# Dr. N.G.P.ARTS AND SCIENCE COLLEGE (Autonomous)

## REGULATIONS 2024-25 for Post Graduate Programme
## (Outcome Based Education model with Choice Based Credit System)

## M.Sc. Degree

(For the students admitted during the academic year 2024-25)

**Programme: M.Sc. Mathematics**

**Eligibility:**

A candidate who has passed the Degree Examination in B.Sc. (Mathematics) or B.Sc. (Mathematics with Computer Applications) of Bharathiar University and as per the norms set by the Government of Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the **Master of Science in Mathematics** Degree Examination of this College after a course of study of two academic years

**Programme Educational Objectives:**

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation:

1. To meet the demand for well trained Post Graduates in Mathematics with academic Excellence.
2. To demonstrate an understanding of the theoretical concepts and axiomatic underpinnings of Mathematics and an ability to construct proofs at the appropriate level.
3. To demonstrate competency in Mathematical modeling of complex phenomena, problem solving and decision making.
4. To demonstrate a level of proficiency in quantitative and computing skills sufficient to meet the growing demands of society upon modern education.

**PROGRAMME OUTCOMES:**

On the successful completion of the program, the following are the expectedoutcomes.

| PO Number | PO Statement |
|---|---|
| **PO1** | Students will have knowledge, understanding and Mathematical thinking of the basic and advanced concepts, techniques from different topics |
| **PO2** | They have a fundamental and advanced understanding of at least one Mathematical topic of their choice and able to solve problem related to the topic |
| **PO3** | They can be able to communicate clearly in writing and orallying the detailed technical arguments of complex Mathematical concepts |
| **PO4** | The students develop problem solving skill and apply them independently to problems in pure and applied Mathematics |
| **PO5** | They can develop the knowledge of formulating, analyzing and problem solving in core areas of the Mathematics including Analysis, Algebra and Statistics |

***PG Credit Distribution:***

| Part | Subjects | No. of Papers | Credit | Semester No. |
|---|---|---|---|---|
| III | Core | 16-18 | 13 x 04 = 52<br>02 x 03 = 06<br>01 x 05 = 05 | I - IV |
| | Elective | 04 | 04 x 04 = 16 | I - IV |
| | EDC | 01 | 01 x 03 = 03 | II |
| | Industrial Training | 01 | 01 x 02 = 02 | III |
| | Project Work | 01 | 01 x 08 = 08 | IV |
| **TOTAL CREDITS** | | | **92** | **-** |

## PG CURRICULUM

## M.Sc. MATHEMATICS – AY 24-25

| Course Code | Course Category | Course Name | L | T | P | Instruction Hours | | Exam (h) | Max Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Week | Total | | CIA | ESE | Total | |
| **First Semester** | | | | | | | | | | | | |
| 24MTP1CA | Core – I | Algebra | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP1CB | Core – II | Advanced Analysis | 4 | 2 | - | 6 | 72 | 3 | 25 | 75 | 100 | 4 |
| 24MTP1CC | Core – III | Ordinary Differential Equations | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP1CD | Core - IV | Operations Research | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP1CE | Core - V | Advanced Statistics | 3 | 2 | - | 5 | 60 | 3 | 25 | 75 | 100 | 3 |
| 24MTP1DA | DSE -I | Numerical Analysis | 4 | - | - | 4 | 48 | 3 | 25 | 75 | 100 | 4 |
| 24MTP1DB | | Commutative Algebra | | | | 4 | 48 | | | | | |
| 24MTP1DC | | Mathematical Modeling | | | | 4 | 48 | | | | | |
| **Total** | | | | | | 30 | 360 | | | | 600 | 23 |

| Course Code | Course Category | Course Name | L | T | P | Instruction Hours | | Exam (h) | Max Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Week | Total | | CIA | ESE | Total | |
| **Second Semester** | | | | | | | | | | | | |
| 24MTP2CA | Core - VI | Complex Analysis | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP2CB | Core - VII | Topology | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP2CC | Core - VIII | Partial Differential Equations | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP2CM | Core -IX Practical | Computational Mathematics | 3 | - | 4 | 7 | 84 | 3 | 40 | 60 | 100 | 5 |
| 24DAP2EB | EDC | Foundations of Data Analytics | 3 | 1 | - | 4 | 48 | 3 | 25 | 75 | 100 | 3 |
| 24MTP2DA | DSE -II | Wavelet Analysis | 4 | - | - | 4 | 48 | 3 | 25 | 75 | 100 | 4 |
| 24MTP2DB | | Information and Coding Theory | | | | 4 | 48 | | | | | |
| 24MTP2DC | | Mathematical Finance | | | | 4 | 48 | | | | | |
| **Total** | | | | | | 30 | 360 | | | | 600 | 24 |

| Course Code | Course Category | Course Name | L | T | P | Instruction Hours | | Exam (h) | Max Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Week | Total | | CIA | ESE | Total | |
| **Third Semester** | | | | | | | | | | | | |
| 24MTP3CA | Core - X | Functional Analysis | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP3CB | Core - XI | Classical Mechanics | 3 | 2 | - | 5 | 60 | 3 | 25 | 75 | 100 | 3 |
| 24MTP3CC | Core - XII | Stochastic Differential Equations | 4 | 2 | - | 6 | 72 | 3 | 25 | 75 | 100 | 4 |
| 24MTP3CD | Core -XIII | Advanced Graph Theory | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP3CE | Core - XIV | Fluid Dynamics | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP3CT | IT | Industrial Training | - | - | - | - | - | - | 40 | 60 | 100 | 2 |
| 24MTP3DA | DSE -III | Finite Element Theory | 4 | - | - | 4 | 48 | 3 | 25 | 75 | 100 | 4 |
| 24MTP3DB | | Algebraic Number Theory | | | | 4 | 48 | | | | | |
| 24MTP3DC | | Actuarial Mathematics | | | | 4 | 48 | | | | | |
| **Total** | | | | | | 30 | 360 | | | | 700 | 25 |

| Course Code | Course Category | Course Name | L | T | P | Instruction Hours | | Exam (h) | Max Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Week | Total | | CIA | ESE | Total | |
| **Fourth Semester** | | | | | | | | | | | | |
| 24MTP4CA | Core - XV | Mathematical Methods | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP4CB | Core - XVI | Distribution Theory | 4 | 1 | - | 5 | 60 | 3 | 25 | 75 | 100 | 4 |
| 24MTP4CV | Core - XVII | Project | - | - | 16 | 16 | 192 | 3 | 80 | 120 | 200 | 8 |
| 24MTP4DA | DSE -IV | Boundary Layer Theory | 4 | - | - | 4 | 48 | 3 | 25 | 75 | 100 | 4 |
| 24MTP4DB | | Lie Algebra | | | | 4 | 48 | | | | | |
| 24MTP4DC | | Mathematical Ecology | | | | 4 | 48 | | | | | |
| | | **Total** | | | | 30 | 360 | | | | 500 | 20 |
| | | | | | | | | | | | | 92 |

BoS Chairman/HoD
Department of Mathematics
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

Dr.N.G.P. Arts and Science College
APPROVED
BoS- 17th 04.04.'24 | AC - 17th 17.04.'24 | GB -

Academic Council CHAIRMAN Dr.N.G.P. Arts and Science College

## DISCIPLINE SPECIFIC ELECTIVE

Students shall select the desired course of their choice in the listed elective course during Semesters I to IV

**Semester I (Elective I)**

**List of Elective Courses**

| S. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | 24MTP1DA | Numerical Analysis |
| 2. | 24MTP1DB | Commutative Algebra |
| 3. | 24MTP1DC | Mathematical Modeling |

**Semester II (Elective II)**

**List of Elective Courses**

| S. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | 24MTP2DA | Wavelet Analysis |
| 2. | 24MTP2DB | Information and Coding Theory |
| 3. | 24MTP2DC | Mathematical Finance |

