOOKS:

1. “Graph Theory”, R. Diestel, Second Edition, Springer, 2017.
2. “Graph Theory with Applications to Engineering and Computer Science”, Narsingh Deo, Prentice-Hall, 2001.

Course has Focus on : Foundation

Websites of Interest:
1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An autonomous college in the jurisdiction of Krishna University)

M. Sc. Mathematics

Second Semester

GRAPH THEORY AND ALGORITHMS – 20MA2T4

Time: 3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Define (i) bipartite graph (ii) Chromatic number (CO1, L1)
b) Define (i) Connected graph (ii) Eulerian circuit (CO1, L2)
c) Define (i) Spanning tree (ii) Weighted graph (CO2, L2)
d) Define (i) Graceful graph (ii) Binary tree (CO2, L3)
e) Define (i) Maximal Matching (ii) Augmenting path (CO3, L2)
f) What is Street Sweeping problem? (CO3, L2)
g) Define (i) k-Connected graph (ii) Maximum flow (CO4, L4)
h) Define (i) k-Coloring of a graph (ii) Clique (CO4, L4)
i) State Brook's theorem. (CO5, L1)
j) Define (i) Planar graph (ii) Dual graph (CO5, L2)

Answer all questions. All questions carry equal marks. **(5X10=50)**

2. a) Show that a graph is Eulerian if and only if it has atmost one non trivial component and its vertices all have even degree. (CO1, L2)

(OR)

b) Show that the minimum number of edges in a connected graph with n vertices is n-1. (CO1, L3)

3. a) For a n vertex graph G, show that the following are equivalent.
(i) G is connected and has no cycles.
(ii) G is connected and has n-1 edges.
(iii)G has n-1 edges and no cycles.
(iv) For u,v $\in$ V(G),G has exactly one u,v-path. (CO2, L5)

(OR)

b) Solve Chinese Postman problem using BFS algorithm. (CO2, L6)

4. a) State and prove Hall's theorem. (CO3, L5)

(OR)

(P.T.O)

b) Write Augmenting path algorithm and show that by applying augmenting path algorithm to a bipartite graph produces a matching and a vertex cover of equal size. (CO3, L3)

5 a) Show that a graph G having atleast three vertices is 2-connected if and only if for each pair $u,v \in V(G)$, there exists internally disjoint u,v-paths in G. (CO4, L3)

(OR)

b) If x, y are vertices of a graph G and $x,y \notin E(G)$, then prove that the minimum size of an x,y-cut equals the maximum number of pairwise internally disjoint x,y-paths. (CO4, L4)

6. a) Show that among the n-vertex simple graphs with no (r+1)-clique, $T_{n,r}$ has maximum number of edges. (CO5, L3)

(OR)

b) If a connected plane graph G has exactly n vertices, e edges and f faces, then prove that n-e+f=2. (CO5, L5)

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Siddhartha Nagar, Vijayawada – 520 010
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Title of the Course: LATTICE THEORY
Semester : II

Course Code	20MA2T5	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2022-23	Year of Revision: 2022-23	Percentage of Revision :10%

Course Objectives : The aim of this course is to understand the concepts of Partly Ordered Sets, Complete lattices, Distributive lattices, Boolean algebras and classical propositional logic.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	Understand partially ordered sets and Jordan Dedekind chain conditions
CO2	Analyze the relationship between posets and lattices, acquire knowledge of fundamental notions from lattice theory
CO3	Define and understand basic properties of complete lattices and conditionally complete lattices, closure operations and their applications.
CO4	Characterize modular and distributive lattices using the Birkhoff and Dedekind criterions
CO5	Understand Boolean algebras, Boolean rings and lattices of relations and propositions

UNIT –I

Partly Ordered Sets: Set Theoretical Notations, Relations, Partly Ordered Sets, Diagrams, Special Subsets of a Partly Ordered Set, Length, Lower and Upper Bounds, The Minimum and Maximum Condition, The Jordan–Dedekind Chain Condition, Dimension Functions.

[Sections 1 to 9 of chapter I of Prescribed Book [1]]

UNIT – II

Lattices in General: Algebras, Lattices, The Lattice Theoretical Duality Principle, Semilattices, Lattices as Partly Ordered Sets, Diagrams of Lattices, Sublattices, Ideals, Bound Elements of a Lattice, Atoms and Dual Atoms, Complements, Relative Complements, Semicomplements, Irreducible and Prime Elements of a Lattice, The Homomorphism of a Lattice, Axiom Systems of Lattices. [Sections 10 to 21 of chapter II of Prescribed Book [1]]

UNIT – III

Complete Lattices: Complete Lattices, Complete Sublattices of a Complete Lattice, Conditionally Complete Lattices, σ-Lattices, Compact Elements, Compactly Generated Lattices, Subalgebra Lattice of an Algebra, Closure Operations, Galois Connections, Dedekind Cuts, Partly Ordered Sets as Topological Spaces.

[Sections 22 to 29 of chapter III of Prescribed Book [1]]

UNIT – IV

Distributive and Modular Lattices: Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sublattices, Distributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices.

[Sections 30 to 36 of chapter IV of Prescribed Book [1]]

UNIT-V

Boolean Algebras: Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings, The Algebra of Relations, The Lattice of Propositions, Valuations of Boolean Algebras. [Sections 42 to 47 of chapter VI of Prescribed Book [1]]

PRESCRIBED BOOK: Gabor Szasz, *Introduction to Lattice Theory*, Acadamic press, 1963.

REFERENCE BOOK: G. Birkhoff, *Lattice Theory*, Third Edition, Colloquium publications, Volume 25, American Mathematical Society,1995.

Course has Focus on : Foundation

Websites of Interest:
1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA
(An autonomous college in the jurisdiction of Krishna University)
M. Sc. Mathematics
Second Semester

LATTICE THEORY-20MA2T5

Time: 3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Define a Partly ordered set and give an example. (CO1, L1)

b) Define JDCC. (CO1, L2)

c) Define (i) Meet irreducible element (ii) Join irreducible element (CO2, L3)

d) Define a sublattice, ideal of a lattice. (CO2, L2)

e) Define closure operation. (CO3, L3)

f) Define complete lattice and Compact element. (CO3, L2)

g) Define Distributive lattice and give an example. (CO4, L5)

h) State the Isomorphism theorem of Modular Lattices. (CO4, L2)

i) Define (i) Boolean Ring (ii) Boolean algebra. (CO5, L3)

j) Define valuation of a Boolean Algebra. (CO5, L2)

Answer all questions. All questions carry equal marks. **(5X10=50)**

2. (a) If every subchain of a non empty partly ordered set P has an upper bound, then prove that P contains a maximal element. (CO1, L2)

(OR)

(b) Prove that a partly ordered set can satisfy both the maximum and minimum conditions if and only if every one of its subchain is finite. (CO1, L3)

3. (a) Show that two lattices are isomorphic if and only if they are also order isomorphic. (CO2, L4)

(OR)

(b) (i) Show that every weakly complemented lattice is semicomplemented.
(ii) Show that every section complemented lattice bounded below is weakly complemented. (CO2, L3)

P.T.O.

4. (a) If a lattice satisfies both the maximum and minimum conditions then show that it is complete. (CO3, L2)

(OR)

(b) Show that every element of a compactly generated lattice can be represented as a meet of finite number of meet irreducible elements. (CO3, L4)

5. (a) State and Prove Dedekind's Modularity criterion. (CO4, L5)

(OR)

(b) Show that all irredundant irreducible meet - representations of any element of a modular lattice have the same number of components. (CO4, L4)

6. (a) For a Complete Boolean algebra B, show that the following conditions are equivalent.

(i) B is Completely meet- distributive.

(ii) B is Atomic.

(iii) B is isomorphic with the subset lattice of a set. (CO5, L5)

(OR)

(b) Show that the algebra of relations *R* (M) of a set M forms a complete Boolean algebra. (CO5, L4)

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

M.Sc (Mathematics) Programme - III Semester

MEASURE AND INTEGRATION

(w.e.f admitted batch 2020-21)

Course Code	**20MA3T1**	Course Delivery Method	Blended Mode
Credits	**5**	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2021-22	Year of Revision: 2021-22	Percentage of Revision :10%

Course Objective : The main objective of the course is to introduce the concept of Lebesgue measure for the subsets of R. This concept of Lebesgue measure is later used in developing the theory of (Lebesgue) Integration which gives stronger (and better) results as compared to the theory of Riemann Integration. The aim of this course is to acquire knowledge on basic concepts of Outer measure, Measurable sets, Lebesgue Measure, Lebesgue Integral, Measurable Functions, and to extend these results and related concepts in a measure space.

Course Outcomes: After successful completion of this course, students will be able to

CO1: Understand the concept of measure and properties of Lebesgue measure (PO5)

CO2: Study the properties of lebesgue integral and compare it with Riemann integral (PO5)

CO3: Find the derivative of an Integral and Integral of a derivative for the functions of bounded variation (PO1)

CO4: Construct different measures for P(X) and study their properties. (PO1)

CO5: Define product measure and study the concept of integral with respect to product measure. (PO1)

(Turn over)

Course Details:

Unit	Learning Units	Lecture Hours
I	**Lebesgue Measure:** Introduction, Outer measure, Measurable sets and Lebesgue measure, A Non measurable set, Measurable functions, Littlewood's three principles. (Chapter3)	15
II	**The Lebesgue Integral:** The Riemann Integral, The Lebesgue Integral of a bounded function over a set of finite measure, The Integral of a non-negative function, The general Lebesgue Integral. (Sections 4.1to 4.4 of Chapter4).	15
III	**Differentiation and Integration:** Differentiation of monotone functions, Functions of bounded variation, Differentiation of an Integral, Absolute continuity. (Sections 5.1 to 5.4 of Chapter 5)	15
IV	**Measure and Integration:** Measure spaces, Measurable functions, Integration, General Convergence theorems, Signed Measures, The Radon-Nikodym theorem. (Sections 11.1to11.6 of Chapter11)	15
V	**Measure and Outer Measure:** Outer Measure and Measurability, The Extension theorem, Product measures. (Sections 12.1, 12.2 &12.4 of Chapter12).	15

PRESCRIBED BOOK:

1. Royden H.L., **Real Analysis,** Third Edition, Pearson publishers.

REFERENCEBOOKS:

1. HalmosP.R, **Measure Theory,** Springer-Verlag, 1974.

2. Bogachev V.I,**MeasureTheory** Springer-Verlag, 1997.

Course has Focus on : Foundation

Websites of Interest: 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

MODEL QUESTION PAPER

MEASURE AND INTEGRATION

Time:3 hours Max. Marks: 70 M

SECTION A

Answer all questions. 10 X 2 = 20

1) Define Outer measure. (CO1,L1)
2) State Littlewoods three principles. (CO1,L2)
3) State bounded convergence theorem. (CO2,L2)
4) If f is integrable, then show that $|f|$ is integrable. (CO2,L4)
5) Define function of bounded variation. (CO3, L1)
6)Define Absolute continuous function. (CO3, L1)
7)Define Positive set and Negative set with respect to a signed measure. (CO4, L1)
8) State Hahn decomposition theorem. (CO4, L2)
9) Define Product measure. (CO5, L2)
10) State Tonelli's theorem. (CO5, L1)

SECTION B

Answer the following questions. All questions carry equal marks. 5 X 10 = 50

11. (a) State and Prove Egoroff's theorem. (CO1, L4)

(Or)

(b) If$\{E_n\}$ is a decreasing sequence of measurable sets with mE_1 finite, then show that $m(\cup E_n) = \lim m(E_n)$. (CO1, L4)

12. (a) State and Prove Lebesgue convergence theorem. (CO2, L3)

(Or)

(b) Let f be a non negative function which is integrable over a set E. Then Show that given $\epsilon > 0$, there is a $\delta > 0$ such that for every set $A \subset E$ with $mA < \delta$, $\int_A f < \epsilon$. (CO2, L3)

13. (a) State and Prove Vitali Covering Lemma. (CO3, L4)

(Or)

(b) If f is absolutely continuous on [a,b] and $f^1(x)=0$ a.e., then show that f is constant. (CO3, L4)

(Turn over)

14. (a) Define Positive set and Negative set with respect to a signed measure ν.
Let E be a measurable set such that $0<\nu(E)<\infty$, then show that there is a positive set A contained in E with $\nu(A)>0$. (CO4, L3)

(Or)

(b) State and prove the Jordan Decomposition Theorem. (CO4, L3)

15. (a) State and prove the Caratheodary Extension Theorem. (CO5, L3)

(Or)

(b) State and prove Fubini's Theorem. (CO5, L3)

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

M.Sc (Mathematics) Programme - III Semester

PROBABILITY& STATISTICS

(w.e.f admitted batch 2020-21)

Course Code	**20MA3T2**	Course Delivery Method	Blended Mode
Credits	**5**	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2021-22	Year of offering : 2021-22	Year of Revision: ------	Percentage of Revision : ----

Course Objectives : The objective of this course is to introduce the basic concepts of statistics like probability theory, distributions, correlation, regression and sampling distributions.

Course Outcomes: After successful completion of this course, students will be able to

CO1: Understand the theorems on probability and solve the problems related to various diversified situations. (PO1)

CO2:Understand various properties of expectation, variance and generating functions (PO5)

CO3:Apply poisson distribution and normal distribution to solve problems in Engineering and related fields. (PO3)

CO4:Solve the problems using correlation and regression analysis. (PO4)

CO5:Solve the statistical problems with different statistical techniques like chi-square distribution. (PO3)

(Turn over)

Course Details:

Unit	Learning Units	Lecture Hours
I	**Theory of Probability-I:** Random Experiment, Sample Space & Elementary Events, Event, Axiomatic probability, Some theorems on probability, Boole's Inequality, Conditional Probability, Multiplication theorem of probability, Independent events, Multiplication theorem on probability for independent Events, Extension of Multiplication theorem of Probability to n Events, Baye's theorem. (Sections 3.8.1, 3.8.2, 3.8.5 and 3.9 to 3.14 of Chapter3 & 4.2 of Chapter4 of [1])	15
II	**Random Variables and Distribution functions**: Distribution Function, Discrete random variable, Continuous random variable, Two Dimensional Random variables. Mathematical expectation**,** Moments of a distribution function, Moment generating functions, Characteristic functions and their properties Chebychev inequality, Probability generating functions. [5.2 to 5.5(up to 5.5.5.) of Chapter- 5, Chapter 6 except 6.7 and 7.1, 7.2, 7.3, 7.5 and 7.9 of Chapter 7]	15
III	**Probability Distributions:** Discrete, Binomial and Poisson distributions and their properties. **Continuous Probability Distributions:** Normal and Rectangular distributions and their properties. [8.1 to 8.5 of Chapter 8 and 9.1 to 9.3 of Chapter 9]	15
IV	**Correlation and Regression**: Correlation, Karl pearson's coefficient of correlation, Calculation of correlation coefficient for bivariant frequency distribution, Spearman's rank correlation coefficient. **Linear regression:** Regression coefficients and their properties - Angle between two lines of regression. [10.1 to 10.5 and 10.7.1 of Chapter 10 and Chapter 11 (upto 11.2.3)]	15
V	**Sampling distribution**: Sampling and Large sample tests. **Exact sampling distributions**:$\chi 2$, t and F-distributions. [Chapter-14, Chapter 15 up to 15.6.4 and Chapter 16 up to 16.6 except 16.4]	15

Prescribed Text Book:
1. Gupta S.C.and Kapoor V.K, **Fundamentals of Mathematical Statistics**, 11th Edition, New Delhi, Sultan Chand &Sons.