**Semester III (Elective III)**

**List of Elective Courses**

| S. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | 24MTP3DA | Finite Element Theory |
| 2. | 24MTP3DB | Algebraic Number Theory |
| 3. | 24MTP3DC | Actuarial Mathematics |

**Semester IV (Elective IV)**

**List of Elective Courses**

| S. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | 24MTP4DA | Boundary Layer Theory |
| 2. | 24MTP4DB | Lie Algebra |
| 3. | 24MTP4DC | Mathematical Ecology |

## EXTRA CREDIT COURSES

**Self-study paper offered by the Mathematics Department**

| S. No. | Course Code | Course Title |
|---|---|---|
| 1. | 24MTPSSA | Research Methodology, IPR and Entrepreneurship |
| 2. | 24MTPSSB | Mathematics of Bioinformatics |

**Semester - I**
**CORE - I : ALGEBRA**

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1CA | ALGEBRA | CORE | 48 | 12 | - | 4 |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• elementary group theory and how to solve contemporary problems<br>• elementary principles on certain algebraic structures<br>• Sylow's theorems that describe the structure of certain finite groups |
| **Prerequisite** | Knowledge on understanding of numbers, ratios, proportions, the order of operations, equality, algebraic symbolism, algebraic equations and functions. |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | define the orbits and p-groups | K1 |
| CO2 | apply Sylow theory in the factorization of polynomials | K2 |
| CO3 | analyze the structure of finite fields | K3 |
| CO4 | explain the applications of automorphisms and isomorphism | K5 |
| CO5 | explain the applications of Galois theory | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | | ✓ | ✓ | ✓ |
| CO2 | | | | ✓ | ✓ |
| CO3 | | ✓ | | ✓ | |
| CO4 | | ✓ | ✓ | | |
| CO5 | ✓ | ✓ | ✓ | | ✓ |

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Direct Products:** External direct products - internal direct products. group action on a set - fixed sets and isotropy subgroups – orbits - application on G-sets to counting: p-groups - Sylow theorems. | 12 | Text Book |
| II | **Applications of the Sylow Theory and Rings of Polynomials:** Applications to p-groups and the class equation - further applications. rings of polynomials: polynomials in an indeterminate - evaluation homomorphisms - division algorithm in $F[x]$ - irreducible polynomials – ideal structure in $F[x]$ - uniqueness of factorization in $F[x]$. | 11 | Reference Book |
| III | **Introduction to Extension Fields:** Extension fields - algebraic and transcendental elements - irreducible polynomial for $\alpha$ over $F$ - simple extensions - Algebraic extensions: finite extensions – algebraically closed and algebraic closures. | 13 | Text Book |
| IV | **Automorphisms of Fields:** Basic isomorphism of algebraic field theory - automorphisms and fixed fields - Frobenius automorphism - isomorphism extension theorem: extension theorem - splitting fields | 14 | Text Book |
| V | **Separable Extensions and Galois Theory:** Multiplicity of zeros of a polynomial - separable extensions- perfect fields - normal extensions - the main theorem - Galois group over finite fields - illustrations of Galois theory: symmetric functions. | 10 | Text Book & You Tube Videos |
| | **Total** | 60 | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Fraleigh J.B, 2003,"A First Course in Abstract Algebra", Third Edition, Narosa Publishing House, New Delhi. |
| **Reference Books** | **1.** | Herstein I.N, 2007, "Topics in Algebra", Second Edition, Narosa Publishing House, New Delhi. |
| | **2.** | Artin M, 1991, "Algebra", Prentice-Hall of India, New Delhi. |
| | **3.** | Fraleigh J.B, 2014,"A First Course in Abstract Algebra", Seventh Edition, Pearson Education Limited, London. |
| | **4.** | Anderson M and Feil T, 2014, "A First Course in Abstract Algebra Rings, Groups, and Fields", Third Edition, Chapman and Hall/CRC, London. |

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| **Journal and Magazines** | https://www.sciencedirect.com/journal/journal-of-algebra |
| **E-Resources and Website** | https://www.uou.ac.in/lecturenotes/science/MSCMT-19/unit%201.pdf |

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|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

## Semester - I
## CORE – II : ADVANCED ANALYSIS

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1CB | ADVANCED ANALYSIS | CORE | 48 | 24 | - | 4 |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the concept of Riemann Stieltjes integral<br>• the inverse and Implicit function theorems<br>• about the concept of Lebesgue measure and Lebesgue integral |
| **Prerequisite** | Knowledge on basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | identify the Riemann Stieltjes Integral of various real functions | K1 |
| CO2 | describe the properties of various forms of Uniform convergence and continuity | K2 |
| CO3 | discuss the concept behind contraction principle of a function | K3 |
| CO4 | demonstrate the Lebesgue measure and its properties | K4 |
| CO5 | apply the properties of The Lebesgue integral to the bounded functions | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | ✓ |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | | ✓ | |
| CO5 | ✓ | ✓ | | ✓ | |

## 24MTP1CB - ADVANCED ANALYSIS

### Syllabus

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Riemann Stieltjes Integral:** Definition and existence of the integral – properties of the integral – integration and differentiation – integration of vector valued function – rectifiable curves. | 15 | Text Book 1 |
| II | **Sequences and Series of Functions:** Uniform convergence and continuity – uniform convergence and integration - uniform convergence and differentiation – equicontinuous families of functions – the Stone Weierstrass theorem. | 14 | Text Book 1 |
| III | **Functions of Several Variables:** Linear transformation – contraction principle – inverse function theorem – implicit function theorem. | 14 | Text Book 1 |
| IV | **Lebesgue Measure:** Outer measure – measurable sets and Lebesgue measure – measurable functions – Littlewood's theorem. | 14 | Text Book 2 |
| V | **Lebesgue Integral:** The Lebesgue integral of bounded functions over a set of finite measure – integral of a non – negative function – general Lebesgue integral. | 15 | Text Book 2 |
| | **Total** | 72 | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Walter Rudin, 1976, "Principles of Mathematical Analysis", McGraw Hill, New York. [Unit I & II : Chapter 6 & 7.Unit III: Chapter 9 (Pages 204 to 227)] |
| | **2.** | Roydon H.L., 1988, "Real Analysis", Third Edition, Macmillan, New York. [Unit IV: Chapter 3 (except Section – 4) , Unit V: Chapter 4 (Sections 2, 3 & 4 only)] |
| **Reference Books** | **1.** | Bartle R. G., 1976, "Elements of Real Analysis", Second Edition, John Wily and Sons, New York. |
| | **2.** | Mainak Mukherjee, 2015, "A course in Real Analysis", Narosa publishing house, New Delhi. |
| | **3.** | Tom M Apostol, 2002, "Mathematical Analysis", Narosa Publishing House Pvt Ltd., Second Edition, New Delhi. |
| | **4.** | Somasundaram D and Choudhary B, 2015, "A first course in Mathematical Analysis", Narosa Publishing House, New Delhi. |

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| **Journal and Magazines** | https://www.worldscientific.com/worldscinet/bms |
| **E-Resources and Website** | https://mathcs.org/analysis/reals/integ/measures.html<br>https://archive.nptel.ac.in/courses/111/106/111106153/<br>https://onlinecourses.nptel.ac.in/noc22_ma43/preview |

| | |
|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

## Semester - I
## CORE - III : ORDINARY DIFFERENTIAL EQUATIONS

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1CC | ORDINARY DIFFERENTIAL EQUATIONS | CORE | 48 | 12 | - | 4 |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the first order and second order ordinary differential equations<br>• the usages of power series method to solve differential equations<br>• the homogenous and non-homogenous order ordinary differential equations |
| **Prerequisite** | Knowledge on Ordinary Differential Equations and its applications |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | define Legendre and Bessel equations | K2 |
| CO2 | describe the concept of fundamental matrix of system | K3 |
| CO3 | apply Lipschitz condition in mathematical problems | K3 |
| CO4 | inspect the existence and uniqueness of solutions | K4 |
| CO5 | analyze the solution using oscillatory theorems | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ | ✓ |
| CO2 | | ✓ | ✓ | | |
| CO3 | ✓ | ✓ | | ✓ | |
| CO4 | | | ✓ | | |
| CO5 | ✓ | ✓ | | ✓ | ✓ |

# 24MTP1CC - ORDINARY DIFFERENTIAL EQUATIONS

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Solutions in power series:** Introduction - second order linear equations with ordinary points - Legendre equation and Legendre polynomials - second order equation with regular singular point - properties of Bessel functions | 12 | Text Book |
| II | **System of Linear differential equations:** System of first order equations - model for ARMS competition between two nations - existence and uniqueness theorem - fundamental matrix. | 11 | Text Book & NPTEL |
| III | **Non-homogeneous linear system:** Non-homogeneous linear systems - linear system with constant coefficients - linear systems with periodic coefficients. | 10 | Text Book |
| IV | **Existence and uniqueness of solutions:** Preliminaries - successive approximations - Picard's theorem- some examples - continuation and dependence on initial conditions - existence of solutions in the large - existence and uniqueness of solutions of system. | 13 | Reference Book |
| V | **Oscillations of second order equations:** Fundamental results - Sturm's comparison theorem - elementary linear oscillations - comparison theorem of Hille - Winter - oscillations of x " +a(t)x=0 | 14 | Text Book & You Tube Videos |
| | **Total** | 60 | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Deo S.G, Lakshmikandham V and Raghavendra V, 2007, "Text book of Ordinary Differential Equations", Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi. |
| **Reference Books** | **1.** | Reid W.T, 1971, "Ordinary Differential Equations", John Wiley & sons, New York. |
| | **2.** | Coddington E.A and Levinson N, 2006, "Theory of Ordinary Differential Equations", Tata McGraw-Hill Publishing Company Limited, New Delhi. |
| | **3.** | Tesch I.G., 2012, "Ordinary Differential Equations and Dynamics Systems", American Mathematical Society, Providence. |
| | **4.** | Coddington E A, 2006, "An introduction to Ordinary Differential Equations", PHI Private Limited, New Delhi. |

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| **Journal and Magazines** | https://www.worldscientific.com/worldscinet/bms |
| **E-Resources and Website** | https://www.sciencedirect.com/topics/mathematics/system-of-ordinary-differential-equations |

| | |
|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

**Semester - I**
**CORE - IV: OPERATIONS RESEARCH**

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1CD | OPERATIONS RESEARCH | CORE | 48 | 12 | - | 4 |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the dynamic, integer programming and decision analysis<br>• concept of queueing and inventory<br>• how to solve the queueing models |
| **Prerequisite** | Knowledge on basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | illustrate the characteristics of dynamic programming problem | K2 |
| CO2 | derive importance of integer programming | K5 |
| CO3 | explain the concept of Markov chain and Markov process in decision making | K3 |
| CO4 | analyze the behavior of various queueing models | K4 |
| CO5 | analyze the applications of inventory | K4 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | | ✓ | | |
| CO2 | | ✓ | | | ✓ |
| CO3 | ✓ | | | ✓ | |
| CO4 | | | ✓ | | ✓ |
| CO5 | ✓ | ✓ | | | ✓ |

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Dynamic Programming:** Prototype example for dynamic programming - characteristics of dynamic programming problems - deterministic dynamic programming. | 12 | Text Book |
| II | **Integer Programming:** Prototype example - some BIP applications - innovative uses of binary variables in model formulation - some formulation examples - some perspectives on solving integer programming problems. | 12 | Text Book |
| III | **Decision Analysis:** Prototype example - decision making without experimentation - decision making with experimentation - decision trees, Markov chains: Stochastic processes - Markov chains. | 12 | Text Book |
| IV | **Queueing Theory:** Prototype example - basic structure - examples of real queueing systems - role of the exponential distribution – birth and death process - queueing models based on birth and death process. | 12 | Text Book |
| V | **Inventory Theory:** Examples - components - deterministic continuous and periodic review model - deterministic multiechelon inventory model for supply chain management. | 12 | Text Book/ You Tube Videos |
| | **Total** | **60** | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Frederick S. Hillier and Gerald J. Lieberman, 2010,"Introduction to Operations Research ", Nineth Edition, McGraw-Hill Companies, New Delhi.. |
| **Reference Books** | **1.** | Taha H.A, 2006, "Operations Research: An Introduction", Eighth Edition, Prentice-Hall of India Private Limited, New Delhi. |
| | **2.** | Kandiswarup, Gupta P.K and Man Mohan, 1998,"Operations Research", S. Chand & Sons Education Publications, New Delhi. |
| | **3.** | Ravindran, Phillips D.T and Solberg J.J, 2005, "Operations Research- Principles and Practice", John Wiley & Sons, New Jersey. |
| | **4.** | Hillier F and Lieberman G, 2010, "Introduction to Operations Research", Nineth Edition, McGraw-Hill Professional, New Delhi.. |

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| **Journal and Magazines** | https://www.worldscientific.com/worldscinet/bms |
| **E-Resources and Website** | https://nptel.ac.in |

| | |
|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

**Semester - I**
**CORE - V: ADVANCED STATISTICS**

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1CE | ADVANCED STATISTICS | CORE | 36 | 24 | - | 3 |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the procedure of finding estimation<br>• the methods of testing hypothesis under various conditions<br>• the importance of linear regression models |
| **Prerequisite** | Knowledge on Basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | define the point estimation | K1 |
| CO2 | identity the confidence intervals for population variance and population parameters | K2 |
| CO3 | explain the procedures for hypothesis testing | K3 |
| CO4 | analyze the linear regression models and method of solving it variance | K4 |
| CO5 | apply various types of non-parametric test to validate hypothesis | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | | ✓ | | ✓ | |
| CO2 | ✓ | | | ✓ | |
| CO3 | ✓ | ✓ | | | ✓ |
| CO4 | | | ✓ | ✓ | |
| CO5 | ✓ | ✓ | | | ✓ |

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Point Estimation:** Introduction - method of moments and maximum likelihood - some desirable properties of point estimators - other desirable properties. | 12 | Text Book |
| II | **Interval Estimation:** Introduction – large sample confidence intervals: one sample case - small sample confidence intervals for μ-A confidence interval for the population variance - confidence interval concerning two population parameters. | 12 | Reference Book |
| III | **Hypothesis Testing:** Introduction – Neyman – Pearson - likelihood ratio test – hypotheses for a single parameter - testing of hypotheses for two samples - Chi-Square tests for count data. | 12 | Text Book |
| IV | **Linear Regression Models:** Introduction – simple linear regression model - inferences on the least square estimators - predicting a particular value. | 12 | Text Book |
| V | **Non-parametric Tests:** Introduction – nonparametric confidence interval - nonparametric hypothesis tests for one sample - nonparametric hypothesis tests for two independent samples - nonparametric hypothesis tests for $k \geq 2$ sample. | 12 | Text Book/ You Tube Videos |
| | **Total** | 60 | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Kandethody M. Ramachandran, Chris P and Tsokos, 2009, "Mathematical Statistics with Applications", Elsevier, Haryana. |
| **Reference Books** | **1.** | Irwin Miller and Marylees Miller, John E. Freund's, 2007,"Mathematical Statistics with Applications", Seventh Edition, Prentices-Hall India Pvt Ltd, New Delhi. |
| | **2.** | Hogg and Craig, 2003"Introduction to Mathematical Statistics", Pearson Education, New Delhi. |
| | **3.** | J.M. Kapur and H.C. Saxena, 2001, "Mathematical Statistics", S. Chand & Co, New Delhi. |
| | **4.** | Ronald E.Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, 2018, Probability and Statistics, Pearson Education, South Asia. |