Reference Book:
1. Walpole Myers, Keying Ye, **Probability and Statistics for Engineers and Scientists**, 9th edition, Pearson Publications

Course has focus on : Employability / Skill Development

Websites of Interest: 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

MODEL QUESTION PAPER

PROBABILITY & STATISTICS

Time:3 hours Max.Marks: 70 M

SECTION A

Answer all questions. 10 X 2 = 20

1) Define Equally likely events. (CO1,L1)
2)Define Axiomatic probability. (CO1,L1)
3) Define Correlation. (CO2,L1)
4) Define random variable. (CO2,L1)
5) Define moment generating function. (CO3,L1)
6) Define Normal distribution. (CO3,L1)
7) Define characteristic function. (CO4,L1)
8) Write Application of Normal distribution. (CO4,L3)
9) Define chi-square distribution of goodness of fit. (CO5,L1)
10) Write properties of F-distribution. (CO5,L2)

SECTION B

Answer the following questions. All questions carry equal marks. 5 X 10 = 50

11. (a) State and prove multiplication theorem of probability. (CO1, L4)

(Or)

(b) State and prove Baye's theorem. (CO1, L4)

12. (a) If $X_1, X_2, \ldots X_n$ are random variables, then Prove that

$$E(X_1 + X_2 + ...X_n) = E(X_1) + E(X_2) + ...E(X_n)$$

(CO2, L3)

(Or)

(b) Write properties of Characteristic function. (CO2, L3)

13. (a) Using MGF derive mean and variance of Binomial distribution. (CO3, L4)

(Or)

(b) Write properties of Normal distribution. (CO3, L4)

(Turn over)

14. (a) Calculate Karl-Pearson's coefficient of correlation between expenditure on advertising and sales from the data given below advertising

Expenses (000's)	39	65	62	90	82	75	25	98	36	78
Sales (Lakhs Rs.)	47	53	58	86	62	68	60	91	51	84

(CO4,L4)

(Or)

(b) What is Linear regression? Find the angle between two regression lines. (CO4,L4)

15. (a) The number of scooter accidents per month in a certain town were as follows:

12 8 20 2 14 10 15 6 9 4

Are there frequencies in agreement with the belief that accident conditions were the same during this 10 month period? (CO5,L4)

(Or)

(b) Ten cartons are taken at random from an automatic filling machine. The mean net weight of the 10 cartons is 11.8 and s.d. is 0.15. Does the sample mean differ significantly from the intended weight of 12.02 Kg. You are given that $v=9$ and $t_{0.05} = 2.26$. (CO5,L4)

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

M.Sc (Mathematics) Programme - III Semester

GALOIS THEORY

(w.e.f admitted batch 2020-21)

Course Code	**20MA3T3**	Course Delivery Method	Blended Mode
Credits	**5**	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2021-22	Year of Revision: 2021-22	Percentage of Revision : 10%

Course Objectives : To develop skills and knowledge on some of the basic concepts in Modules, Algebraic Extensions, Splitting fields, Polynomials solvable by radicals.

Course Outcomes: After successful completion of this course, students will be able to

CO1: Understand the concepts of modules, submodules, quotient modules, homomorphisms and characterize completely reducible modules. (PO1)

CO2: Derive and apply Gauss Lemma, Eisenstein criterion for irreducibility of Polynomials. (PO3)

CO3: Demonstrate Field extensions and characterization of finite normal extensions as splitting fields and study prime fields. (PO1)

CO4: Derive Fundamental theorem of Galois theory, fundamental theorem of Algebra and related results. (PO5)

CO5: Understand cyclotomic polynomials, cyclic extensions and Ruler & Compass Constructions. (PO1)

(Turn over)

Unit	Learning Units	Lecture Hours
I	**Modules:** Definition and examples, sub modules and direct sums, R-homomorphisms and quotient modules, Completely reducible modules. (Sections 1 to 4 of chapter 14 of [1])	15
II	**Algebraic Extensions of fields:** Irreducible polynomials and Eisenstein's criterion, Adjunction of roots, Algebraic extensions, Algebraically closed fields. (Sections 1 to 4 of chapter 15 of [1])	15
III	**Normal and Separable extensions:** splitting fields, Normal extensions, Multiple roots, Finite fields, Separable extensions. (Sections 1 to 5 of chapter 16 of [1])	15
IV	**Galois Theory:** Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra. (Sections 1 to 3 of chapter 17 of [1])	15
V	**Applications of Galois Theory to Classical Problems:** Roots of unity and cyclotomic polynomials-Cyclic extensions- Ruler and compass constructions (Sections 1, 2, 5 of chapter 18 of [1])	15

PRESCRIBED TEXT BOOK:

1. Bhattacharya, P. B. Jain S. K and Nagpaul S. R, **Basic abstract algebra,** Second edition, Cambridge Press.

REFERENCE BOOKS:

1. Joseph Rotman, **Galois theory,** Second edition, Springer, 1998.
2. Artin M, **Algebra,**PHI, 1991.
3. David S Dummit and Richard M Foote, **Abstract Algebra**, Third Edition, Wiley Publications.

Course has Focus on: Foundation

Websites of Interest: 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

MODEL QUESTION PAPER

GALOIS THEORY

Time: 3 hours Max. Marks: 70 M

SECTION A

Answer all questions. 10 X 2 = 20

1) Define R-Module and a Sub module. (CO1,L1)
2) Define R-homomorphism and irreducible R-module. (CO1,L1)
3) Define root of a polynomial and a monic polynomial. (CO2,L1)
4) Show that $x^2 -2$ is irreducible over Z. (CO2,L3)
5) Define splitting field of a polynomial and give an example. (CO3,L2)
6) Define normal extension of a field and a prime field of a field. (CO3,L2)
7) What is meant by fixed field of a Group homomorphism? (CO4,L1)
8) Write a Short notes on Galois extension of a field. (CO4,L1)
9) What is Cyclotomic polynomial? Explain with an example. (CO5,L2)
10) Define Cyclic extension and give an example. (CO5,L1)

SECTION B

Answer all questions. All questions carry equal marks. 5 X 10 = 50

11.a) Let f be an R-homomorphism of an R-module M into an R-module N. Then prove that $M / \ker f \cong f(M)$ (CO1,L2)

(Or)

b) Let R be a ring with unity. Then prove that an R-module M is cyclic iff $M \cong R/ I$, for some left ideal I of R. (CO1,L2)

12. a) State and prove Gauss lemma. (CO2,L3)

(Or)

b) Define algebraic element and algebraic extension of a field. If E is a finite extension of a field F, then prove that E is an algebraic extension of F. (CO2,L3)

13.a) State and prove Uniqueness of splitting field. (CO3,L3)

(Or)

b) Let $f(x) \in F[x]$ be a polynomial of degree ≥ 1 with α as a root. Then prove that α is a multiple root if and only if $f'(\alpha) = 0$. (CO3,L3)

14. a) State and prove Dedikind lemma. (CO4,L4)

(Or)

b) State and prove the fundamental theorem of Galois theory. (CO4,L4)

15. a) Let F be a field contains a primitive nth root ω of unity, then prove the following are equivalent.

i) E is a finite cyclic extension of degree n over F.

ii) E is the splitting field of an irreducible polynomial $x^n - b \in F[x]$. (CO5,L4)

(Or)

b) If a and b are constructible numbers, then prove that

i) ab is constructible.

ii) a / b, $b \neq 0$ is constructible. (CO5,L4)

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

M.Sc (Mathematics) Programme - III Semester

MATHEMATICAL METHODS

(w.e.f admitted batch 2020-21)

Course Code	**20MA3T4**	Course Delivery Method	Blended Mode
Credits	**5**	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2021-22	Year of offering : 2021-22	Year of Revision: ---	Percentage of Revision : ---

Course Objectives : The aim of this course is provide the students with the basic knowledge of various mathematical methods like Fourier series, calculus of variations, difference equations and the Laplace Transformations which play an important role in solving various problems of Engineering and science.