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|---|---|
| **Journal and Magazines** | www.isaacpub.org/AboutThisJournal.aspx?ids=2 |
| **E-Resources and Website** | https://www.lkouniv.ac.in/site/writereaddata/siteContent/<br>20200416062602 3624Rajiv_Saksena_Advance_Statistical_Inference.pdf |

| | |
|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

## Semester - I
## DSE 1: NUMERICAL ANALYSIS

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1DA | NUMERICAL ANALYSIS | DSE | 48 | - | - | 4 |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the method of solving nonlinear equations<br>• analyze the solution of ordinary differential equations<br>• analyze the convergence of various methods |
| **Prerequisite** | Knowledge on basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | apply the numerical method to solve nonlinear equations | K2 |
| CO2 | categorize the system of equations and solve by appropriate method | K3 |
| CO3 | examine the solution got by applying various of numerical differentiation and integration methods | K3 |
| CO4 | apply the Taylor's method to differential equations | K4 |
| CO5 | analyze the nature of solution of one and two dimensional partial differential equations | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | | | | | |
| CO2 | ✓ | | | | |
| CO3 | ✓ | | | | |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ |

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Nonlinear Equations:** Interval halving (Bisection) revisited - linear interpolation methods - Newton's method -fixed-point iteration: $x = g(x)$ method - multiple roots -nonlinear systems. | 10 | Text Book |
| II | **Solving System of Equations:** Matrices and vectors - elimination methods - the inverse of a matrix and matrix pathology - iterative methods - parallel processing. | 10 | Text Book |
| III | **Numerical Differentiation and Integration:** Numerical integration - Trapezoidal Rule - Simpson's rules - Fourier series and Fourier transforms - adaptive integration - gaussian quadrature - multiple integrals - applications of cubic splines. | 10 | Text Book |
| IV | **Numerical Solution of Ordinary Differential Equations and Optimization:** Taylor-Series Method - Euler method and its modifications - Runge-Kutta methods - multistep methods - higher-order equations and systems. Optimization: Finding the minimum of $y = f(x)$ - minimizing a function of several variables-linear programming. | 09 | Text Book |
| V | **Numerical Solutions of Partial-Differential Equations**: Elliptic equations - parabolic equations - hyperbolic equations - finite elements for ordinary and partial differential equations. | 09 | Text Book |
| | **Total** | **48** | |

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|---|---|---|
| **Text Book** | **1.** | Gerald C. F. and Wheatley P. O., 1999, "Applied Numerical Analysis", 7th Edition, Pearson Education, New York. |
| **Reference Books** | **1.** | Smith. G. D., 1985, "Numerical Solution of Partial Differential Equations – Finite Difference Methods", Oxford University Press, Oxford. |
| | **2.** | Jain M. K., Iyengar S. R. K. and Jain R. K., 1993, "Numerical Methods for Scientific and Engineering Computation", 3rd Edition, Wiley Eastern Ltd, Noida. |
| | **3.** | Marghitu D. B. and Dupac M., 2012, "Advanced Dynamics: Analytical and Numerical Calculations with MATLAB", Springer, New York. |
| | **4.** | Samuel Conte D. and Boor C. D., 1983, "Elementary Numerical Analysis", McGraw-Hill International Edition, New Delhi. |

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| **Journal and Magazines** | https://www.sciencedirect.com/journal/applied-numerical-mathematics, |
| **E-Resources and Website** | https://www.math.wsu.edu/math/kcooper/M448/resources.php,<br>https://nptel.ac.in |

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|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

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|---|---|
| **Focus of the Course** | Skill Development/Employability |

## Semester - I
## DSE I: COMMUTATIVE ALGEBRA

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1DB | COMMUTATIVE ALGEBRA | DSE | 48 | - | - | 4 |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the concepts of ideals and modules through examples<br>• the properties to decompose the Noetherian and Artin rings.<br>• the importance of dimension theory of rings and modules |
| **Prerequisite** | Knowledge on Modern Algebra |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | define new modules using operations like tensor product and other operations | K1 |
| CO2 | discuss the construction of field | K2 |
| CO3 | demonstrate the concept of integral dependence of extension ring and chain conditions of modules. | K3 |
| CO4 | analyze the importance of discrete valuation of rings and dedekind domains | K4 |
| CO5 | summarize the various forms of dimension theory and its influence in local rings | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO2 | ✓ | | ✓ | ✓ | ✓ |
| CO3 | ✓ | ✓ | | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | ✓ | | ✓ | ✓ |

## 24MTP1DB - COMMUTATIVE ALGEBRA

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Rings and Ideals:**<br>Rings and ring homomorphisms - ideals - quotient rings - zero divisors, nilpotent elements, units - prime ideal and maximal ideals - nilradical and Jacobson radical - operations on ideals - extension and contraction.<br>Modules: modules and module homomorphisms – submodulus and quotient modulus - operations on submodules - finitely generated modulus. | 09 | Text Book |
| II | **Rings, modules of fractions and primary decomposition:**<br>Local properties - extended and contracted ideals in rings of fractions - primary decomposition. | 09 | Reference Book |
| III | **Integral dependence and valuations:**<br>Integral dependence - the going up theorem -Integrally closed integral domains - the going down theorem - valuation rings - Chain conditions. | 09 | Text Book |
| IV | **Noetherian rings, artin rings, Discrete valuation rings and Dedekind domains:**<br>Primary decomposition in Noetherian rings - artin rings - structure theorem for artin rings - discrete valuation rings - dedekind domains - fractional ideals. | 09 | Text Book /NPTEL |
| V | **Completions and Dimension Theory:**<br>Topologies and completions - filtrations - graded rings and modules - the associated graded ring - Hilbert functions - dimension theory of Noetherian local rings - regular local rings - transcendental dimension. | 12 | Text Book /You Tube Videos |
| | **Total** | **48** | |

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|---|---|---|
| **Text Book** | **1.** | Atiyah-Macdonald, 1994, "Commutative Algebra", Westview Press, London. |
| **Reference Books** | **1.** | Zariski and Samuel, 1991, "Commutative Algebra I, II", Springer, New York. |
| | **2.** | Eisenbud, 1995, "Commutative Algebra with a View Towards Algebraic Geometry", Springer, New York. |
| | **3.** | Bourbaki, 1989, "Commutative Algebra", Springer, New York. |
| | **4.** | Herstein I N, 2000, "Topics in Algebra", Second Edition, John Wiley and Sons, New Jersey. |

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| **Journal and Magazines** | https://www.worldscientific.com/worldscinet/bms |
| **E-Resources and Website** | https://nptel.ac.in |

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| **Learning Method** | Chalk and Talk/Assignment/Seminar |

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|---|---|
| **Focus of the Course** | Skill Development/Employability |

**Semester - I**
**DSE I: MATHEMATICAL MODELING**

| Semester | Course Code | Course Name | Category | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| I | 24MTP1DC | MATHEMATICAL MODELING | DSE | 48 | - | - | 4 |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the deterministic states and analysis of models<br>• the stochastic analysis of models<br>• various evolution of models |
| **Prerequisite** | Knowledge on Basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | describe the optimal power and exponential models | K2 |
| CO2 | discuss the dimensional analysis and similarity | K2 |
| CO3 | apply the concept of probability density function to define stochastic states | K3 |
| CO4 | analyze the properties of various forms of changes using modeling | K4 |
| CO5 | develop the models for situations involving evolution theory | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | |
| CO2 | ✓ | | ✓ | | |
| CO3 | | ✓ | | ✓ | |
| CO4 | | | ✓ | ✓ | |
| CO5 | | ✓ | | ✓ | ✓ |

## 24MTP1DC - MATHEMATICAL MODELING

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Deterministic Analysis of Observations:** Data transformations: Linear model – polynomial models – population modeling – global warming modeling - model errors – optimal linear models – optimal quadratic models – optimal power and exponential models. | 9 | Text Book |
| II | **Deterministic States:** Dimensional analysis and similarity - applications of low-complexity – applications of medium complexity- time measurement - applications of high-complexity. | 10 | Text Book & Reference Book |
| III | **Stochastic States:** Probability density functions – models for probability density functions – data analysis – real distribution. | 9 | Text Book |
| IV | **Deterministic and stochastic Changes:** Linear changes - linear changes with delays - nonlinear changes - linear stochastic changes - diffusion - Brownian motion - population dynamics. | 10 | Text Book |
| V | **Deterministic and Stochastic Evolution:** Heat and Mass Transfer: Balance – Newton's laws of motion: oscillations – population ecology: growth and self-limitation – oscillations and collapse - PDF evolution equations - Solutions to the Fokker Plank equation. | 10 | Text Book & You Tube Videos |
| | **Total** | 48 | |

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| **Text Book** | **1.** | Stefen Heinz, 2011,"Mathematical Modeling", Springer-Verlag, New York. |
| **Reference Books** | **1.** | Kapur J.N., 1998, "Mathematical Modeling", New Age International (P) Limited, New Delhi. |
| | **2.** | Crossand and Moscrcadini A.O, 1976,"The Art of Mathematical Modeling", Ellis Harwood and John Wiley, New York. |
| | **3.** | Sarah. P.Otto and Troy Day, 2000, "A Biologist guide to Mathematical Modeling in Ecology and Evolution", Princeton University Press, Princeton. |
| | **4.** | Frank. R.Glordance, Maurice D. Weir and William P.Fox, 2003, "A First course in Mathematical Modeling", Thomson Learning, London. |

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| **Journal and Magazines** | https://www.sciencedirect.com/journal/applied-mathematical-modelling |
| **E-Resources and Website** | https://en.wikipedia.org/wiki/Mathematical_model#:~:text=A%20mathematical%20model%20is%20an,model%20is%20termed%20mathematical%20modeling. |

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| **Learning Method** | Chalk and Talk/Assignment/Seminar |

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|---|---|
| **Focus of the Course** | Skill Development/Employability |

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Dr.N.G.P. Arts and Science College
APPROVED

| BoS- 17th | AC - 17th | GB - |
|---|---|---|
| 04.04.2024 | 17.04.2024 | |

Academic Council
CHAIRMAN
Dr.N.G.P. Arts and Science College

| Semester - II<br>CORE: COMPLEX ANALYSIS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2CA** | **COMPLEX ANALYSIS** | **CORE** | **48** | **12** | **-** | **4** |

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| **Preamble** | This course has been designed for students to learn and understand<br>• the methods of integration with complex function.<br>• the existence and applications of conformal mapping.<br>• the concept of elliptic functions |
| **Prerequisite** | Real Analysis, Complex Variables |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | apply the concept of analytic function and linear transformations. | K2 |
| CO2 | illustrate complex integration through Cauchy's integral formula. | K3 |
| CO3 | analyze the calculus of residues and evaluating complex integrals | K3 |
| CO4 | assess the boundary behavior at an angle through reflection principle | K4 |
| CO5 | examine the properties of simply periodic functions and doubly periodic functions. | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | | ✓ | ✓ | ✓ |
| CO2 | | ✓ | ✓ | ✓ | ✓ |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | | |
| CO5 | ✓ | ✓ | ✓ | | ✓ |

| 24MTP2CA | CORE: COMPLEX ANALYSIS |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Complex integration:** Line integrals - Rectifiable arcs – Line integrals as functions of arcs – Cauchy's theorem for a rectangle - Cauchy's theorem in a disk - Cauchy's integral formula – Higher derivatives. Removable singularities - Taylor's theorem – Zeros and poles – Local mapping – Maximum principle. | 14 | Text Book |
| II | **Calculus of residues:** Residue theorem – Argument principle – Evaluation of definite integrals. Mean-value property – Poisson's formula. | 12 | Text Book |
| III | **Series and product developments:** Weierstrass's theorem – Taylor series – Laurent series. Partial fractions – Infinite products – Canonical products. | 12 | Text Book |
| IV | **Riemann mapping theorem and applications:** Riemann mapping theorem – Statement and proof – Boundary behavior – Use of the reflection principle – Analytic arcs - behavior at an angle –Schwarz-Christoffel formula – Mapping on a rectangle | 11 | Text Book |
| V | **Elliptic Functions:** Simply periodic functions - The Fourier development – Functions of finite order – Doubly periodic functions -The period module – Unimodular transformations – the Cannonical Base – General properties of Elliptic functions – The Weierstrass p-function – The differential equations. | 11 | Text Book |
| | **Total** | **60** | |

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|---|---|---|
| **Text Book** | **1.** | Ahlfors, Lars V, 2019, "Complex Analysis", 3rd Edition., McGraw-Hill, New Delhi. |
| **Reference Books** | **1.** | James Ward Brown and Churchill, Ruel V, 2013, "Complex Variables and Applications", 9th Edition., Tata McGraw Hill, New Delhi. |
| | **2.** | Joseph Bak and Newman, Donald J., 2010, "Complex Analysis", 3rd Edition, Springer, New York. |
| | **3.** | Kasana, H.S., 2005, "Complex Variables: Theory and Applications", 2nd Edition, PHI Learning, New Delhi |
| | **4.** | Conway, John B., 2000, "Functions of one Complex variable", 2nd Edition, Narosa Publication, New Delhi. |

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| **Journal and Magazines** | https://onlinelibrary.wiley.com/journal/9372 |
| **E-Resources and Website** | https://nlist.inflibnet.ac.in/<br>https://www.youtube.com/watch?v=JPg4XFjDOW4 |

| | |
|---|---|
| **Learning Method** | Chalk and Board, Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

| Semester - II<br>CORE: TOPOLOGY | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2CB** | **TOPOLOGY** | **CORE** | **48** | **12** | **-** | **4** |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the concept of topological Spaces<br>• the countability and separation axioms<br>• the influence of metric space in topology |
| **Prerequisite** | Real Analysis and Abstract Algebra |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| **CO1** | explain the concepts behind topological spaces | K1 |
| **CO2** | analyzing connectedness and compactness concepts | K3 |
| **CO3** | applying countability axioms to find the existence of countable set with certain properties | K3 |
| **CO4** | examine the properties of metric spaces | K4 |
| **CO5** | analyzing the concept of complete metric spaces and function spaces | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | | ✓ | |
| **CO2** | ✓ | ✓ | ✓ | | ✓ |
| **CO3** | ✓ | ✓ | | ✓ | |
| **CO4** | ✓ | | ✓ | ✓ | |
| **CO5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| 24MTP2CB | CORE: TOPOLOGY |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Topological Spaces and Continuous Functions:** Topological spaces – basis – order topology – subspace topology - closed sets and limit points – continuous functions – product topology – metric topology. | 14 | Textbook |
| II | **Connectedness and compactness:** Connected Spaces – connected subspace of the real line R – components and local connectedness – compact spaces – compact subspaces of the real line - limit point compactness - local compactness. | 12 | Textbook |
| III | **Countability and seperation axioms:** Countability axioms – separation axioms - normal spaces – Urysohn's Lemma – Urysohn metrization theorem - Tietz extension theorem. | 12 | Textbook |
| IV | **The Tychonoff Theorem, metrization Theorems and paracompactness:** Tychonoff Theorem - stone-cech compactification - local finiteness - Nagata-Smirnov metrization theorem - paracompactness - The Smirnov metrization theorem. | 12 | Textbook |
| V | **Complete Metric spaces and Function Spaces:** Complete metric spaces – compactness in metric Spaces – pointwise and compact convergence - Ascoli's theorem. | 10 | Textbook |
| | **Total** | **60** | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Munkres, J. R., 2021, "Topology", 2nd Edition., Prentice-Hall of India Private Limited, New Delhi.. |
| **Reference Books** | **1.** | Nainpally, S. and Peters, J, 2013, "Topology with Applications: Topological Spaces via Near and Far", World Scientific, Singapore. |
| | **2.** | Sze-Tsen Hu., 1966, "Introduction to General Topology", Holden-Day, INC., San Franscisco. |
| | **3.** | Adams and Franzosa, 2007, "Introduction to Topology: Pure and Applied", Pearson-Prentice Hall, New Delhi. |
| | **4.** | Simmons, G.F., 2004, "Introduction to topology and modern analysis", Tata McGraw-Hill, New Delhi. |