Course Outcomes: After successful completion of this course, students will be able to

CO1: Gain knowledge of finite and infinte Fourier Series and study their applications(PO1)

CO2: Understand the extremals of functionals and study their applications (PO1)

CO3: Formulate and solve the difference equations. (PO5)

CO4: Find Laplace Transforms of different functions (PO4)

CO5: Find Inverse Laplace Transforms and apply Convolution theorem. (PO4)

(Turn over)

Unit	Learning Units	Lecture Hours
I	**Fourier Series:** Introduction, Euler's Formulae, Conditions for a Fourier Expansion, Functions having points of discontinuity, Change of Interval, Even and Odd functions, Half-range series. (Sections 10.1 to 10.7 of Chapter 10 of [1])\	15
II	**Calculus of variations:** Introduction, Functionals, Euler's Equation, Solutions of Euler's Equation, Geodesics, Isometric Problems, Several Dependent Variables, Functionals involving higher order derivatives, Hamilton's Principle, Lagrange's Equation. (Sections 35.1 to 35.8, 35.11 and 35.12 of Chapter 35 of [1])	15
III	**Difference Equations:** Introduction, Definition, Formation of Difference equations, Linear Difference equations, Rules for finding the Complementary Function, Rules for finding the Particular Integral. (Sections 31.1 to 31.6 of Chapter 31 of [1])	15
IV	**The Laplace Transform:** Existence of Laplace Transform, Functions of exponential order, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Laplace Transform of the derivative of F(t), Initial value theorem, Final value theorem, Laplace Transform of integrals, Multiplication by t, Multiplication by t^n, division by t, Periodic functions, Some special functions. (Sections 1.5 to 1.22 of Chapter I of [2]).	15
V	**The Inverse Laplace Transform:** Inverse Laplace transforms, Null Function, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Use of partial fractions-Inverse Laplace transforms of derivatives, Inverse Laplace transforms of integrals-multiplication by powers of p, Division by powers of p, Convolution theorem-Heaviside's expansion theorem or formula, The Complex inversion formula. (Sections 2.1, 2.2, 2.6 to 2.16 and 2.18 of Chapter II of [2])	15

PRESCRIBED TEXT BOOKS:

[1] Grewal B.S, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2018.
[2] Vasihatha A.R. and Gupta R.K, Integral Transforms, 36th edition, KRISHNA Prakashan Media (P) Ltd.2017.

REFERENCE BOOKS:

1. Differential Equations Theory, Technique and Practice by George F. Simmons and Steven G.Krantz, Tata McGraw-Hill Edition.

Course has focus on : Skill Development

Websites of Interest: 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

MODEL QUESTION PAPER

MATHEMATICAL METHODS

Time: 3 hours Max. Marks: 70 M

SECTION A

Answer all questions. 10 X 2 = 20

1) Write the Dirichlet's conditions for a Fourier series. (CO1,L1)
2) Write the Fourier series expansion of even periodic function. (CO1,L1)
3) Write Euler's Equation. (CO2,L1)
4) Find the extremal of the functional $\frac{\sqrt{1+(y^1)^2}}{y}$. (CO2,L3)
5) Solve the difference equation $y_{n+2} - 5y_{n+1} - 6y_n = 0$. (CO3,L4)
6) Find the complete solution of $y_{n+2} - 4y_{n+1} + 3y_n = 5^n$. (CO3,L4)
7) Write the first shifting theorem of Laplace transformations. (CO4,L1)
8) Find the Laplace transformation of sinat. (CO4,L4)
9) Find Inverse Laplace transformation of $\frac{p}{p^2 - a^2}$ (CO5,L4)
10) Find Inverse Laplace transformation of $\log\left(\frac{p+3}{p+4}\right)$. (CO5,L4)

SECTION B

Answer all questions. All questions carry equal marks. 5 X 10 = 50

11. a) Obtain the Fourier series for the function $f(x) = e^{-x}$ in the interval $0 < x < 2\pi$.(CO1,L3)

(Or)

b) Find the Fourier series of the function $f(x) = x \sin x$ as a cosine series in $(0,\pi)$.

Deduce that $\frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5.7} - \ldots\ldots\infty = \frac{\pi - 2}{4}$ (CO1,L3)

12. a) Prove that necessary condition for the functional $I = \int_{x_1}^{x_2} f(x, y, y^1)dx$ to be an extremum is $\frac{\partial f}{\partial y} - \frac{\partial}{\partial x}\left(\frac{\partial f}{\partial y}\right) = 0$. (CO2,L4)

(Or)

b) Show that the curve which extremizes the functional $I = \int_0^{\pi/4} (y^{11^2} - y^2 + x^2)dx$ under the conditions $y(0)= 0$, $y^1(0) = 1$, $y(\pi/4)= y^1(\pi/4) = 1/\sqrt{2}$ is $y = \sin x$.

(CO2,L4)

(Turn over)

13. a) Form the difference equation corresponding to the family of curves y = ax+bx^2 (CO3,L4)

(Or)

b) (i) Solve $y_{n+2} - 4y_n = n^2+n-1$ (ii) Solve $y_{n+2} - 2y_{n+1} + y_n = n^2\, 2^n$. (CO3,L4)

14. a) Prove the following Hypothesis: If F(t) is continuous for all $t \geq 0$ and be of exponential order a as $t \to \infty$ and if $F^1(t)$ is of class A, then the Laplace transformation of the derivative $F^1(t)$ exist when p > a and L$\{F^1(t)\}$ = p L$\{F(t)\}$ −F(0) .(CO4,L3)

(Or)

b) Find the Laplace transformations of $\dfrac{e^{-at} - e^{-bt}}{t}$ and $J_0(t)$. (CO4,L3)

15. a) Find the inverse Laplace Transformation of the following functions

(i) $\dfrac{2p+1}{(p+2)^2(p-1)^2}$ (ii) $\dfrac{e^{-4p}}{(p-3)^4}$

(CO5,L3)

(OR)

b) State and prove convolution theorem. (CO5,L3)

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

M.Sc (Mathematics) Programme - III Semester

ANALYTICAL NUMBER THEORY

(w.e.f admitted batch 2020-21)

Course Code	**20MA3T5**	Course Delivery Method	Blended Mode
Credits	**5**	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2021-22	Year of offering : 2021-22	Year of Revision: ---	Percentage of Revision : ---

Course Objectives : This course is introduced to develop problem solving skills and to acquire knowledge on concepts of Arithmetical functions, Dirichlet multiplication, Averages of Arithmetical functions and Congruences.

Course Outcomes: After successful completion of this course, students will be able to

CO1:define and interpret the concepts of divisibility, congruence, dirichlet product and multiplicative functions. (PO3)

CO2:understand the concept of arithmetical functions and properties of multiplicative functions such as Euler phi function etc. (PO3)

CO3:understand Chebyshev's functions $\psi(x)$and $\vartheta(x)$, some equivalent forms of the prime number theorem and applications of Shapiro's Tauberian theorem.(PO3)

CO4:apply the theory of congruences in various disciplines of science (PO4)

CO5: study the applications of the Chinese Remainder Theorem. (PO5)

(Turn over)

Unit	Learning Units	Lecture Hours
I	**Arithmetical Functions and Dirichlet Multiplication:** Introduction, The Mobius function μ(n), The Euler Totient function φ(n), A relation connecting φ and μ, A product formula for φ(n), The Dirichlet product of arithmetical functions, Dirichlet inverses and the Mobius inversion formula, The Mangoldt function Λ(n), Multiplicative functions, Multiplicative functions and Dirichlet multiplication, The inverse of a completely multiplicative function, Liouville's function λ(n), The divisor function $\sigma_\alpha(n)$, Generalize convolutions. (Sections2.1to2.14of Chapter2 of [1])	15
II	**Averages of Arithmetical Functions:** Introduction, The big oh notation Asymptotic equality of functions, Euler's summation formula, Some elementary asymptotic formulas, The average order of d(n), The average order of divisor functions $\sigma_\alpha(n)$, The average order of φ(n), An application to the distribution of lattice points visible from the origin, The average order of μ(n) and of Λ(n), The partial sums of a Dirichlet product, Applications to μ(n) and Λ(n), Another identity for the partial sums of a Dirichlet product. (Sections3.1to3.12of Chapter3 of [1])	15
III	**Some Elementary Theorems on the Distribution of Prime Numbers:** Introduction, Chebyshev's functions ψ(x) and ϑ(x). Relations connecting ϑ(x) and π(x), Some equivalent forms of the prime number theorem, Inequalities of π(n) and p_n, Shapiro's Tauberian theorem, Application of Shapiro's theorem, An asymptotic formula for the partial sums $\sum_{p\le x}(1/p)$, The Partial Sums of the Mobius function.(Sections 4.1to 4.9 of Chapter4 of [1])	15
IV	**Congruences:** Definition and basic properties of congruences, Residue classes and complete residue systems, Linear congruences, Reduced residue systems and Euler- Fermat theorem,Polynomial congruences modulo p, Lagrange's theorem. (Sections 5.1to 5.5 of Chapter5 of [1])	15
V	Applications of Lagrange's Theorem, Simultaneous linear congruences, The Chinese remainder theorem, Applications of the Chinese Remainder Theorem, Polynomial Congruences with prime power moduli. (Sections 5.6 to 5.9 of Chapter 5 of [1]).	15

(Turn over)

PRESCRIBED TEXT BOOK:

1. Apostol Tom M, **Introduction to Analytic Number Theory,** New Delhi, Narosa Publishing House, 1998.

REFERENCE BOOK:

1. Hardy G.H. and Wright E.M, **An Introduction to the Theory of Numbers,** Oxford Press.

Course has focus on : Skill Development

Websites of Interest:
1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

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Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada.
(An autonomous college in the jurisdiction of Krishna University)

MODEL QUESTION PAPER

ANALYTICAL NUMBER THEORY

Time: 3 hours Max. Marks: 70 M

SECTION A

Answer all questions. 10 X 2 = 20

1) Define Mobius function $\mu(n)$. (CO1,L1)

2) Define multiplicative function. (CO1,L1)

3) Define the average order of d(n). (CO2,L1)

4) Write the average order of $\mu(n)$ and $\wedge(n)$. (CO2,L2)

5) Define Chebyshev's functions. (CO3,L1)

6) State Shapiro's Tauberian theorem. (CO3,L1)

7) Show that the linear congruence $2x \equiv 3 \pmod 4$ has no solution. (CO4,L3)

8) Prove that congruence is an equivalence relation. (CO4,L2)

9) State Little Fermat's Theorem. (CO5,L1)

10) Solve the congruence $5x \equiv 3 (\bmod 24)$. (CO5,L4)

SECTION B

Answer all questions. All questions carry equal marks. 5 X 10 = 50

11. a) Define the Dirichlet product. State and prove Mobius Inversion formula. (CO1,L3)

(Or)

b) Show that if both g and $f * g$ are multiplicative, then f is also multiplicative. (CO1, L3)

12. a) State and prove Euler's summation formula. (CO2, L3)

(Or)

b) State and prove Legendre's Identity. (CO2,L3)

13. a) State and prove Abel's Identity. (CO3,L3)

(OR)

b) Show that the following relations are logically equivalent: (CO3,L3)

(i) $\lim_{x\to\infty} \frac{(\pi(x)\log x)}{x} = 1$ (ii) $\lim_{x\to\infty} \frac{\vartheta(x)}{x} = 1$ (iii) $\lim_{x\to\infty} \frac{\psi(x)}{x} = 1$,

Where $\pi(x)$ is the number of primes not exceeding x and $\vartheta(x)$ and $\psi(x)$ are Chebyshev's functions.

14. a) Assume (a, m) = d, where a, b and m are integers, m > 0. Then show that the linear congruence ax ≡ b (mod m) has solutions if and only if d/b. (CO4,L4)

(Or)

b) State and prove Euler-Fermat Theorem. (CO4,L4)

15. a) Show that for a prime p, (p-1)! ≡ -1 (mod p). (CO5,L3)

(Or)

b) State and prove the Chinese Remainder theorem. (CO5,L3)

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010
Reaccredited at 'A+' level by NAAC
Autonomous & ISO 9001:2015 Certified

Title of the Course: RINGS AND MODULES
Semester : IV

Course Code	20MA4T1	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2021-22	Year of Revision: 2021-22	Percentage of Revision :10%

Course Objectives : The main objective of the course is to acquire knowledge on Boolean Algebras, isomorphism theorems, Prime ideals in commutative rings, complete ring of quotients, Prime ideal spaces, functional representations of elements of a ring.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the fundamental concepts of rings and modules.
CO2	study classical isomorphism theorems and the properties of direct sum, product of rings and modules.
CO3	understand the concept of Prime ideals and radicals in commutative rings
CO4	study the Wedderburn –Artin theorem and its applications
CO5	study functional representations and Prime ideal spaces.

UNIT – I

Fundamental Concepts of Algebra: Rings and related Algebraic systems, Subrings, Homomorphisms, Ideals. (Sections 1.1, 1.2 of chapter 1 of prescribed book [1])

UNIT –II

Fundamental Concepts of Algebra: Modules, Direct products and Direct sums, Classical Isomorphism Theorems. (Sections 1.3, 1.4 of chapter 1 of prescribed book [1])

UNIT – III

Selected Topics on Commutative Rings: Prime ideals in commutative Rings, Prime ideals in Special commutative Rings. (Sections 2.1, 2.2 of chapter 2 of prescribed book [1])

UNIT – IV

Selected Topics on Commutative Rings: The Complete Ring of Quotients of a commutative Ring, Rings of quotients of Commutative Semiprime Rings. (Sections 2.3, 2.4 of chapter 2 of prescribed book [1])

UNIT – V

Selected Topics on Commutative Rings: Prime Ideal Spaces (Section 2.5 of chapter 2 of prescribed book [1])
Appendices: Functional Representations
(Appendix 1: Proposition 1 to Proposition 9 of prescribed book [1])

PRESCRIBED BOOK:

1. Lambek J, Lectures on Rings and Modules**,** Blaisdell Publications (2009).

REFERENCE BOOKS:

1. Hungerford Thomas W, Algebra, Springer publications (1974).

Course has Focus on : Foundation (Elective Paper)

Websites of Interest: 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An Autonomous college in the jurisdiction of Krishna University)

M.Sc. Mathematics

Fourth Semester

RINGS AND MODULES-20MA4T1

Time:3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Define Boolean Algebra and Boolean ring. (CO1, L1)

b) Define congruence relation and homomorphic relation. (CO1, L2)

c) Define direct sum of modules. (CO2, L3)

d) Define Artinian and Noetherian Modules. (CO2, L2)

e) Define prime radical and Jacobson radical. (CO3, L2)

f) Define a prime ideal and a regular ring. (CO3, L2)

g) If D and D^1 are dense ideals of a ring R, show that $D \cup D^1$ is also dense. (CO4, L4)

h) Define complete ring of quotients. (CO4, L2)

i) Define a compact Topological space. (CO5, L2)

j) Define interior of a set and exterior of a set V in a topological space Π. (CO5, L3)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. (a) Show that a Boolean algebra becomes a complemented distributive lattice by defining $a \vee b = (a' \wedge b')'$ & $1 = 0'$ and conversely, any complemented distributive lattice is a Boolean algebra in which these equations are provable identities. (CO1, L2)

(OR)

(b) Show that there is a one-one correspondence between the ideals K and the congruence relations θ of a ring R such that $r - r' \in K \Leftrightarrow r\ \theta\ r'$ and this is an isomorphism between the lattice of ideals and the lattice of congruence relations. (CO1, L3)

3 (a) Show that the following statements are equivalent.