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| **Journal and Magazines** | Topology and its Applications: Elsevier, Journal of Topology: Oxford Academic |
| **E-Resources and Website** | wikipedia.org, planetmath.org, topologyatlas.org |

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|---|---|
| **Learning Method** | Chalk and Talk, Assignment, Seminar |

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|---|---|
| **Focus of the Course** | Skill development |

| Semester - II<br>CORE: PARTIAL DIFFERENTIAL EQUATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2CC** | **PARTIAL DIFFERENTIAL EQUATIONS** | **CORE** | **48** | **12** | **-** | **4** |

| | |
|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the basic forms of partial differential equations and methods to solve it<br>• analytical techniques used to solve parabolic and hyperbolic equations<br>• the various forms of solutions that exists for partial differential equations |
| **Prerequisite** | Ordinary Differential Equations |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | identify the method of solving first order partial differential equations | K2 |
| CO2 | determine the characteristic curve for a second order partial differential equation | K3 |
| CO3 | analyze the characteristics of Laplace's equation | K4 |
| CO4 | analyze the solvability of wave equations | K4 |
| CO5 | evaluating diffusion equations by using integral transforms method | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | | ✓ | ✓ | | ✓ |
| **CO2** | | ✓ | ✓ | ✓ | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | |
| **CO4** | ✓ | ✓ | | ✓ | |
| **CO5** | ✓ | | | ✓ | |

| 24MTP2CC | CORE: PARTIAL DIFFERENTIAL EQUATIONS |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Partial differential equations of first order:** Cauchy's problem for first order equations-nonlinear partial differential equations of the first order-Cauchy's method of characteristics-compatible systems–Charpit's method-special types–solutions satisfying given conditions. | 14 | Textbook |
| II | **Partial differential equations of second order:** Origin–second order and higher order equations in physics-linear partial differential equations with constant coefficients–equations with variable coefficients–characteristic curves - characteristics of equations in three variables. | 13 | Textbook |
| III | **Laplace equation:** Occurrence-elementary solutions of Laplace's equation–families of equipotential surfaces-boundary value problems-separation of variables-problems with axial symmetry. | 11 | Textbook |
| IV | **Wave equation:** Occurrence–elementary solutions of the one-dimensional wave equation– Riemann-Volterra solution-vibrating membranes-applications of the Calculus of variations–three dimensional problems - general solution of the wave equation. | 12 | Textbook |
| V | **The Diffusion equation:** Occurrence–resolution of boundary value problems-elementary solutions of the diffusion equation–separation of variables-use of integral transforms - use of Green's function. | 10 | Textbook |
| | **Total** | 60 | |

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|---|---|---|
| **Text Book** | **1.** | Sneddon, I. N., 2006, "Elements of Partial Differential Equations", Dover Publications, New York. |
| **Reference Books** | **1.** | TynMyint-U and Lokenath Debnath, 2007, "Linear Partial Differential Equations for Scientists and Engineers", 4th Edition, Birkhavser, Boston. |
| | **2.** | AslakTveito and Ragnar Winther, 1998, "Introduction to Partial Differential Equations: A Computational Approach", Springer-Verlag, New York. |
| | **3.** | Hillen T, Leonard E.I and Van Roessel H, 2012, "Partial Differential Equations: Theory and Completely Solved Problems", John Wiley& Sons, New Jersey. |
| | **4.** | O'Neil V., 2008, "Beginning Partial Differential Equations", 2nd Edition., John Wiley & Sons, New Jersey. |

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| **Journal and Magazines** | https://www.scitechnol.com/scholarly/calculus-journals-articles-ppts-list.php<br>https://maa.org/press/periodicals/mathematics-magazine |
| **E-Resources and Website** | https://www.coursera.org/projects/finite-element-method-linear-nonlinear-analysis-post-processing<br>https://www.edx.org/learn/finite element method |

| | |
|---|---|
| **Learning Method** | Chalk and Talk, Assignment, Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill development, Employability |

| Semester - II<br>CORE PRACTICAL: COMPUTATIONAL MATHEMATICS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2CM** | **COMPUTATIONAL MATHEMATICS** | **CORE** | **36** | **-** | **48** | **5** |

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| **Preamble** | This course has been designed for students to learn and understand<br>• the method of typesetting using Latex<br>• various build - in functions from Latex and MATLAB<br>• the logic of coding in MATLAB |
| **Prerequisite** | Knowledge on Basic Mathematics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| **CO1** | define various basic commands in Latex | K1 |
| **CO2** | illustrate the method of representing equations, tables and diagrams in Latex | K2 |
| **CO3** | describe the basic commands in MATLAB | K3 |
| **CO4** | design graphs by computation through MATLAB | K4 |
| **CO5** | employ MATLAB for computation | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO2** | | ✓ | ✓ | | ✓ |
| **CO3** | ✓ | | ✓ | ✓ | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | |
| **CO5** | ✓ | ✓ | ✓ | | ✓ |

| 24MTP2CM | CORE PRACTICAL: COMPUTATIONAL MATHEMATICS |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **LATEX: Basics and Basic Typesetting:**<br>Introduction to LATEX: Pros and Cons – basics - document hierarchy - document management - labels and cross - references - bibliography - table of contents and lists of things - class files – packages - errors and troubleshooting.<br>Running text: Special characters– abbreviations - alignment.<br>1. Create a Latex document with Mathematical formulas<br>2. Create a Latex document with proper justification<br>3. Create a bibliography using Latex | 16 | Text Book 1 & Reference Books 1, 2 & 3 |
| II | **LATEX: Tables, Diagrams, and Data Plots:**<br>Presenting External Pictures: Figure environment - special packages - external picture files - graphicx package - setting default key values - setting a search path - graphics extensions.<br>Presenting Diagrams: tikzpicture Environment - \tikz command - grids - paths - coordinate labels - extending paths - actions on paths - nodes and node labels - spy library – trees – logic circuits – commutative diagrams – option – styles.<br>4. Create a Latex document with table, graph or picture<br>5. Create a question paper using Latex<br>6. Create a simple beamer presentation<br>7. Create a one-page curriculum vitae in Latex<br>8. Rewrite a research article in the form of LATEX document | 16 | Text Book 1 & Reference Books 1, 2 & 3 |
| III | **MATLAB: Introduction and Iterative Computation:**<br>Maximum and minimum value of a function- necessary conditions for extreme values - sufficient condition - use of second order derivative- applications<br>9. Create a simple MATLAB program using arithmetic operators<br>10. Write MATLAB code with matrix operations<br>11. Write MATLAB code for finding the results of the students in exam | 16 | Text Book 2 & Reference Book 4 |
| IV | **MATLAB: Graphics & Errors:**<br>Graphics: Basic 2-D plots – 3-D plots – handle graphics – saving and printing graphs – animation. | 16 | Text Book 2 & Reference Book 4 |

| | | | |
|---|---|---|---|
| | Errors.<br>12. Design a simple plot, multiple plots and contour plots in a single window<br>13. Design a bar chart and phi chart<br>14. Design a 3D plot | | |
| V | **MATLAB: Applications:**<br>Algebraic equations: Linear Algebra - nonlinear algebraic equations.<br>Data analysis and regression: Curve fitting and regression analysis – correlations - statistics.<br>Differential equations: Numerical integration – solution of ODEs for initial value problems - solution of ODEs for boundary value problems – advanced topics.<br>Solving an equation with one variable- finding a minimum or a maximum of a function- numerical integration.<br>15. Solve a first order differential equation using Euler's method and Runge-Kutta fourth order method<br>16. Solve the wave and heat equations.<br>17. Write a MATLAB program to find minimum and a maximum value of a given function.<br>18. Solve simple integral equations with boundary values.<br>19. Find the eigen values and eigen vectors of the system of equations.<br>20. Solve numerical integration problems using Simpson's 1/3 rule, Trapezoidal rule and Romberg's method. | 20 | Text Book 2 & Reference Book 4 |
| | **Total** | 84 | |