(i) R is isomorphic to a finite direct product of rings R_i (i =1,2, …n)

(ii)There exist central orthogonal idempotents $e_i \in R$ such that $1 = \sum_{i=1}^{n} e_i$, $e_i R \cong R_i$

(iii) R is a finite direct sum of ideals $K_i \cong R_i$ (CO2, L2)

(OR)

(b) Let B be a sub module of A_R. Then show that A is Artinian if and only if B and A/B are Artinian. (CO2, L4)

4. (a) Show that the radical of a ring R consists of all elements $r \varepsilon R$ such that $1 - rx$ is a unit for all $x \varepsilon R$. (CO3, L5)

(OR)

(b) Let R be a subdirectly irreducible commutative ring with smallest nonzero ideal J. Then show that

(i) The annihilator J^* of J is the set of all zero divisors.

(ii) J^* is a maximal ideal and $J^{**} = J$. (CO3, L4)

5. (a) If R is any commutative ring , then show that Q(R) is rationally complete.(CO4, L2)

(OR)

(b) If R is commutative ring, then show that Q(R) is regular if and only if R is semiprime. (CO4, L3)

6. (a) Show that a Boolean algebra is isomorphic to the algebra of all subsets of a set if and only if it is complete and atomic. (CO5, L5)

(OR)

(b) If P is a prime ideal of the commutative ring R, then show that $P/0_P$ is a prime ideal of $R/0_P$ and it contains all zero – divisors of $R/0_P$. (CO5, L3)

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010
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Autonomous & ISO 9001:2015 Certified

Title of the Course: OPERATIONS RESEARCH
Semester : IV

Course Code	20MA4T2	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2021-22	Year of Revision: 2021-22	Percentage of Revision :10%

Course Objective : To develop problem solving skills and to acquire knowledge on basic concepts of linear programming problems, Transportation problems, Assignment problems and Job sequencing.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the theory of Simplex method.
CO2	convert standard business problems into linear programming problems and solve using simplex algorithm.
CO3	formulate and solve transportation problems
CO4	formulate and solve the Assignment problem and compare Transportation and Assignment problems
CO5	formulate and solve Job sequencing problems.

UNIT - I

Mathematical Background : Lines and hyperplanes: Convex sets, Convex sets and hyperplanes, Convex cones. [Sections 2.19 to 2.22 of Chapter 2of [1]].
Theory of the simplex method : Restatement of the problem, Slack and surplus Variables, Reduction of any feasible solution to a basic feasible solution, Some definitions and notations, Improving a basic feasible solution, Unbounded solutions, Optimality conditions, Alternative optima, Extreme points and basic feasible solutions.
[Sections 3.1, 3.2, 3.4 to 3.10 of Chapter 3 of prescribed book [1]]

UNIT –II

Detailed development and Computational aspects of the simplex method:

The Simplex method, Selection of the vector to enter the basis, degeneracy and breaking ties, Further development of the transportation formulas, The initial basic feasible solution artificial variables, Tableau format for simplex computations, Use of the tableau format, conversion of a minimization problem to a maximization problem, Review of the simplex method, Illustrative examples. [Sections 4.1 to 4.5, 4.7 to 4.11 of Chapter 4 of prescribed book [1]].

UNIT –III

Transportation problem: Introduction, properties of the matrix A, The Simplex Method and transportation problems, Simplifications R resulting from all $y_{ij}^{\alpha\beta} = \pm 1$ or 0, The Transportation Problem Tableau, Bases in the transportation Tableau, The Stepping-Stone algorithm, Determination of an initial basic feasible solution, Alternative procedure for computing $z_{ij} - c_{ij}$; duality. [Sections 9.1 to 9.7 & 9.10, 9.11 of Chapter 9 of prescribed book [1]].

UNIT – IV

The Assignment problem : Introduction, Description and Mathematical statement of the problem, Solution using the Hungarian method, The relationship between Transportation and Assignment problems, Further treatment of the Assignment problem, The Bottleneck Assignment problem. (Chapter 6 of prescribed book [2])

UNIT – V

Job Sequencing: Introduction, Classification, Notations and Terminologies, Assumptions, Sequencing Problems: Sequence for n jobs through two machines, Sequence for n jobs through three machines, Sequence for 2 jobs through m machines, Sequence for n jobs through m machines (Sections 12.1 to 12.5 of chapter 12 of prescribed book [3])

PRESCRIBED BOOKS:

[1] Hadley G, Linear programming, Addison Wesley Publishing Company(1978).
[2] Benjamin Lev and Howard J. Weiss, Introduction to Mathematical Programming, Edward Arnold Pub, London (1982).
[3] Rathindra P. Sen, Operations Research- Algorithms and Applications, PHI(2009).

REFERENCE BOOK: Nita H. Shah, Ravi M. Gor, Hardik Soni, Operations Research**,** PHI(2010).

Course has Focus on : Skill Development (Elective Paper)

Websites of Interest : 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA
(An Autonomous college in the jurisdiction of Krishna University)
M.Sc. Mathematics
Fourth Semester
OPERATIONS RESEARCH -20MA4T2

Time:3 hours **Max. Marks: 70**

1.Answer all questions. **(10x2=20)**

a) Define convex set, hyperplane. (CO1, L1)
b) Define an extreme point and basic feasible solution to an L.P.P. (CO1, L1)
c) Define slack and surplus variables. (CO2, L2)
d) Write the standard form of an L.P.P. (CO2, L1)
e) Write mathematical formulation of Transportation problem. (CO3, L2)
f) Explain row minima method to find a basic feasible solution to a transportation problem. (CO3, L3)
g) What is unbalanced Assignment problem? (CO4, L2)
h) Write any two differences between Transportation problem and Assignment problem. (CO4, L5)
i) Explain briefly about Job sequencing problem. (CO5, L2)
j) Write applications of Job Sequencing. (CO5, L2)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. (a) Find all basic feasible solutions for the system (CO1, L5)

$$2x_1 + 6x_2 + 2x_3 + x_4 = 3$$
$$6x_1 + 4x_2 + 4x_3 + 6x_4 = 2$$
$$x_i \geq 0 \text{, i=1,2,3,4.}$$

(OR)

(b) If a closed strictly bounded convex set X has a finite number of extreme points, then prove that any point in the set can be written as a convex combination of the extreme points. (CO1, L2)

3. (a) Write the simplex algorithm. (CO2, L3)

(OR)

(Turn Over)

(b) Solve the following L.P.P using simplex method. (CO2, L5)

$$\max z = 6x_1 - 2x_2$$
$$sub: 2x_1 - x_2 \leq 2$$
$$x_1 \leq 4,$$
$$x_1, x_2 \geq 0.$$

4. (a) Find the optimal solution by finding the IBFS using the Vogel's method for the following Transportation problem. (CO3, L6)

	I	II	III	Availabilities
A	2	7	4	5
B	3	3	1	8
C	5	4	7	7
D	1	6	2	14
Requirements	7	9	18	

(OR)

(b) Solve the following Transportation Problem using stepping stone algorithm.