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|---|---|---|
| **Text Book** | **1.** | Van Dongen M.R.C., 2012, "LATEX and Friends", Springer-Verlag Berlin Heidelberg, New York. |
| | **2.** | RudraPratap, 2017, "Getting started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press, New York. |
| **Reference Books** | **1.** | Stefan Kottwitz, 2011, "LATEX Beginner's Guide", Packt Publishing Limited, London. |
| | **2.** | Kopka H., and Daly P.W., 1999, "A Guide to LATEX", 3rd Edition, Addison Wesley, London. |
| | **3.** | Nambudiripad K.B.M., 2014, "LATEX for Beginners", Narosa Publishing House Private Limited, New Delhi. |
| | **4.** | Kirani Singh Y., and Chaudhuri B.B., 2007, "MATLAB Programming", 1st Edition, PHI Learning, New Delhi. |

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|---|---|
| **Journal and Magazines** | https://oa.mg/journals/open-access-matlab-journals |
| **E-Resources and Website** | https://www.mathworks.com/help/matlab-online-server/ug/matlab-online.html<br>https://nptel.ac.in/courses/111102137 |

| | |
|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development/Employability |

| Semester - II<br>EDC: FOUNDATIONS OF DATA ANALYTICS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24DAP2EB** | **FOUNDATIONS OF DATA ANALYTICS** | **EDC** | **36** | **12** | **-** | **3** |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• The core principles and foundations of data analytics<br>• The concepts of data pre-processing and clustering<br>• The application of frequent itemset mining, regression and classification |
| **Prerequisite** | Basic Knowledge in Statistics |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | understand the various types of data and data science components | K2 |
| CO2 | apply appropriate data preprocessing methods to solve data driven problems | K3 |
| CO3 | interpret various clustering methods | K2 |
| CO4 | analyze the suitable type of itemset mining | K4 |
| CO5 | apply the concepts of regression and classification to solve problems | K3 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ | ✓ |
| CO2 | ✓ | ✓ | ✓ | | |
| CO3 | ✓ | | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | | ✓ | ✓ | ✓ |

| 24DAP2EB | EDC: FOUNDATIONS OF DATA ANALYTICS |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | Understanding Data and Data Analytics:<br>Introduction – Types of Data: Numeric-Categorical Graphical-High dimensional data – sources : Time series- Transactional data- Biological data- Spatial data –Social Network data – Big Data and Data science – Big Data Architecture – Data Analytics – Examples of Data Use – Methodologies for Data Analytics – Knowledge Discovery in Databases (KDD) Process | 10 | Text Book |
| II | Data Quality and Data Preprocessing:<br>Data Quality - Missing values - Redundant data – Inconsistent Data – Noisy Data – Outliers – Converting Nominal to Relative – Converting Ordinal to Relative - Data Transformation – Dimensionality Reduction – Attribute Aggregation – Principal Component Analysis- Independent Component Analysis – Multidimensional Scaling- Attribute Selection – Filters – Wrappers - Embedded | 9 | Text Book |
| III | Clustering:<br>Distance Measures – Distance Measures for objects with Quantitative Attributes- Distance Measures for Non-Conventional Attributes - Clustering Validation – Clustering Techniques - K –means – Centroids and Distance Measures - DBSCAN – Agglomerative Hierarchical Clustering Techniques - Dendrograms | 9 | Text Book |
| IV | Frequent Pattern Mining:<br>Frequent Itemsets - Setting the Threshold – Apriori a join-based Method - FP Growth- Maximal Frequent Itemsets - Closed Frequent itemsets – Association Rules – Support and Confidence - Sequential patterns - Frequent Sequence Mining - Closed and Maximal sequences | 10 | Text Book |
| V | Regression and Classification:<br>Regression: Predictive Performance Estimation and Measures for Regression - Types : Linear, Ridge, Lasso Regression - Classification : Binary classification – Distance Based Learning Algorithms – K Nearest Neighbor Algorithm – Decision Trees - Probabilistic Classification Algorithms – Naive Bayes Algorithm. Case Study: Using Linear Regression to Predict Performance | 10 | Text Book |
| | **Total** | 48 | |

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|---|---|---|
| **Text Book** | **1.** | Moreiraj.M, Andre Carvalho, T.Horvath, 2019, "A General Introduction to Data Analytics", John wiley and Sons, USA. |
| **Reference Books** | **1.** | Jain, V.K, 2018, "Data Science and Analytics", Khana Book Publishing, New Delhi. |
| | **2.** | Woz, R.J., 2017, "Data Analytics for Beginners", Createspace Independent Platform, California. |

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| **Journal and Magazines** | International Journal of Data Science and Analytics<br>Analytics India Magazine |
| **E-Resources and Website** | https://skillsbuild.org/students/course-catalog/data-science<br>https://www.coursera.org/specializations/machine-learning-introduction?<br>https://datasciencefoundation.org/ |

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|---|---|
| **Learning Method** | Chalk and Talk/Assignment/Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill Development |

| Semester - II<br>DSE: WAVELET ANALYSIS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2DA** | **WAVELET ANALYSIS** | **DSE** | **48** | **-** | **-** | **4** |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• Influence of Fourier analysis in processing signals<br>• the Concept of Haar wavelet analysis and multi resolution analysis<br>• the necessity of wavelet algorithm, wavelet transform and its inverse |
| **Prerequisite** | Fourier Transforms |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | explain the relation between Fourier transform and discrete signals | K2 |
| CO2 | describe the concept of Haar wavelet analysis | K2 |
| CO3 | explain multi resolution analysis | K3 |
| CO4 | discuss the applications of Daubechies wavelets | K4 |
| CO5 | analyze the computational complexity and wavelet algorithm | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ |
| CO2 | | ✓ | ✓ | ✓ | ✓ |
| CO3 | ✓ | ✓ | | ✓ | ✓ |
| CO4 | ✓ | ✓ | | | ✓ |
| CO5 | ✓ | ✓ | | | ✓ |

| 24MTP2DA | DSE: WAVELET ANALYSIS |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **The Fourier transform and discrete Fourier analysis:** Informal development of the Fourier transform - properties - discrete Fourier transform - discrete signals | 10 | Textbook |
| II | **Haar wavelet analysis:** Haar wavelets - Haar scaling function - basic properties of the Haar scaling function - Haar wavelet -Haar decomposition and reconstruction algorithms - decomposition - reconstruction - filters and diagrams | 10 | Textbook |
| III | **Multi resolution analysis:** The multire solution framework - scaling relation - associated wavelet and wavelet spaces - implementing decomposition and reconstruction - decomposition and reconstruction algorithm - processing a signal - Fourier transform criteria | 10 | Textbook |
| IV | **Daubechies wavelets:** Daubechies' construction - classification - moments - smoothness - computational issues - the scaling function at dyadic points | 9 | Textbook |
| V | **Wavelets in higher dimensions:** Computational complexity - wavelets in higher dimensions - relating decomposition and reconstruction - wavelet transform | 9 | Textbook |
| | **Total** | 48 | |

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|---|---|---|
| **Text Book** | **1.** | Albert Bogges, Francis .J. Narcowich, 2009, "A first course in Wavelets with Fourier analysis", John Wiley & Sons, Inc, New Jersey |
| **Reference Books** | **1.** | Raghuveer Rao and AjitS.Bopardikar, 2000, "Wavelet transforms Introduction, Theory and applications", Pearson Education Asia, HongKong |
| | **2.** | Goswami J.C and Chan A.K., 2011, "Fundamentals of Wavelets: Theory, Algorithms, and Applications", 2nd Edition, Wiley, New Jersey |
| | **3.** | Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, 2010, "Wavelets and their Applications", John Wiley & Sons, New Jersey |
| | **4.** | Joseph Burgess, 2018, " Wavelets: Principles, Analysis and Applications", Nova Science, Italy |