(CO3, L6)

	I	II	III	IV	supply
A	40	44	48	35	160
B	37	45	50	52	150
C	35	40	45	50	190
Demand	80	90	110	220	

5.(a) Solve the following assignment problem by using Hungarian method. (CO4, L5)

	I	II	III	IV	V
A	45	30	65	40	55
B	50	30	25	60	30
C	25	20	15	20	40
D	35	25	30	30	20
E	80	60	60	70	50

(OR)

(Turn Over)

(b) Solve the following by using bottle neck assignment algorithm. (CO4, L5)

	A	B	C	D
1	2	4	2	4
2	8	5	4	5
3	4	6	8	9
4	8	4	2	4

6. (a) Five jobs are performed first on machine X and then on machine Y. Then time taken in hours by each job on each machine is given below:

Jobs	A	B	C	D	E
Time on machine X	12	4	20	14	22
Time on machine Y	6	14	16	18	10

Determine the optimum sequence of jobs that minimizes the total elapsed time to complete the jobs. Also compute the idle time. (CO5, L6)

(OR)

(b) Find the optimal sequence for the following problem to minimize time and also obtain elapsed time: (CO5, L6)

Jobs	Machine A	Machine B	Machine C
1	13	8	13
2	8	9	12
3	12	10	11
4	7	7	14
5	10	6	15
6	6	11	14

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010
Reaccredited at 'A+' level by NAAC
Autonomous & ISO 9001:2015 Certified

Title of the Course: FUNCTIONAL ANALYSIS
Semester : IV

Course Code	20MA4T3	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2017-18	Year of offering : 2021-22	Year of Revision: 2021-22	Percentage of Revision : 40 %

Course Objective : The main objective of the course is to understand concepts of Banach Spaces, Hilbert Spaces, operators on Hilbert spaces and applications of Hahn –Banach theorems, Open mapping theorem and Uniform boundedness theorem.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	study the properties of normed and Banach Spaces, linear operators, bounded and continuous operators on finite dimensional normed spaces. .
CO2	understand concepts of Hilbert and Inner Product spaces and construct orthonormal sequences and series using Gram- Schmidt process.
CO3	understand Riesz representation theorem, study properties of Hilbert- Adjoint, self adjoint, unitary operators on Hilbert spaces.
CO4	study the applications of Hahn-Banach theorem, open mapping theorem, uniform boundedness theorem.
CO5	study the applications of Banach's theorem to linear equations, Differential equations, and Integral equations.

UNIT – I

Normed Spaces. Banach Spaces: Normed space, Banach space – Further properties of normed spaces – Finite dimensional normed spaces and subspaces – Compactness and finite dimension – Linear operators – Bounded and continuous linear operators – Linear functionals - Linear operators and functionals on finite dimensional spaces–Normed spaces of operators, Dual space. [Section 2.2 to 2.10 of Chapter 2 of Prescribed Book [1]]

UNIT – II

Inner Product Spaces. Hilbert Spaces: Inner product space, Hilbert space – Further Properties of Inner Product spaces –Orthogonal Complements and direct sums – Orthonormal sets and Sequences - Series related to orthonormal sequences and sets.
[Section 3.1-3.5 of Chapter 3 of Prescribed Book [1]]

UNIT – III

Inner Product Spaces. Hilbert Spaces: Total Orthonormal sets and sequences – Representation of functionals on Hilbert spaces – Hilbert-Adjoint operator – Self adjoint, Unitary and Normal operators.
[Sections 3.6 and 3.8-3.10 of Chapter 3 of Prescribed Book [1]]

UNIT – IV

Fundamental Theorems for Normed and Banach spaces: Hahn- Banach theorem -Hahn-Banach theorem for complex vector spaces and normed spaces–Adjoint operator–Reflexive spaces– Category theorem, Uniform Boundedness theorem–Open Mapping theorem– Closed Graph theorem.
[Sections 4.2, 4.3,4.5 - 4.7,4.12 and 4.13of Chapter 4 of Prescribed Book [1]]

UNIT – V

Further Applications :Banach Fixed point Theorem: Banach fixed point theorem-Applications of Banach's theorem to linear equations- Applications of Banach's theorem to Differential equations- Applications of Banch's theorem to Integral equations.
[Section 5.1to 5.4 of Chapter 5 of Prescribed Book [1]]

PRESCRIBED BOOK:

1. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley &Sons, 1989.

REFERENCE BOOKS:

1. G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw-Hill Edition.
2. E. Taylor, Introduction to Functional analysis, Wiley International Edition.
3. C. Goffman and G. Pedrick, First Course in Functional analysis, Prentice Hall Of India Private Limited(1991).

Course has Focus on : Foundation

Websites of Interest : 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An Autonomous college in the jurisdiction of Krishna University)

M.Sc. Mathematics

Fourth Semester

FUNCTIONAL ANALYSIS- 20MA4T3

Time:3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Define a Banach space and give an example. (CO1, L1)
b) Define a linear operator and give an example. (CO1, L2)
c) Define an innerproduct space and give an example. (CO2, L2)
d) State Bessel's inequality. (CO2, L1)
e) Define Hilbert adjoint operator, self adjoint operator. (CO3, L1)
f) Define an orthonormal sequence. (CO3, L1)
g) State uniform boundedness theorem. (CO4, L2)
h) Define adjoint operator and Algebraic reflexive of a vector space. (CO4,L2)
i) State Banach fixed point theorem. (CO5, L2)
j) Define a contraction mapping. (CO5, L3)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. a) Show that every finite dimensional subspace of a normed space is complete. (CO1, L2)

(OR)

b) Prove that if a normed space X is finite dimensional, then every linear operator on X is bounded. (CO1, L3)

3. a) State and prove Schwarz inequality on an Inner product space. (CO2, L4)

(OR)

b) Let X be an inner product space and M is a non empty subset which is complete.

Prove that for x ϵ X, there exists a unique y ϵ M such that $\delta = \inf_{y \in M} \|x - \bar{y}\| = \|x - y\|$ (CO2, L4)

4. a) Show that an Orthonormal set M in a Hilbert space H is total in H if and only if for all x ϵ H the Parseval relation holds. (CO3,L4)

(OR)

(Turn Over)

b) Show that every bounded linear functional f on Hilbert space H can be represented as

f(x) = < x, z > where z depends on f, is uniquely determined by f and has norm

$\|z\| = \|f\|$ (CO3, L3)

5.a) Let f be a bounded linear functional on a subspace Z of a normed space X. Then show

That there exists a bounded linear functional $\tilde{f}$ on X which is an extension of f to X and

has the norm $\|\tilde{f}\|_X = \|f\|_Z$. (CO4, L3)

(OR)

b) State and prove the Open mapping theorem. (CO4, L5)

6. a) Suppose that X is a complete metric space and T:X→X is a contraction on X. Show that

T has precisely one fixed point. (CO5,L5)

(OR)

b) State and prove Picard's existence and uniqueness theorem. (CO5,L5)

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010

Reaccredited at 'A+' level by NAAC

Autonomous & ISO 9001:2015 Certified

Title of the Course: MATHEMATICAL MODELLING

Semester : IV

Course Code	20MA4T4	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2021-22	Year of offering : 2021-22	Year of Revision:	Percentage of Revision :

Course Objectives : The objectives of this course is to enable students with the basic Mathematical modelling skills such as formulation of Mathematical Models, Solving the Mathematical Models and interpreting the solutions of Mathematical Models.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	Understand different classifications of Mathematical Models
CO2	Formulate and solve Mathematical Models of Ordinary differential equations
CO3	Formulate and solve Mathematical Models through systems of ordinary differential equations
CO4	Formulate and solve Mathematical Models through difference equations
CO5	Formulate and solve Mathematical Models through Graphs.

UNIT – I

Mathematical Modelling - Need, Techniques, Classifications and simple illustrations: Simple situations requiring Mathematical Modelling, Classification of Mathematical Models, Some characteristics of Mathematical Models.

Mathematical Modelling through Ordinary differential equations of first order: Mathematical Modelling through differential equations, Linear growth and Decay Models, Non linear growth and Decay Models, Compartment Models, Mathematical Modelling in dynamics through ordinary differential equations of first order, Mathematical Modelling of Geometrical problems through ordinary differential equations of first order.