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| **Journal and Magazines** | https://www.worldscientific.com/worldscinet/ijwmip<br>https://www.quantamagazine.org/how-wavelets-allow-researchers-to-transform-and-understand-data-20211013/ |
| **E-Resources and Website** | https://www.angelfire.com/ma/madany/Wavelets.html<br>https://ocw.mit.edu/courses/18-327-wavelets-filter-banks-and-applications-spring-2003/ |

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|---|---|
| **Learning Method** | Chalk and Talk, Assignment, Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill development |

| Semester - II<br>DSE: INFORMATION AND CODING THEORY | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2DB** | **INFORMATION AND CODING THEORY** | **DSE** | **48** | **-** | **-** | **4** |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the concept of information in the context of communication theory<br>• the error correcting codes to support error-free transmission<br>• the various kinds of linear codes and their matrix descriptions |
| **Prerequisite** | Basics of Probability and Linear Algebra |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| CO1 | define basic ideas of information and coding theory | K1 |
| CO2 | describe error-correcting codes using linear algebra and matrix theory concepts | K2 |
| CO3 | apply the entropy function to measure information along with theorem of Shannon | K4 |
| CO4 | analyze Hadamard matrices and codes | K3 |
| CO5 | explain the properties of various forms of linear codes | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ | ✓ |
| CO2 | ✓ | ✓ | | | ✓ |
| CO3 | | | ✓ | ✓ | ✓ |
| CO4 | ✓ | | | ✓ | ✓ |
| CO5 | | | ✓ | ✓ | ✓ |

| 24MTP2DB | DSE: INFORMATION AND CODING THEORY |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Source coding and optimal codes:** Source coding: definitions and examples - Uniquely decodable codes - Instantaneous Codes - Constructing instantaneous codes - Kraft's inequality - McMillan's inequality - Comments - Optimality binary Huffman codes - Average word-length - Optimality - r-ary Huffman codes - Extensions of Sources | 10 | Textbook |
| II | **Entropy and information channels:** Entropy: Information and entropy - properties - entropy and average word-length - Shannon-Fane coding - entropy of extensions and products - Shannon's first theorem and example. Information Channels: definitions - the binary symmetric channel -system entropies - extension of Shannon's first theorem | 12 | Textbook |
| III | **Information channels and using an unreliable channel:** Information channels: Mutual information - Mutual information for the binary symmetric channel -channel capacity - Decision rules - example of improved reliability - hamming distance - statement and outline proof of Shannon's theorem - comments | 10 | Textbook |
| IV | **Error-correcting codes:** Introductory concepts - examples - minimum distance - Hamming's sphere-packing bound - the Gilbert-Varshamov bound - Hadamard matrices and codes. | 8 | Textbook |
| V | **Linear codes:** Matrix description of linear codes - equivalence of linear codes - minimum distance of linear codes - the Hamming Codes -the Golay codes - the standard array contents - syndrome decoding. | 8 | Textbook |
| | **Total** | 48 | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Gareth A. Jones and Mary Jones, 2002, "Information and Coding Theory", Springer-Verlag, New York. |
| **Reference Books** | **1.** | Monica Borda, 2011, "Fundamentals in Information Theory and Coding", Springer-Verlag Berlin. |
| | **2.** | Ranjan Bose, 2008, "Information Theory, Coding and Cryptography", second edition, Tata McGraw Hill Education, New Delhi. |
| | **3.** | P.S. Satyanarayana, 2005, "Concepts of Information Theory and Coding", Dynaram Publication, New Delhi. |
| | **4.** | Richard B. Wells, 2004, "Applied Coding and Information Theory for Engineers", Pearson Education Pte. Ltd, New Delhi. |

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| **Journal and Magazines** | https://www.mdpi.com/journal/entropy/special_issues/4NW2965K19 |
| **E-Resources and Website** | https://www.coursera.org/learn/information-theory<br>https://www.ee.iitb.ac.in/web/course_lists/ee-708-information-theory-and-coding/ |

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|---|---|
| **Learning Method** | Chalk and Talk, Assignment, Seminar |

| | |
|---|---|
| **Focus of the Course** | Skill development, Employability |

| Semester - II<br>DSE: MATHEMATICAL FINANCE | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **II** | **24MTP2DC** | **MATHEMATICAL FINANCE** | **DSE** | **48** | **-** | **-** | **4** |

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|---|---|
| **Preamble** | This course has been designed for students to learn and understand<br>• the terminologies used in financial markets<br>• various models used to price options<br>• the concept of hedging and bonds |
| **Prerequisite** | ODE, PDE, Graphs, Trees |

**Course Outcomes (COs)**

| CO Number | Course Outcomes (COs) Statement | Bloom's Taxonomy Knowledge Level |
|---|---|---|
| **CO1** | represent the financial market terminologies using Mathematical concepts | K1 |
| **CO2** | discuss the various option pricing models | K2 |
| **CO3** | explain the concept behind Black-Scholes model | K3 |
| **CO4** | analyze the output from various interest rate models | K4 |
| **CO5** | determine the price of a bond through various models | K5 |

**Mapping with Program Outcomes:**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | ✓ | | ✓ | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO3** | | ✓ | | ✓ | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | |
| **CO5** | ✓ | ✓ | ✓ | | ✓ |

| 24MTP2DC | DSE: MATHEMATICAL FINANCE |
|---|---|

**Syllabus**

| Unit | Content | Hours | E-Contents / Resources |
|---|---|---|---|
| I | **Financial markets, Binomial trees, Portfolios and Arbitrage:** Markets and Math – Stocks -derivatives -futures contracts – Bond markets-interest rate futures- Game theory method – replicating portfolios – probabilistic approach -risk-Arbitrage | 11 | Text Book |
| II | **Stock models and Option Pricing models:** Stock model- Tree model – Pricing an American and Exotic option- adjusting to real world data -Hedging the N-period – Discrete and continuous model – Black-Scholes formula and its derivation – Trees and Continuous models.. | 9 | Text Book |
| III | **Black-Scholes model and Hedging:** Black-Scholes model- derivation-Options on futures – Delta hedging – methods of hedging – Implied volatility-parameters $\Delta, \Gamma$ and $\Theta$. | 8 | Text Book/Reference book |
| IV | **Interest Rate models:** Interest rates and forward rates – Zero-coupon bonds – Swaps – Pricing and hedging a swap- Interest Rate models. | 10 | Text Book |
| V | **Pricing Bonds:** Bond price dynamics – Bond price formula – spot rate -The HJM miracle – Tree models for bond prices - a Binomial Vasicek model. | 10 | Text Book |
| | **Total** | **48** | |

| | | |
|---|---|---|
| **Text Book** | **1.** | Joseph Stampfli, Victor Goodman.(2003), The Mathematics of Finance: Modeling and Hedging, Thomson Brooks/Cole, Singapore. |
| **Reference Books** | **1.** | Sankarshan Basu, John.C.Hull, (2022), Options, Futures and Other Derivatives (11th Edition),Pearson Education, New Delhi. |
| | **2.** | Mark S.Joshi, (2008), The Concepts and Practice of Mathematical Finance, Cambridge University Press, London. |
| | **3.** | Sheldon M. Ross, (2011), An Elementary Introduction to Mathematical Finance, Cambridge University Press, London |
| | **4.** | Ernst Eberlein, Jan Kallsen, (2019), Mathematical Finance, Springer Nature , Switzerland. |

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| **Journal and Magazines** | SIAM Journal on Financial Mathematics, Applied Mathematical Finance |
| **E-Resources and Website** | https://www.optiontradingtips.com/pricing/free-spreadsheet.html<br>https://study.com/academy/lesson/fundamentals-of-option-valuation.html |

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|---|---|
| **Learning Method** | Chalk and Talk, Seminar |

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|---|---|
| **Focus of the Course** | Skill development, Employability, Entrepreneurship |

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