(Sections 1.1 to 1.4 of Ch. 1 and Sections 2.1 to 2.6 of Ch. 2 of [1])

UNIT – II

Mathematical Modelling through systems of ordinary differential equations of first order:

Mathematical Modelling in population dynamics, Mathematical Modelling of epidemics through systems, Compartment Models through systems, Mathematical Modelling in Economics, Mathematical Models in Medicine etc, Mathematical Modelling in Dynamics.

(Sections 3.1 to 3.6 of Ch.3 of [1])

UNIT – III

Mathematical Modelling through Ordinary differential equations of Second order:

Mathematical Modelling of planetary motions, Mathematical Modelling of circular Motion and Motion of satellites, Mathematical Modelling linear differential equations of second order, Miscellaneous Mathematical Models.

(Sections 4.1 to 4.4 of Ch.4 of [1])

UNIT – IV

Mathematical Modelling through difference equations:

The need for Mathematical Modelling through difference equations, Some simple Models, Basic theory of Linear difference equations with constant coefficients, Mathematical Modelling through difference equations in Economics, Finance, Population dynamics, Genetics and Probability theory, Miscellaneous examples.

(Sections 5.1 to 5.6 of Ch.5 of [1])

UNIT – V

Mathematical Modelling through Graphs:

Situations that can be modelled through graphs, Mathematical Models in terms of directed graphs, Mathematical Models in terms of Signed graphs, Mathematical Models in terms of weighted graphs , and Mathematical Models in terms of un oriented graphs.

(Sections 7.1 to 7.5 of Ch.7 of [1])

PRESCRIBED BOOK:

1. J N Kapur, Mathematical Modelling, New Age International Publishers, 2008

REFERENCE BOOKS:

1. Sandip Banerjee, Mathematical Modelling- Models, Analysis and Applications

2. W.J.Meyer , Concepts of Mathematical Modelling , Mc Graw Hill. 1985

Course has Focus on : Foundation

Websites of Interest : 1. www. nptel.ac.in
2. www.epgp.inflibnet.ac.in
3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An Autonomous College in the Jurisdiction of Krishna University)

M.Sc. Mathematics

Fourth Semester

MATHEMATICAL MODELLING- 20MA4T4

Time:3 hours **Max. Marks: 70**

1. Answer all questions. **(10x2=20)**

a) Classify the Mathematical Models. (CO1, L2)
b) Write some characteristics of Mathematical Models (CO1, L2)
c) Define compartment model with an example. (CO2, L2)
d) Give an example of a Mathematical Model in Economics (CO2, L2)
e) State Kepler's laws of planetary Motions. (CO3, L2)
f) Define Linear difference equation. (CO3, L2)
g) Give an example of a Mathematical Model through difference equations. (CO4, L2)
h) Define complete graph and give an example. (CO4, L2)
i) Define weighted digraph. (CO5, L2)
j) Define planar graph and give an example. (CO5, L2)

Answer the following questions. All questions carry equal marks. (5X10=50)

2. a) Find the Orthogonal trajectories of the families of curves $y^2+x^2 -2ax =0$ (CO1, L3)

(OR)

b) Explain briefly about Non Linear growth and decay Models with examples. (CO1, L4)

3. a) Explain briefly about Prey –Predator Models with examples. (CO2, L4)

(OR)

b) Show that the Model represented by $\frac{dx}{dt} = x(4-x-y), \frac{dy}{dt} = y(15-5x-3y), x \geq 0, y \geq 0$ has a position of equilibrium, this position is stable and two species can coexist.

(CO2, L3)

4. a) Solve $x^{11}+8x^1+36x =24 \cos 6t$ and discuss the behavior of the solution as t approaches Infinity. (CO3, L3)

(OR)

b) Explain briefly about Mathematical Modelling of planetary motions under the inverse square law. (CO3, L4)

5. a) Solve $x_{t+2} - 7x_{t+1} + 12x_t = 0$ and discuss the behavior of the solution as x tends to ∞.

(CO4, L3)

(OR)

b) Explain the concept of Mathematical Modelling through difference equations in genetics. (CO4, L4)

6. a) Explain about Konigberg Problem and suggest deletion or addition of minimum number of bridges which may a lead a solution of the problem. (CO5, L4)

(OR)

b) Explain the concept of Mathematical Modelling in terms of weighted digraphs with an example. (CO5, L4)

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P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010
Reaccredited at 'A+' level by NAAC
Autonomous&ISO 9001:2015 Certified

Title of the Course: ADVANCED LINEAR ALGEBRA (MOOCS)
Semester : IV

Course Code	21MA4M1	Course Delivery Method	Blended Mode
Credits	5	CIA Marks	30
No. of Lecture Hours / Week	5	Semester End Exam Marks	70
Total Number of Lecture Hours	75	Total Marks	100
Year of Introduction : 2022-23	Year of offering : 2022-23	Year of Revision:---	Percentage of Revision :---

Course Objectives : The main objective of this course is to provide students with an understanding of Mathematical concept on Linear Algebra that includes basic as well as advanced level with computational perspective. Linear System of Equations, Vector Spaces, Linear Transformations, Canonical Forms and Jordan Forms, Inner Product Spaces, Bilinear forms and singular value decomposition are the major components.

COURSE OUTCOME	Upon successful completion of this course, students will be able to:
CO1	understand the basics of Linear algebra.
CO2	understand the concepts of Linear transformations
CO3	understand the concepts of canonical forms.
CO4	understand the concepts of Inner Product Spaces.
CO5	understand the basics of Singular Value decomposition.

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	0	0	0	0	0	0
CO2	0	0	0	0	0	0	2
CO3	0	0	0	0	0	0	3
CO4	0	0	0	0	0	0	3
CO5	3	0	0	0	0	0	0

UNIT – I

Linear Equations: Systems of Linear Equations, Matrices and Elementary row operations, Row Reduced Echelon Matrices, Invertible Matrices.

Vector Spaces: Vector Spaces, Subspaces, Bases and Dimension, Coordinates, Computations Concerning Subspaces.

(Sections 1.2 to 1.6 of chapter 1 and sections 2.1 to 2.6 of chapter 2 of prescribed book [1])

UNIT –II

Linear Transformations: Linear Transformations, The algebra of Linear Transformations, Isomorphism, Representation of Transformations by Matrices, Linear Functionals, The Double Dual, The Transpose of a Linear Transformation.
(Sections 3.1 to 3.7 of chapter 3 of prescribed book [1])

UNIT – III

Elementary Canonical Forms: Introduction, Characteristic Values, Annihilating Polynomials, Invariant Subspaces, Simultaneous Triangulation; Simultaneous Diagonalization, Direct –Sum Decompositions, Invariant Direct sums, The Primary Decomposition theorem, Cyclic Decompositions and rational Form, The Jordan Form.

(Sections 6.1 to 6.7 of chapter 6 and sections 7.2 and 7.3 of chapter 7 of prescribed book [1])

UNIT – IV

Inner Product Spaces: Inner Products, Inner Product Spaces, Linear Functionals and Adjoints, Unitary Operators, Normal Operators and Spectral Theory.

(Sections 8.1 to 8.5 of chapter 8 and section 9.5 of chapter 9 of prescribed book [1])

UNIT – V

Bilinear and Quadratic Forms, Orthogonal Projections, Spectral Theorem, g inverse of a matrix and Singular value decomposition.

REFERENCE BOOKS:

1.Kenneth Hoffman and Ray Kunze, Linear Algebra, Second edition, PHI publications (1992).
2.Stevan Roman, Advanced Linear Algebra, Springer.
3.K. B. Datta, Matrix and Linear Algebra, PHI Publications.

Course has Focus on : Skill Development

Websites of Interest: 1. https://onlinecourses.nptel.ac.in/noc23_ma17/preview

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu