MASTER OF SCIENCE IN MATHEMATICS

CURRICULUM - SEMESTER PATTERN

(From Calendar Year 2021 onwards)

தமிழ்நாடு திறந்தநிலைப் பல்கலைக்கழகம்
Tamil Nadu Open University
[A State Open University established by Government of TamilNadu, Recognized by UGC-DEB, Member in Asian Association of Open Universities and Association of Commonwealth Universities]

School of Sciences
Department of Mathematics

தமிழ்நாடு திறந்தநிலைப் பல்கலைக்கழகம்

Tamil Nadu Open University, Chennai

சென்னை – 15

School of Sciences

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பாடத்திட்ட அறிக்கை & விரிவான பாடத்திட்டம்

Programme Project Report (PPR) & Detailed Syllabus

NOVEMBER 2020

Tamil Nadu Open University

[A State Open University established by Government of Tamil Nadu, Recognized by UGC-DEB, Member in Asian Association of Open Universities and Association of Commonwealth Universities]

No- 577, Anna Salai, Saidapet, Chennai -600015, Tamil Nadu, India

Prof. K.Parthasarathy
Vice-Chancellor

FOREWORD

My dear Learners, Vanakkam,

I deem it a great privilege to extend a hearty welcome to you to the Post Graduate Programme being offered by the Tamil Nadu Open University (TNOU). I also appreciate your keen interest of know about the curriculum of the Programme, in which you shall gain an enthralling experience, and pleasurable and beneficial learning.

With passing a specific act in the Tamil Nadu Legislative Assembly (TNLA) in 2002, the TNOU came into existence as a State Open University (SOU). It has been offering the socially relevant academic Programmes in diverse disciplines with due approval of the University Grants Commission (UGC) and the Distance Education Bureau (DEB), New Delhi since its inception. This Post Graduate Programme is one among the approved Programmes.

The Board of Studies, a statutory academic body of the University, consisting of the versatile scholars, eminent teachers including both internal and external, well acclaimed industrialists, outstanding alumni, and prospective learners as members, has designed the robust curriculum of this Programme. The curriculum is overhauled to be more suitable to the socio-economic and scientific needs in the modern era based on the emerging trends in the discipline of State and National as well as International level and accordingly, modified to our local context. Moreover, the whole syllabi of this Programme have special focuses on promoting the learners to the modern learning environment.

With a Credit System / Choice Based Credit System (CBCS), this Programme is offered in semester / non-semester pattern. The Self-Learning Materials that are the mainstay of pedagogy in the Open and Distance Learning (ODL) have been developed incorporating both the traditional and the modern learning tools, like web-resources, multi-media contents, text books and reference books with a view to providing ample opportunities for sharpening your knowledge in the discipline.

At this juncture, I wish to place on record my deepest appreciations and congratulations to the Chairperson and the Members of the Board of Studies concerned for having framed the curriculum of high standard.

I would also like to acknowledge the Director, the Programme Coordinator and the members of staff of the respective School of Studies for their irrevocable contributions towards designing the curriculum of this Programme.

Last but not least, I register my profuse appreciation to Prof. S. Balasubramanian, the Director (i/c), Curriculum Development Centre (CDC), TNOU, who have compiled this comprehensive Programme Project Report (PPR) that includes the regulations and syllabi of the Programme, and also facilitated the designing in the form of e-book as well as printed book.

I am immensely hopeful that your learning at TNOU shall be stupendous, gratifying, and prosperous. Wish you all success in your future endeavours!

With regards,

Date: 05.11.2020

(K.PARTHASARATHY)

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TAMIL NADU OPEN UNIVERSITY
School of Sciences
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Chennai - 15

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Tamil Nadu Open University, Chennai – 15

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TAMIL NADU OPEN UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF MATHEMATICS

M.Sc., MATHEMATICS

(From Calendar Year 2021 onwards)

M.Sc., MATHEMATICS

Programme Project Report (PPR)

Programme's Mission and Objectives:

Master of Science in Mathematics Programme has been designed to provide in-deep knowledge inMathematics to those students who are not having opportunity to study in regular mode and for drop-out students from rural and urban areas of Tamil Nadu. The main Objective of this Programme is to see that the recent developments in Mathematics, has been included in the enriched M.Sc., (Mathematics) curriculum to meet out the present day needs of Academic and Research, Institutions and Industries.

Relevance of the Programme with HEI's Mission and Goals:

The Programme M.Sc., (Mathematics) is offered to meet current needs of aspiring youths and adult population and also create awareness about the basic Mathematicaspects to the society. This Programme aims at creating equity in education by providing opportunity to rural people for whom Higher Education is unreachable.

Nature of prospective target group of Learners:

Master of Science (Mathematics is meant for students who have completed an Undergraduate Degree Programme in Mathematics from recognized University or graduate teachers (BT assistant) are the target groups. It also targets the rural population to reach their dream of obtaining Higher Education for whom the opportunity weas denied due to lack of limited number of seats available in the conventional University system.

Appropriateness of Programme to be conducted in ODL mode to acquire specific skills and competence: Master's Degree Programme in Mathematicswillmeet out the present day needs of academic and Research, Institutions and Industries. As Programme outcome of the students may acquire depth knowledge in Algebra, Analysis, Topology, Functional, Optimisation Techniques and Graph Theory which will motivate the students to go for higher studies/research in Mathematics. Their learning needs will be addressed by providing the printed copy of 'Self Learning Materials (SLM)'.

5. Instructional Design:

The Curriculum and the Syllabus for Master of Science in Physics Programme has been designed to provide the recent developments in Mathematical sciences, has been included in the enriched M.Sc., (Mathematics) Syllabus to meet out the present day needs of academic and Research, Institutions and Industries. The course for the degree of Master of Science in Physics shall consist of two years (Four Semester) and the medium of instruction is English.

The Master of Science in Mathematics Programme is offered through the Learner Support Centres established by TNOU in the affiliated Arts and Science College, where the same Programme is offered through Conventional Mode.

The Faculty Members available at Department of Mathematics, School of Science of Tamil Nadu Open University and the faculties approved as Academic Counsellors of TNOUat Learner Support Centres will be used for delivering the Master of Science Degree Programme in Mathematics.

The credits systems suggested as per UGC-ODL Regulations-2020 have been assigned to The Master of Science in Mathematics Programme. The total number of credit assigned for the Programme is 74. The Self Learning Materials in the form of print, e-content and audio/ video materials wherever required has also been developed for the Programme.

Procedure for admissions, curriculum transaction and evaluation:

Eligibility:A candidate who has passed the B.Sc., Degree Examination in Branch III Mathematics Main or / Any B.Sc., degree with specialization Applied Mathematics, Applied, B.E (Mechanical, Civil, EEE, ECE and CSE) or an examination of some other university accepted by the syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc. Mathematics Degree Examination of this University after a course of two academic years. Admissions performed in both academic year and calendar year.

The Programme Fee is Rs.10000/- for two years, plus Registration and other Charges. The admission are carried out by Tamil Nadu Open University and through its Regional Centres located within the State of Tamil Nadu. The Theory Counselling and the Practical Counselling will be conducted through the Learners Support Centres of Tamil Nadu Open

University. The evaluation will be carried by Tamil Nadu Open University consists of Continuous Internal Assessment through Assignment and External Assessment through Term End Examination.

Financial Assistance: SC/ST Scholarship available as per the norms of the State Government of Tamil Nadu. Complete Admission fee waiver for the Physically challenged/ differently abled persons.

Policy of Programme delivery: The Academic Calendar for the Programme will be available for the learners to track down the chronological events/ happenings. The Counselling schedule will be uploaded in the TNOU website and the same will be intimated to the students through SMS.

Evaluation System: Examination to Master Degree Programme in Mathematics is designed to maintain quality of standard. Theory will be conducted by the University in the identified Examination Centres. For the Assignment students may be permitted to write with the help of books/materials for each Course, which will be evaluated by the Evaluators appointed by the University.

Continuous Internal Assessment (CIA): Assignment: 1 assignment for 2 credits are to be prepared by the learners. E.g. If a Course is of Credit 6, then 3 number of Assignments are to be written by the learner to complete the continuous assessment of the course. Assignment carries 30 Marks (Average of Total no of Assignment), consists of Long Answer Questions (1000 words) for each Course.

Sec-A	Answer any one of the question not exceeding 1000 words out of three questions.	1 x 30 = 30 Marks

Theory Examination: Students shall normally be allowed to appear for theory examination by completing Practical and Assignment. The Term -End Examination shall Carry 70 marks and has PART: A, B and C and will be of duration 3 hours.

Question Pattern for Theory Examinations:

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

PART - A (5 × 2 = 10 marks)
Answer all FIVE questions in 50 words
[All questions carry equal marks]

1. From Block - I
2. From Block - II
3. From Block - III
4. From Block - IV
5. From Block- V

PART - B (4 × 5 = 20 marks)
Answer any FOUR questions out of Seven questions in 150 words
All questions carry equal marks

6. From Block - I
7. From Block - II
8. From Block - III
9. From Block - IV
10. From Block- V
11. From any Block
12. From any Block

PART - C (4 × 10 = 40 marks)
Answer any FOUR questions out of Seven questions in 400 words
[All questions carry equal marks]

13. From Block - I
14. From Block - II
15. From Block - III
16. From Block - IV
17. From Block - V
18. From any Block
19. From any Block

Passing Minimum:

For Theory Examination: The candidate shall be declared to have passed the examination if the candidate secures not less than 32 marks in the University examination in each theory paper and overall 50 percent in both Term End Examination and Continuous Internal Assment (Assignment) taken together.

Continuous Internal Assessment (CIA)		Term End Examination (TEE)		Overall Aggregated Marks	Maximum Marks
Minimum Pass Mark	Maximum Mark	Minimum Pass Mark	Maximum Mark	CIA + TEE	
13	30	32	70	50	100

Classification of Successful Candidate:

Candidates who pass all the Courses and who secure 60 per cent and above in the aggregate of marks will be placed in the First Class. Those securing 50 per cent and above but below 60 per cent in the aggregate will be placed in the Second Class.

Requirement of laboratory and Library Resources:

The Programme will be offered through the Learner Support Centre(LSC) maintained by Tamil Nadu Open University. The LSC's have the required infrastructural facilities to conduct the Counselling for the students who wish clear their doubts. There is no lab forMaster Degree Programme in Mathematics.

A well-equipped Library is available in the University Headquarters with about 24,000 books and lot of research journals. The Learners Support Centre through which the Degree Programme is to be offered is also equipped will a full-fledged library having books and journals related Physics.

Cost estimate of the Programme and the provisions:

S.No	Details	Amount in Rs.
1	Programme development and launching cost(Expenditure)	-67,98,704
2	Programme Fee charged for 2 years per student (Income)	10000
3	Examination Fee charged for 2 years (Income) per student	9000
4	Examination expenses per student for 2 years per student (Expenditure)	-15000

Quality Assurance Mechanism and Programme Outcomes: The Quality of the Master's Degree Programme in Physics ismaintained by adopting the curriculum suggested by the UGC. As per UGC guidelines the core courses, six subject specific elective coursesare included in the Programme. The Curriculum of Master Degree Programme in Mathematics was approved by the Board of Studies held on 24-06-2020. It is placed before forthcoming Academic Council Syndicate of our University for approval subsequently. As a part of

Quality assurance, the curriculum for the Programme will be updated once in three years. Necessary steps will be taken to obtain feedback from the students and the Academic Counsellors who are part of the Programme for effective delivery of the Programme.

Programme Outcomes

- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
- Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
- Imbibe effective scientific and/or technical communication in both oral and writing.
- Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
- Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

Detailed Syllabus

Structure of the M.Sc., Mathematics Programme

Course	Course Code	Course Title	Evaluation			Credits
			CIA	TEE	Total	
Semester - I						
Core I	MMSS - 11	Abstract Algebra	30	70	100	4
Core II	MMSS - 12	Advanced Calculus	30	70	100	4
Core III	MMSS - 13	Real Analysis	30	70	100	4
Elective- 1	MMSS-EL1	Differential Geometry	30	70	100	3
Elective -2	MMSS-EL2	Programming in C++	30	70	100	3
Semester - II						
Core IV	MMSS - 21	Applied Mechanics	30	70	100	4
Core V	MMSS - 22	Complex Analysis	30	70	100	4
Core VI	MMSS - 23	Linear Algebra	30	70	100	4
Elective -3	MMSS-EL3	Partial Differential Equations	30	70	100	3
Elective- 4	MMSS-EL4	Mathematical Statistics	30	70	100	3
Semester – III						
Core VII	MMSS - 31	Topology	30	70	100	4
Core VIII	MMSS - 32	Functional Analysis	30	70	100	4
Core IX	MMSS - 33	Ordinary Differential Equations	30	70	100	4
Core X	MMSS - 34	Numerical Analysis	30	70	100	4
Elective -5	MMSS-EL5	Graph Theory	30	70	100	3
Semester - IV						
Core XI	MMSS-41	Integral Transforms and Calculus of Variations	30	70	100	4
Core XII	MMSS - 42	Probability and Random Processes	30	70	100	4
Core XIII	MMSS - 43	Continuum Mechanics	30	70	100	4
Core XIV	MMSS - 44	Mathematical Methods	30	70	100	4
Elective 6	MMSS-EL6	Optimization Techniques	30	70	100	3
		Total	**600**	**1400**	**2000**	**74**

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - I Semester (Distance Mode)

Course Title	**ABSTRACT ALGEBRA**
Course Code	**MMSS 11**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **ABSTRACT ALGEBRA**, the Learner shall be able to:

- The objective of this course is to introduce the basic ideas of counting principle, Sylow subgroups, finite abelian groups, field theory and Galois Theory and to see its application to the solvability of polynomial equations by radicals.

COURSE OUTCOMES

After completion of the **ABSTRACT ALGEBRA**, the Learner will be able :

- to find the number of Sylow subgroups.
- to find the number of non isomorphic abelian groups.
- to find the splitting field, Galois group of the given polynomial.
- to check whether the given polynomial is solvable by radicals or not.

BLOCK I: SYLOW'S THEOREM

Another Counting Principle – 1st, 2nd and 3rd parts of Sylow's Theorems – double coset – the normalizer of a group.

BLOCK II : FINITE ABELIAN GROUPS

External and Internal direct Products – structure theorem for finite abelian groups – non iso-morphic abelian groups - polynomial rings.

BLOCK III : SPLITTING FIELD

Polynomials over rational fields – the Eisenstein criterion - extension fields – roots of polynomials – splitting fields.

BLOCK IV : GALOIS THEORY

More about roots – simple extension – separable extension – fixed fields – symmetric rational functions – normal extension - Galois group – fundamental theorem of Galois theory.

BLOCK V : SOLVABILITY BY RADICALS

Solvable group – the commutator subgroup – Solvability by radicals - finite fields- Wedderburn Theorem.

REFERENCE BOOKS :

1.I.N. Herstein, Topics in Algebra, 2nd Edition, John Wiley and Sons, New York, 1975.

UNIT	Chapter(s)	Sections
I	2	2.11 & 2.12
II	2 & 3	2.13, 2.14, 3.9
III	3 & 5	3.10, 5.1, 5.3
IV	5	5.5 & 5.6
V	5 & 7	5.7, 7.1

2. S. Lang, *"Algebra"*, 3rd Edition, Addison-Wesley, Mass, 1993.

3. John B. Fraleigh, *"A First Course in Abstract Algebra",* Addison Wesley, Mass, 1982.

4. M. Artin, *"Algebra",* Prentice-Hall of India, New Delhi, 1991.

5. V. K. Khanna and S.K. Bhambri, *"A Course in Abstract Algebra"*, Vikas Publishing House Pvt Limited, 1993.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - I Semester (Distance Mode)

Course Title	**ADVANCED CALCULUS**
Course Code	**MMSS 12**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **ADVANCED CALCULUS**, the Learner shall be able to:

- To introduce the basic notion of applied aspects of analysis and familiarize with the theoretical sides of the subject.

COURSE OUTCOMES

After completion of the **ADVANCED CALCULUS**, the Learner will be able to:

- This course prepares the student to take up other courses in Mathematics. It provides theoretical foundation for calculus of one and several variables at advanced level.
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.
- Engage in research in the fieldof pure and applied Mathematicsand involve in lifelong learning

BLOCK : PARTIAL DIFFERENTIATION

Functions of several variables - Homogeneous functions - Total derivative - Higher order Derivatives, Equality of cross derivatives - Differentials - Directional Derivatives.

BLOCK II: IMPLICIT FUNCTIONS AND INVERSE FUNCTIONS

Implicit functions - Higher order derivatives - Jacobians - Dependent and independent variables - The inverse of a transformation - Inverse function theorem - Change ofvariables - Implicit function theorem - Functional dependence - Simultaneous equations.

BLOCK III: TAYLOR'S THEOREM AND APPLICATIONS

Taylor's theorem for functions of two variables - Maxima and Minima of functions of two and three variables - Lagrange Multipliers.

BLOCK IV: LINE AND SURFACE INTEGRALS

Definition of line integrals - Green's theorem - Applications - Surface integrals - Gauss theorem - Verification of Green's and Gauss theorems.

BLOCK V: TRANSFORMATION AND LINE INTEGRALS IN SPACE

Change of variables in multiple integrals - Definition of line integrals in space - Stoke's theorem - Verification of Stoke's theorem.

REFERENCE BOOKS :

1. Widder D.V.,"Advanced Calculus", Prentice Hall of India, New Delhi, 12th Print, Second Edition, 2002.
2. Kaplan W., "Advanced Calculus", Addison Wesley (Pearson Education, Inc.), Fifth Edition, 2003.
3. Malik S.C., "Mathematical Analysis", New Age International Publishers, New Delhi, 1992.
4. Burkill J.C. and Burkill H., "A Second course in Mathematical Analysis", Cambridge University Press, New York, 2002.
5. Apostol T.M., "Mathematical Analysis", Second Edition, Narosa Publishing House, New Delhi,2013.

M.Sc., Mathematics
First Year - I Semester (Distance Mode)

Course Title	**REAL ANALYSIS**
Course Code	**MMSS 13**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **REAL ANALYSIS**, the Learner shall be able to:

- Real Analysis is the fundamental behind almost all other branches of Mathematics.
- The aim of the course is to make the students understand the basic concepts of Real analysis..

COURSE OUTCOMES

After completion of the **REAL ANALYSIS**, the Learner will be able to:

- understand the treatment of Integration in the sense of both Riemann and Lebesgue.
- The students get introduce to the approach of integration via measure, rather than measure via integration.
- The students will be able to understand the methods of Decomposing signed measures which has applications in probability theory and Functional Analysis.

BLOCK I: CONTINUITY AND RIEMANN - STIELTJES INTEGRAL

Limit – Continuity - Connectedness and Compactness - Definition and existence of the integral - Properties of the integral - Integration and Differentiation.

BLOCK II: SEQUENCES AND SERIES OF FUNCTIONS

Pointwise convergence - Uniform convergence - Uniform convergence and continuity - Uniform convergence and Integration, Uniform Convergence and differentiation. Equi – continuous families of functions, Weierstrass and Stone-Weierstrass theorem.

BLOCK III: MEASURE AND MEASURABLE SETS

Lebesgue Outer Measure - Measurable Sets - Regularity - Measurable Functions - Abstract Measure - Outer Measure - Extension of a Measure - Measure Spaces.

BLOCK IV: LEBESGUE INTEGRAL

Integrals of simple functions - Integrals of Non Negative Functions - Fatou's Lemma, Lebesgue monotone convergence Theorem - The General Integral - Riemann and Lebesgue Integrals - Integration with respect to a general measure - Lebesgue Dominated Convergence Theorem.

BLOCK V: LEBESGUE DECOMPOSITION

Signed measures and Hahn Decomposition - Radon-Nikodym Theorem and Lebesgue Decomposition Theorem - Riez Representation Theorem for L1 and Lp .

REFERENCE BOOKS :

1. Rudin, W., "Principles of Mathematical Analysis", Mc Graw-Hill, Third Edition, 1984.
2. G. de Barra, "Measure Theory and Integration", New Age International Pvt. Ltd, Second Edition, 2013.
3. Avner Friedman, "Foundations of Modern Analysis", Hold Rinehart Winston, 1970.
4. Rana I. K., "An Introduction to Measure and Integration", Narosa Publishing House Pvt. Ltd., Second Edition, 2007.
5. Royden H. L., "Real Analysis", Prentice Hall of India Pvt. Ltd., Third Edition, 1995.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - I Semester (Distance Mode)

Course Title	**DIFFERENTIAL GEOMETRY**
Course Code	**MMSS-EL1**
Course Credit	**3**

COURSE OBJECTIVES

While studying the **DIFFERENTIAL GEOMETRY**, the Learner shall be able to:

- This course gives students basic knowledge of classical differential geometry of curves and surfaces such as the catenary, the tractrix, the cycloid and the surfaces of constant Gaussian curvature and minimal surfaces

COURSE OUTCOMES

After completion of the **DIFFERENTIAL GEOMETRY,** the Learner will be able to:

- calculate the curvature and torsion of a curve.
- find the osculating surface and osculating curve at any point of a given curve.
- calculate the first and the second fundamental forms of surface.
- calculate the Gaussian curvature, the mean curvature, the curvature lines, the asymptotic lines, the geodesics of a surface.

BLOCKI : SPACE CURVES

Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torsion – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – Intrinsic equations – Fundamental existence theorem for space curves – Helics.

BLOCKII: INTRINSIC PROPERTIES OF A SURFACE

Definition of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties.

BLOCKIII: GEODESICS

Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature- Gauss-Bonnet Theorem – Gaussian curvature – Surface of constant curvature.

BLOCKIV: NON INTRINSIC PROPERTIES OF A SURFACE

The second fundamental form – Principal curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface – Minimal surfaces – Ruled surfaces.

BLOCKV: DIFFERENTIAL GEOMETRY OF SURFACES

Compact surfaces whose points are umblics – Hilbert's lemma – Compact surface of constant curvature –Complete surface and their Characterization – Hilbert's Theorem – Conjugate points on geodesics.

REFERENCE BOOKS :

1. T.J. Willmore, *"An Introduction to Differential Geometry"*, Oxford University press, (17th Impression), New Delhi, 2002. (Indian Print)

UNIT	Chapter(s)	Sections
I	I	1 – 9
II	II	1 – 9
III	II	10 – 18
IV	III	1 – 8
V	IV	1 – 8

2. D.T. Struik, *"Lectures on Classical Differential Geometry"*, Addition –Wesley, Mass, 1950.

3. S. Kobayashi and K. Nomizu, *"Foundations of Differential Geometry",* Interscience Publishers, 1963.

4. W. Klingenberg, *"A Course in Differential Geometry*", Graduate Texts in Mathematics, Springer – Verlag 1979.

5. C.E.Weatherburn, *"Differential Geometry of Three Dimensions*",University Press, Cambridge, 1930.

6. Polynomial, Newton Interpolation Polynomial,Divided differencetable, Interpolation with equidistance points, Spline interpolation

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - I Semester (Distance Mode)

Course Title	**PROGRAMMING IN C++**
Course Code	**MMSS-EL2**
Course Credit	**3**

COURSE OBJECTIVES

While studying the **PROGRAMMING IN C++**, the Learner shall be able to:

- To develop programming skills in C++ and its object oriented concepts.
- To expose the standard numerical techniques as a powerful tool in scientific computing

COURSE OUTCOMES

After completion of the **PROGRAMMING IN C++**, the Learner will be able to:

- understand the basic principles of scientific and engineering programming
- proficient in object oriented programming concept in C++ tokens, operators, class declaration and definition and its objects ,constructors, destructors , operator overloading and the concept inheritance.
- efficiently use the techniques, skills, and computational skills to solve real time numerical problems

BLOCK I: INTRODUCTION

Beginning with C++ & Tokens, Expressions and Control Structures, Applications of C++– A simple C++ Program— An Example with Class– Structure of C++ Program–Creating the Source File– Compiling and Linking–Introduction– Token and Keyword.

BLOCK II: Functions in C++ and classes

Introduction– the Main Function– Function Prototyping– Call by Reference–Return by Reference– Inline Function– Defaults Arguments– const Arguments– Function Overloading– Friend and Virtual Functions– C Structures Revisited– Specifying a Class– Defining Membership Functions– A C++ Program with Class– Making an Outside Function Inline– Nesting of Member Functions– Private Member Functions– Arrays with an Class

BLOCK III: Objects & Constructors

Introduction––Memory Allocation for Objects–Static Data Member–Static Member Functions–Arrays of Objects– Objects as Function Arguments– Friendly Functions– Returning Objects–const Member Functions–Pointers of Members–Local Classes–Constructors–Parameterized Constructors– Multiple constructors in a class– Constructors with Default Arguments.

BLOCK IV: Destructors & Operator Overloading and Types Conversions

Introduction — Dynamic Initialization of Objects– Copy Constructor– Dynamic Constructors–Constructing Two–Dimensional Arrays– const Objects –Destructors– Introduction– Defining Operator Overloading– Overloading Unary Operators– Overloading Binary Operators–Overloading Binary Operators Using Friends– Manipulation of Strings Using Operators–Rules For Overloading Operators– Type Conversions.

BLOCK V: Inheritance: Extending Classes and Pointers, Virtual Functions and Polymorphism

Introduction–Defining Derived Classes– Single Inheritance–Making a Private Member Inheritance–Making a Private Member Inheritable–Multilevel Inheritance–Multiple Inheritance–Hierarchical Inheritance–Hybrid Inheritance–Virtual Base Classes–Abstract Classes–Constructors in Derived Classes–Member Classes: Nesting of Classes–Introduction–Pointers to Objects–this Pointer–Pointers to Derived Classes–Virtual Functions–Pure Virtual Functions.

REFERENCE BOOKS:

1. E.Balagurusamy, Object Oriented Programming with C++, 4th Edition, The McGraw–Hill CompanyLtd, New Delhi, 2008.
2. V. Ravichandran, Programming with C++, Second Edition Tata McGraw – Hill, New Delhi, 2006.
3. H. Schildt, The complete Reference of C++, Tata–McGraw–Hill publishing Company Ltd. New Delhi, 2003.
4. S.B. Lipman and J.Lafer, C++ Primer, Addition Wesley, Mass., 1998.
5. Ashok N.Kamthane, Object Oriented Programming with ANSI and TURBO C++, Pearson Education(P) Ltd, 2003.
6. BjarmeStroustrup, The C++ Programming Language, AT & T Labs, Murray Hills, NewJersey, 1998.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - II Semester (Distance Mode)

Course Title	**APPLIED MECHANICS**
Course Code	**MMSS 21**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **APPLIED MECHANICS**, the Learner shall be able to:

Tostudythe fundamentals of wave mechanics.

- Classical Mechanics is one of the two major sub fields of mechanics. It emphasis the motion of macroscopic objects from projectiles to the pass of machinery as well as astronomical objects on the qualitative structure of phase space

COURSE OUTCOMES

After completion of the **APPLIED MECHANICS**, the Learner will be able to:

- This subject emphasis the analysis of problems in which quantum and relativistic effects are negligible and its principle and mathematics are the foundation upon which numerous branches of modern physics are founded

BLOCK I: KINEMATICS

Kinematics of a particle and a rigid body - Moments and products of inertia - Kinetic energy - Angular momentum.

BLOCK II: METHODS OF DYNAMICS IN SPACE

Motion of a particle - Motion of a system - Motion of a rigid body.

BLOCK III: APPLICATIONS OF DYNAMICS IN SPACE

Motion of a rigid body with a fixed point under no forces - Spinning top - General motion of top.

BLOCK IV: EQUATIONS OF LAGRANGE AND HAMILTON

Lagrange's equation for a particle - Simple dynamical system - Hamilton's equations.

BLOCK V: HAMILTONIAN METHODS

Natural Motions - Space of events - Action - Hamilton's principle - Phase space -Liouville's theorem.

REFERENCE BOOKS :

1. Synge L. and Griffith B.A., "Principles of Mechanics", Tata McGraw Hill, 1984.

2. Rana N.C. and Joag P.S., "Classical Mechanics", Tata McGraw Hill, 1991.

3. Berger V.D. and Olsson M.G., "Classical Mechanics - a modern perspective",

Tata McGraw Hill International,1995.

4. Bhatia V.B., "Classical Mechanics with introduction to non-linear oscillations and chaos", Narosa Publishing House, 1997.

5. Sankara Rao K. "Classical Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

6. Greenwood D. T., "Principles of Dynamics", Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

7. David Morin, "Introduction to Classical Mechanics with problems and solutions", Cambridge University Press, New Delhi, 2007.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - II Semester (Distance Mode)

Course Title	**COMPLEX ANALYSIS**
Course Code	**MMSS 22**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **COMPLEX ANALYSIS**, the Learner shall be able to:

- Introduce a modern treatment to classical Complexanalysis
- Develop clear thinking and analyzing capacity forresearch.

COURSE OUTCOMES

After completion of the **COMPLEX ANALYSIS**, the Learner will be able to:

- Complex analysis, in particular the theory of conformal mappings, has many physical applications and is also used throughout analytic number theory.
- In modern times, it has become very popular through a new boost from complex dynamics and the pictures of fractals produced by iterating holomorphic functions.
- Another important application of complex analysis is in string theory which studies conformal invariants in quantum field theory.

BLOCK I: COMPLEX INTEGRATION

Fundamental Theorems: Cauchy's Theorem for a Rectangle- Cauchy's Theorem in a Disk. Cauchy's Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions:Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle.

BLOCK II: COMPLEX INTEGRATION

The Genral Form of Cauchy's Theorem: Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multilply connected regions - Residue theorem - The argument principle. Evaluation of Definite Integrals and Harmonic Functions: Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.

BLOCK III: SERIES AND PRODUCT DEVELOPMENTS

Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem

Riemann Theta Function and Normal Families: Product development – Extension of $\zeta(s)$ to the whole plane – The zeros of zeta function – Equicontinuity – Normality and compactness – Arzela's theorem – Families of analytic functions – The Classical Definition.

BLOCK IV: CONFORMAL MAPPINGS

Riemann mapping Theorem: Statement and Proof – Boundary Behaviour – Use of the Reflection Principle. Conformal mappings of polygons: Behaviour at an angle – Schwarz-Christoffel formula – Mapping on a rectangle. Harmonic Functions: Functions with mean value property – Harnack's principle.

BLOCK V: ELLIPTIC FUNCTIONS

Simply Periodic Functions : Representation by Exponentials-The Fourier Development - Functions of Finite Order. Doubly Periodic Functions:The Period Module-Unimodular Transformations - The Caninical Basis-General Properties of Elliptic Functions. Weierstrass Theory: The WeierstrassÃ-function – The functions z(s) and s(s) – The differential equation – The modular equation l(t) – The Conformal mapping by l(t).

REFERENCE BOOKS:

1. Lars F. Ahlfors, Complex Analysis, (3rd Edition) McGraw Hill Book Company, New York, 1979.

2. H.A. Presfly, Introduction to complex Analysis, Clarendon Press, oxford, 1990.

3. J.B. Corway, Functions of one complex variables, Springer - Verlag, International student Edition, Narosa Publishing Co.

4. E. Hille, Analytic function Thorey (2 vols.), Gonm& Co, 1959.

5. M.Heins, Complex function Theory, Academic Press, New York,1968.

M.Sc., Mathematics
First Year - II Semester (Distance Mode)

Course Title	**LINEAR ALGEBRA**
Course Code	**MMSS 23**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **LINEAR ALGEBRA**, the Learner shall be able to:

- Develop a strong foundation in linear algebra that provide a basic for advanced studies not only in mathematics but also in other branches like engineering, physics and computers, etc. Particular attention is given to canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.

COURSE OUTCOMES

After completion of the **LINEAR ALGEBRA**, the Learner will be able to:

- Describe a diagonalizable operator T and a triangulable operator
- Find the minimal polynomials, Jordan forms and the rational forms of real matrices.

BLOCK I: LINEAR TRANSFORMATIONS

Linear transformations – Isomorphism of vector spaces – Representations of linear transformations by matrices – Linear functionals.

BLOCK II: ALGEBRA OF POLYNOMIALS

The algebra of polynomials –Polynomial ideals - The prime factorization of a polynomial - Determinant functions.

BLOCK III: DETERMINANTS

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials.

BLOCK IV: DIAGONALIZATION

Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant direct sums – Primary decomposition theorem.

BLOCK V: THE RATIONAL AND JORDAN FORMS

Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem - Rational forms – Jordan forms.

REFERENCE BOOKS :

1. Kenneth M Hoffman and Ray Kunze, Linear Algebra, 2nd Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.

UNIT	Chapter(s)	Sections
I	3	3.1 – 3.5
II	4 & 5	4.1, 4.2, 4.4, 4.5 and 5.1, 5.2
III	5 & 6	5.3, 5.4 and 6.1 – 6.3
IV	6	6.4 – 6.8
V	7	1.1 – 7.3

2. M. Artin, *"Algebra"*, Prentice Hall of India Pvt. Ltd., 2005.
3. S.H. Friedberg, A.J. Insel and L.E Spence, *"Linear Algebra"*, 4th Edition, Pritice-Hall of India Pvt. Ltd., 2009.
4. I.N. Herstein, *"Topics in Algebra"*, 2nd Edition, Wiley Eastern Ltd, New Delhi, 2013.
5. J.J. Rotman, *"Advanced Modern Algebra"*, 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
6. G. Strang, *"Introduction to Linear Algebra"*, 2ndEdition, Prentice Hall of India Pvt. Ltd, 2013.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - II Semester (Distance Mode)

Course Title	**PARTIAL DIFFERENTIAL EQUATIONS**
Course Code	**MMSS-EL3**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **PARTIAL DIFFERENTIAL EQUATIONS**, the Learner shall be able to:

- Familiarize the students with the fundamental concepts of Partial differential equations which will be used as background knowledge for the specialized courses in any field. This course provides an introduction to the study and solution methods of solving Heat, Wave, Laplace, and Diffusion Equations and integral Transforms. To increase self confidence in conducting research independently or within a team.

COURSE OUTCOMES

After completion of the **PARTIAL DIFFERENTIAL EQUATIONS**, the Learner will be able to:

- Describe real world system using Partial Differential Equations
- Identify, analyse, and subsequently solve physical situations whose behavior can be described by Partial Differential Equations.
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.

BLOCK I: PARTIAL DIFFERENTIAL EQUATIONS OF THE FIRST ORDER

Partial Differential Equations – Origins of First Order Differential Equations – Cauchy's Problem for first order equations – Linear Equations of the first order – Nonlinear partial differential equations of the first order – Cauchy's method of characteristics – Compatible system of First order Equations – Solutions satisfying Given Condition, Jacobi's method

BLOCK II: PARTIAL DIFFERENTIAL EQUATIONS OF THE 2nd ORDER

The Origin of Second Order Equations – Linear partial Differential Equations with constant coefficients – Equations with variable coefficients – Separation of variables – The method of Integral Transforms – Non – linear equations of the second order.

BLOCK III: LAPLACE'S EQUATION

Elementary solutions of Laplace equation – Families of Equipotential Surfaces – Boundary value problems – Separation of variables – Surface Boundary Value Problems – Separation of Variables – Problems With Axial Symmetry – The Theory of Green's Function for Laplace Equation.

BLOCK IV: THE WAVE EQUATION

The Occurrence of the wave equation in Physics – Elementary Solutions of the One – dimensional Wave equations – Vibrating membrane, Application of the calculus of variations – Three dimensional problem – General solutions of the Wave equation.

BLOCK V: THE DIFFUSION EQUATION

Elementary Solutions of the Diffusion Equation – Separation of variables – The use of Integral Transforms – The use of Green's functions

REFERENCE BOOKS :

1. Ian Sneddon – Elements of Partial Differential Equations – McGraw Hill International Book Company, New Delhi, 1983

2. M.D. Raisinghania Advanced Differential Equations S. Chand and Company Ltd., New Delhi, 2001

3. K. Sankara Rao, Introduction to Partial Differential Equations, Second edition – Prentice – Hall of India, New Delhi 2006

4. J.N. Sharma & K. Singh Partial Differential Equations for Engineers & Scientists, Narosa Publishing House, 2001

5. R. Dennemeyer, Introduction to Partial Differential Equations and Boundary value Problems, McGraw Hill Book Company, New York, 1968.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
First Year - II Semester (Distance Mode)

Course Title	**MATHEMATICAL STATISTICS**
Course Code	**MMSS-EL4**
Course Credit	**3**

COURSE OBJECTIVES

While studying the **MATHEMATICAL STATISTICS,** the Learner shall be able to:

- Teach various statistical techniques from both applied and theoretical points of view
- Impart extended knowledge of characteristic function and its properties in the theoretical statistical distributions
- Introduce essential concepts of convergence for statistical distributions and estimation theory

COURSE OUTCOMES

After completion of the **MATHEMATICAL STATISTICS**, the Learner will be able to:

- acquire knowledge of Probability Distributions and Limit theorems
- familiarize with sampling distribution and to find estimators for the parameters
- determine the estimators for the parameters
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.

BLOCK I: SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY

Sampling distributions - Characteristics of good estimators - Method of Moments - Maximum Likelihood Estimation - Interval estimates for mean, variance and proportions.

BLOCK II: TESTING OF HYPOTHESIS

Type I and Type II errors - Tests based on Normal, t, c2 and F distributions for testing of mean, variance and proportions - Tests for Independence of attributes and Goodness of fit.

BLOCK III: CORRELATION AND REGRESSION

Method of Least Squares - Linear Regression - Normal Regression Analysis - Normal Correlation Analysis - Partial and Multiple Correlation - Multiple Linear Regression.

BLOCK IV: DESIGN OF EXPERIMENTS

Analysis of Variance - One-way and two-way Classifications - Completely Randomized Design - Randomized Block Design - Latin Square Design.

BLOCK V: MULTIVARIATE ANALYSIS

Mean Vector and Covariance Matrices - Partitioning of Covariance Matrices - Combination of Random Variables for Mean Vector and Covariance Matrix - Multivariate, Normal Density and its Properties - Principal Components: Population principal components - Principal components from standardized variables.

REFERENCE BOOKS :

1. Freund J.E.," Mathematical Statistics", Prentice Hall of India, Fifth Edition, 2001.

2. Johnson R.A. and Wichern D.W., "Applied Multivariate Statistical Analysis", Pearson Education Asia, Sixth Edition, 2007.

3. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", Sultan Chand & Sons, Eleventh Edition, 2003.

4. Devore J.L. "Probability and Statistics for Engineers", Brooks/Cole (Cengage Learning), First India Reprint, 2008.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - III Semester (Distance Mode)

Course Title	**TOPOLOGY**
Course Code	**MMSS 31**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **TOPOLOGY,** the Learner shall be able to:

- Introduce the basic notion of a topological space, continuous mappings between topological spaces connectedness and compactness of a topological space. Also to teach them the countability and separation axioms, Urysohn metrization theorem and Tychonoff theorem.

COURSE OUTCOMES

After completion of the **TOPOLOGY**, the Learner will be able to:

- demonstrate an understanding of the concepts of metric spaces and topological spaces and their role in mathematics
- demonstrate familiarity with a range of examples of these structures
- prove basic results about completeness, compactness and connectedness within these structures
- demonstrate skills in communicating mathematics orally and in writing
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.

BLOCK I: TOPOLOGICAL SPACES

Topological spaces - Basis for a topology - Product topology on finite cartesian products – Subspace topology.

BLOCK II: CLOSED SETS AND CONTINUOUS FUNCTIONS

Closed sets and Limit points - Continuous functions - Homeomorphism - Metric Topology – Uniform limit theorem.

BLOCK III: CONNECTEDNESS AND COMPACTNESS

Connected spaces - Components - Path components - Compact spaces - Limit point compactness - Local compactness.

BLOCK IV: COUNTABILITY AND SEPARATION AXIOMS

Countabilityaxioms-T1-spaces-Hausdorffspaces-Completelyregularspaces-Normalspaces.

BLOCK V: URYSOHN LEMMA AND TYCHONOFF THEOREM

Urysohn lemma - Urysohn metrization theorem - Imbedding theorem - Tietze extension theorem - Tychonoff theorem.

REFERENCE BOOKS :

1. Munkres J.R., “Topology”, Prentice-Hall of India, New Delhi, Second Edition, 2003.

2. Simmons G.F., “Introduction to Topology and Modern Analysis”, International Student Edition, Tata McGraw Hill Kogakusha Ltd., 1983.

3. Murdeshwar M.G., “General Topology”, Wiley Eastern, Second Edition, 1990.

4. Kelly J.L., “General Topology”, Van Nostrand, 1955.

5. Dugundji J., “Topology”, University Book Stall, New Delhi, 1990.

6. Joshi K. D., “Introduction to General Topology”, New Age International, New Delhi, 2000.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - III Semester (Distance Mode)

Course Title	**FUNCTIONAL ANALYSIS**
Course Code	**MMSS 32**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **FUNCTIONAL ANALYSIS,** the Learner shall be able to:

- Highlight the interplay between algebraic structures and distance structures
- Introduce Operator theory and its application to finite dimensional Spectral Theory.

COURSE OUTCOMES

After completion of the **FUNCTIONAL ANALYSIS**, the Learner will be able to:

- understand an abstract approach to analysis
- understand the interplay between algebraic structures and distance structures
- understand Operator Theory and its application to finite dimensional Spectral Theory
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.

BLOCK I: BANACH SPACES

Banach Spaces - Definition and Examples - Continuous linear transformations

BLOCK II: FUNDAMENTAL THEOREMS IN NORMED LINEAR SPACES

The Hahn-Banach theorem - The natural imbedding of N in N** - The open mapping theorem -Closed graph theorem - The conjugate of an operator - Uniform boundedness theorem.

BLOCK III: HILBERT SPACES

Hilbert Spaces - Definition and Properties - Schwarz inequality - Orthogonal complements - Orthonormal sets - Bessel's inequality - Gram–Schmidt orthogonalization process - The conjugate space H*- Riesz - Representation theorem.

BLOCK IV: OPERATOR ON A HILBERT SPACE

The adjoint of an operator - Self-adjoint operators - Normal and unitary operators - Projections.

BLOCK V: SPECTRAL AND FIXED POINT THEOREMS

Matrices - Determinants and the spectrum of an operator - Spectral theorem - Fixed point theorems and some applications to analysis.

REFERENCE BOOKS :

1. Simmons G.F., "Introduction to Topology and Modern Analysis", Tata Mc-Graw Hill Pvt. Ltd., New Delhi, 2011.
2. Kreyszig E.," Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 2007.
3. Limaye B. V.," Functional Analysis", New Age International Ltd., Publishers, Second Edition, New Delhi,1996.
4. Coffman C. and Pedrick G., "First Course in Functional Analysis", Prentice-Hall of India, New Delhi, 1995.
5. Conway J.B., "A Course in Functional Analysis", Springer-Verlag, New York, 2008.
6. Bollobas B.,"Linear Analysis", Cambridge University Press, Indian Edition, New York, 1999.

7.. Nair M.T., "Functional Analysis, A First course", Prentice Hall of India, New Delhi, 2010

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - III Semester (Distance Mode)

Course Title	**ORDINARY DIFFERENTIAL EQUATIONS**
Course Code	**MMSS 33**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **ORDINARY DIFFERENTIAL EQUATIONS,** the Learner shall be able to:

- Inculcate the concept of the existence, uniqueness and continuous dependence of the solution of initial and boundary value problems
- Introduce mathematical techniques for solving higher order ordinary differential equations using special functions

COURSE OUTCOMES

After completion of the **ORDINARY DIFFERENTIAL EQUATIONS**, the Learner will be able to:

- Have in-depth knowledge of mathematical techniques for solving higher order ordinary differential equations
- Understand the conditions for the existence and uniqueness of solutions for Initial and Boundary value problems
- Demonstrate the ability to integrate knowledge and ideas of differential equations by analyzing their solution to explain the underlying physical processes.

BLOCK I: LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Introduction - Second order homogenous equations - Initial value problem for second order equations - Linear dependence and independence - A formula for Wronskian

BLOCK II: LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS (Cont'd.)

The Non- homogenous equations of order two-homogenous and Non - homogenous equations of order n - Initial value problems for n^{th} order equations- Annihilator method to solve non- Homogenous equation.

BLOCK III: LINEAR EQUATIONS WITH VARIABLE COEFFICIENTS

Initial value problem - Existence and uniqueness theorem - The Wronskian and linear independence - Reduction of the order of a homogenous equation - The non- Homogenous equation - Homogenous equations with analytic coefficients - The Legendre equations .

BLOCK IV: LINEAR EQUATIONS WITH REGULAR SINGULAR POINTS

The Euler equations - Second order equations with regular singular points - Exceptional cases - The Bessel equation – The Bessel equation contd.

BLOCK V: EXISTENCE AND UNIQUENESS OF SOLUTIONS TO FIRST ORDER EQUATIONS

Equations with variable separated - Exact equations - The method of successive approximation - The Lipschitz Condition - Convergence of the successive approximation - Non-local existence of solutions - Approximations to and uniqueness of solutions.

REFERENCE BOOKS :

1. Earl A. Coddington, An Introduction to Oridinary Differential Equations – Prentice – Hall of India Private Limited, New Delhi 2008.

2. Williams E. Boyce and Richard C. Diprima Elementary Differential Equations and Boundary Value Problems, 10th edition John Wiley and Sons, New York 2012

3.M.D. Raisinghania, Advanced Differential Equations, S. Chand & CompanyLtd.,New Delhi 2012

4.George F. Simmons, Differential Equations with Application And HistoricalNotes, Tata McGraw Hill, New Delhi 1974

5.B. Rai, D.P. Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd, New Delhi 2012.

6. Ravi P. Agarwal and Ramesh C. Gupta, Essentials of Ordinary Differential Equations, McGraw Hill, New York, 1991.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - III Semester (Distance Mode)

Course Title	**NUMERICAL ANALYSIS**
Course Code	**MMSS 34**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **NUMERICAL ANALYSIS,** the Learner shall be able to:

- Understand the mathematical concepts of numerical methods, their implementation and analysis.

COURSE OUTCOMES

After completion of the **NUMERICAL ANALYSIS**, the Learner will be able to:

- undertake the study of advanced courses like Numerical solution of Partial Differential Equations, Functional Analysis and its applications to Partial Differential Equations.
- The students will be able to understand, analyze and solve various problems arising in Science and Engineering numerically.
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.
- Engage in research in the fieldof pure and applied Mathematicsand involve in lifelong learning

BLOCK I: SYSTEMS OF LINEAR EQUATIONS AND ALGEBRAIC EIGENVALUE PROBLEMS

Direct Method: Gauss elimination method - Error Analysis - Iterative methods: Gauss-Jacobi and Gauss-Seidel - Convergence considerations - Eigenvalue Problem: Power method.

BLOCK II: INTERPOLATION, DIFFERENTIATION AND INTEGRATION

Interpolation: Lagrange's and Newton's interpolation - Errors in interpolation - Optimal points for interpolation - Numerical differentiation by finite differences - Numerical Integration: Trapezoidal, Simpson's and Gaussian quadratures - Error in quadratures.

BLOCK III: APPROXIMATION OF FUNCTIONS

Norms of functions - Best Approximations: Least squares polynomial approximation – Approximation with Chebyshev polynomials - Piecewise Linear & Cubic Spline approximation.

BLOCK IV: ORDINARY DIFFERENTIAL EQUATIONS

Single-Step methods: Euler's method - Taylor series method - Runge-Kutta method of fourth order - Multistep methods: Adams-Bashforth and Milne's methods – Stability considerations - Linear Two point BVPs: Finite Difference method.

BLOCK V: PARTIAL DIFFERENTIAL EQUATIONS

Elliptic equations: Five point finite difference formula in rectangular region - Truncation error; One dimensional - Parabolic equation: Explicit and Crank-Nicholson schemes; Stability of the above schemes - One-dimensional Hyperbolic equation: Explicit scheme.

REFERENCE BOOKS :

1. Atkinson K.E., "An Introduction to Numerical Analysis", Wiley, 1989.
2. Conte S.D. and Carl de Boor, "Elementary Numerical Analysis", Tata McGraw-Hill Publishing Company, Third Edition, 2005.
3. Kincaid D. and Chenney W., "Numerical Analysis: Mathematics of Scientific Computing", AMS, University Press, Hyderabad, Third Edition, 2009.
4. Isaacson E. and Keller, H.B., "Analysis of Numerical Methods" , Dover Publication, 1994.
5. Philips G.M and Taylor P.J., "Theory and Applications of Numerical Analysis", Elsevier, New Delhi, Second Edition, 2006.
6. Jain M.K., Iyengar S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering", New Age International Pub. Co., Third Edition, 1993.
7. Iserles, A., "A first course in the Numerical Analysis of Differential Equations", Cambridge University press, New Delhi, 2010.
8. Brian Bradie., "A Friendly Introduction to Numerical Analysis", Pearson Education, New Delhi, First edition, 2007
9. C. E. Froberg., "Introduction to Numerical Analysis", Addison-Wesley Publishing Company, Second Edition, 1969.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - III Semester (Distance Mode)

Course Title	**GRAPH THEORY**
Course Code	**MMSS-EL5**
Course Credit	**3**

COURSE OBJECTIVES

While studying the **GRAPH THEORY,** the Learner shall be able to:

- Give a broader view of concepts in basic graph theory
- Emphasize on application aspect of graph theory
- Introduce interconnection networks and to study some networks and its topological properties

COURSE OUTCOMES

After completion of the **GRAPH THEORY**, the Learner will be able to:

- understand advances in graph theory
- have acquired fundamental knowledge of finding shortest paths in networks using algorithms
- have learnt a clear perspective of solving real life problems using advanced graph theory
- understand the concept of networking and select an appropriate and adequate topological structure of interconnection networks while applying it in network communication problems
- Apply knowledge of Mathematics to become successful in national level examinations like NET, SLET, GATEetc.

BLOCK I: INTRODUCTION

An Introduction to graphs: Definitions and basic concepts – Graph Models – Vertex degrees – Isomorphism and Automorphism – Special class of graphs – The pigeonhole principles and Turan's theorem – Walk, Path and Connectedness – Distance, Radius, Diameter and Girth – Subgraphs and Isometric subgraphs –Operations on Graphs The Adjacency, Incidence and Path matrices – Algorithms – Introduction to Algorithms – Breadth-first search Algorithm – Dijkstra's Algorithm – Ford's Algorithm.

Bipartite Graphs: Characterisations of bipartite graphs – Trees – cut edges and cut vertices – Spanning trees and isometric trees – Cayley's Formula – Binary trees – Algorithms – Spanning tree Algorithm – Kruskal's Algorithm – Prim's Algorithm.

BLOCK II: CONNECTIVITIY AND GRAPHICAL SEQUENCES

Connectivity: Connectivity and edge connectivity – 2-Connected graphs – Menger's Theorem – Separable graphs, 1-Isomorphism and 2-Isomorphism.

Graphic Sequences: Degree sequences – Graphic sequences – Wang and Kleitman's Theorem – Algorithms – Algorithm 1 – Algorithm 2.

BLOCK III: EULERIAN AND HAMILTONIAN GRAPHS

Charecterisations of Eulerian Graphs – Degree Sets – Randomly Eulerian Graphs – Application – Algorithm – Fleury's Algorithm – Further Readings – Enumeration – Hamiltonian Graphs – Hamilton Cycle in Power Graphs and Line Graphs – Hamiltonian Sequences – Application – Algorithms – Two Optimal Algorithm – The Closest Insertion Algorithm – Albertson's Algorithm – Related Parameters.

Matchings: Matching – System of Distinct Representatives and Marriage Problem – Covering – 1-Factor – Stable Matchings – Application – Algorithm – The Hungaria Algorithm – Algorithm for Maximum Matching.

BLOCK IV: INDEPENDENCE

Independent Sets – Edge colourings – Application – Vizing's Theorem – Vertex Colouring – Uniquely Colourable Graphs – Brook's Bound and Improvements – Hajos Conjecture – Mycielski's Construction – Line-distinguishing Colourings – Chromatic Polynomials – Algorithm – Sequential Colouring Algorithm.

BLOCK V: PLANAR GRAPHS

Planar Embedding – Euler's Formula – Maximum Planar Graphs – Geometric dual – Characterisations of Planar Graphs – Algorithm – DMP Planarity Algorithm – Colouring in Planar Graphs – Face Colouring.

Reference Books

1. M.Murugan, Graph Theory and Algorithms, Muthali Publishing House, Annanagar, Chennai, 2003.
2. J.A. Bondy and U.S.R. Murthy, Graph Theory with applications, Macmillan Co., London, 1976.
3. D.B.West, Introduction to graph theory, Prentice Hall of India, 2001.
4. J. Clark and D.A. Holton, A First look at Graph Theory, Allied Publishers, New Delhi, 1995.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - IV Semester (Distance Mode)

Course Title	**INTEGRAL TRANSFORMS AND CALCULUS OF VARIATIONS**
Course Code	**MMSS- 41**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **INTEGRAL TRANSFORMS AND CALCULUS OF VARIATIONS,** the Learner shall be able to:

- Familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.
- Expose the students to variational formulation and numerical integration techniques and their applications to obtain solutions for one and two dimensional conditions.
- Study different analytical techniques tocharacterize thesamples

COURSE OUTCOMES

After completion of the **INTEGRAL TRANSFORMS AND CALCULUS OF VARIATIONS**, the Learner will be able to:

- develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.

BLOCK I: LAPLACE TRANSFORMS

Transforms of elementary functions - Unit step and Dirac delta functions - Properties – Differentiation and integration of transforms - Periodic functions - Initial & final value theorems - Inverse Laplace transforms - Convolution theorem - Error function - Transforms involving Bessel functions.

BLOCK II: FOURIER TRANSFORMS

Fourier integral representation - Fourier transform pairs - Properties - Fourier sine and cosine transforms - Transforms and inverse transforms of elementary functions - Convolution theorem - Transforms of derivatives.

BLOCK III: APPLICATIONS OF TRANSFORMS

Application of Laplace Transforms - Evaluation of integrals - Solution of Linear ODE - Applications of Fourier Transforms – wave equation -Heat equation on infinite and semi-infinite line – Potential problems in half-plane.

BLOCK IV: VARIATIONAL PROBLEMS

Variation of a functional and its properties - Euler's equations - Functionals with several arguments - Higher order derivatives - Functionals dependent on functions of several independent variables - Variational Problems in Parametric form.

BLOCK V: MOVING BOUNDARIES AND DIRECT METHODS IN VARIATIONAL PROBLEMS

Variation problems with a movable boundary for functionals dependent on one and two functions - One-sided variations - Constraints - Isoperimetric Problems - Direct Methods in Variational Problems - Rayleigh-Ritz method and Kantorovich method.

REFERENCE BOOKS :

1. Andrews, L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Sneddon, I.N., "The use of integral Transforms", Tata Mc-Graw Hill, 1974.
4. Elsgolts,L., "Differential equations and the Calculus of Variations", MIR Publishers, 1980.
5. Churchill, R.V, " Operational Mathematics", Mc Graw Hill Company, 3rd Edition,1972, U.S.

TAMIL NADU OPEN UNIVERSITY
School of Sciences
Department of Mathematics
Chennai - 15

M.Sc., Mathematics
Second Year - IV Semester (Distance Mode)

Course Title	**PROBABILITY AND RANDOM PROCESSES**
Course Code	**MMSS- 42**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **PROBABILITY AND RANDOM PROCESSES,** the Learner shall be able to:

- Introduce essential concepts of probability, moment generating and characteristic functions
- Impart extended knowledge of Poisson processes, Markov Chains and Martingales

COURSE OUTCOMES

After completion of the **PROBABILITY AND RANDOM PROCESSES**, the Learner will be able to:

- identify and characterize the classes of states in Markov chains
- derive differential equations for time continuous Markov processes with a discrete state space.
- use martingales and related tools to study the behavior of stochastic processes

BLOCK I: PROBABILITY AND RANDOM VARIABLES

Probability Concepts - Random variables - Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Erlang, Weibull and Normal distributions - Functions of a Random variable - Moments, Moment generating function.

BLOCK II: TWO DIMENSIONAL RANDOM VARIABLES

Joint distributions - Transformation of random variables and their distributions – Conditional expectation - Computing probabilities and expectations by conditioning - Correlation and Regression.

BLOCK III : LIMIT THEOREMS

Modes of convergence - Markov, Chebyshev's and Jensen's inequalities - Weak law of large numbers - Strong law of large numbers - Central limit theorem (i.i.d case).

BLOCK IV: MARKOV CHAINS

Stochastic processes - Classification - Markov chain - Chapman Kolmogorov equations – Transition probability Matrix - Classification of states - First passage times – Stationary distribution - Mean time spent in a transient state.

BLOCK V: MARKOV PROCESSES

Markov process - Poisson process - Pure birth process - Pure death process - Birth and death process - Limiting probabilities - Non-homogeneous Poisson process - Compound Poisson process.

REFERENCE BOOKS :

1. Ross S.M., "Introduction to Probability Models", Academic Press Inc., Ninth Edition, 2007.
2. Rohatgi V.K. and A.K. Md. Ehsanes Saleh," An introduction to Probability and Statistics", John Wiley & Sons, Inc., Second Edition, 2001.
3. Karlin S and H.M.Taylor, "A First Course in Stochastic Processes", Academic Press, Second Edition,1975, (An imprint of Elsevier).
4. Medhi J, "Stochastic Processes", New Age International (P) Ltd., New Delhi, Second Edition, 2001.

TAMIL NADU OPEN UNIVERSITY
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Chennai - 15

M.Sc., Mathematics
Second Year - IV Semester (Distance Mode)

Course Title	**CONTINUUM MECHANICS**
Course Code	**MMSS- 43**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **CONTINUUM MECHANICS,** the Learner shall be able to:

- Continuum Mechanics is a branch of mechanics that deals with the analysis of the kinematics and the mechanical behaviour of materials modeled as a continuous mass rather than a discrete particle.

COURSE OUTCOMES

After completion of the **CONTINUUM MECHANICS**, the Learner will be able to:

- familier with vector analysis, including the laws of Gauss and Stokes and should have some understanding of matrix operations. The key mathematical concept in continuum mechanics is the tensor and it convects the mathematical notion of a tensor to the physics of continuous media.

BLOCK I: TENSORS

Summation Convention - Components of a tensor - Transpose of a tensor - Symmetric & antisymmetric tensor - Principal values and directions - Scalar invariants.

BLOCK II: KINEMATICS OF A CONTINUUM

Material and Spatial descriptions - Material derivative - Deformation - Principal Strain - Rate of deformation - Conservation of mass - Compatibility conditions.

BLOCK III: STRESS

Stress vector and tensor - Components of a stress tensor - Symmetry - Principal Stresses – Equations of motion - Boundary conditions.

BLOCK IV: LINEAR ELASTIC SOLID

Isotropic solid - Equations of infinitesimal theory - Examples of elastodynamics and elastostatics.

BLOCK V: NEWTONIAN VISCOUS FLUID

Equations of hydrostatics - Newtonian fluid - Boundary conditions - Stream lines – Examples of laminar flows - Vorticity vector - Irrotational flow.

REFERENCE BOOKS :

1. Lai W.M., Rubin D. and Krempel E., “Introduction to Continuum Mechanics”, Pergamon Unified Engineering Series, 1974.
2. Hunter S.C., “Mechanics of Continuous Media”, Ellis Harwood Series, 1983.
3. Chandrasekaraiah D.S. and Loknath Debnath, “Continuum Mechanics”, Prism Books Private Limited, 1994.
3. Chung T.J., “Continuum Mechanics”, Prentice Hall, 1988.

TAMIL NADU OPEN UNIVERSITY
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M.Sc., Mathematics
Second Year - IV Semester (Distance Mode)

Course Title	**MATHEMATICAL METHODS**
Course Code	**MMSS- 44**
Course Credit	**4**

COURSE OBJECTIVES

While studying the **MATHEMATICAL METHODS,** the Learner shall be able to:

- Understand about Fourier Transforms, Fourier Sine Transforms, Fourier Cosine Transforms, Hankel Transforms, Integral Equations, Fredholm Integral Equations, Volterra Integral Equations, Singular Integral Equations and Calculus of variations

COURSE OUTCOMES

After completion of the **MATHEMATICAL METHODS**, the Learner will be able to:

- Acquire knowledge about integral equations and approximation method
- Ability to solve the problems using Fourier transformation
- Apply the skills in application of Intergal equation to ordinary integral equation

BLOCK I: INTEGRAL EQUATIONS

Types of Integral equations – Integral Fredholm Alternative - Approximate method – Equation with separable Kernel - Volterra integral equations – Fredholm's theory.

BLOCK II: APPLICATION OF INTEGRAL EQUATIONS TO ORDINARY INTEGRAL EQUATIONS AND SINGULAR INTEGRAL EQUATIONS

Initial value problems Boundary value problems – singular integral equations – Abel Integral equation.

BLOCK III: FOURIER TRANSFORMS

Fourier Transforms, Fourier sine and cosine transforms – Fourier transforms of derivatives - convolution integral – Parseval's Theorem - Solution of Laplace Equations by Fourier transform.

BLOCK IV: HANKEL TRANSFORMS

Properties of Hankel Transforms – Hankel transformation of derivatives of functions - The Parseval's relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space - Axisymmetric Dirichlet problem for a thick plate.

BLOCK V: CALCULUS OF VARIATIONS

Variation and its properties – Euler's(Euler Lagrange's) equation – functionals dependent on the functions of several independent variables – variational problems in parametric form –applications.

REFERENCE BOOKS :

1. Linear Integral Equations Theory and Technique by R.P.Kanwal, Academic Press, New York, 1971.

2. The Use of Integral Transforms by I.N.Sneddon, McGraw-Hill, NewYork, 1972.

3. Differential Equations and Calculus of Variations by L.Elsgolts, Mir Publishers, Moscow, 1970.

4. Integral Equations by Shanti Swarup, Krishna Prakashan Media Ltd, Meerut,1982.

5. Integral Transforms and their Applications by Lokenath Debnath, Dambaru Bhatta, Taylor & Francis Group, London, 2007.

TAMIL NADU OPEN UNIVERSITY
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Chennai - 15

M.Sc., Mathematics
Second Year - IV Semester (Distance Mode)

Course Title	**OPTIMIZATION TECHNIQUES**
Course Code	**MMSS- EL6**
Course Credit	**3**

COURSE OBJECTIVES

While studying the **OPTIMIZATION TECHNIQUES,** the Learner shall be able to:

- Use integer programming problem to solve system of linear equations.
- Provide the depth knowledge about inventory control theory and make students to solve the inventory problems.
- Introduce the concept of non–linear programming problems.
- Using optimization techniques to solve many practical problems.

COURSE OUTCOMES

After completion of the **OPTIMIZATION TECHNIQUES**, the Learner will be able to:

- fall skill ful in decision making, markov process, integer programming, enumeration algorithm, dynamic programming, stage coach and cargo leading problem, EOQ, inventory, queuing theory and acquire essential concepts in non linear programming.

BLOCK I: LINEAR PROGRAMMING – NETWORK PROBLEMS

Preliminary ideas – Network linear programme- ensuring total supply equals total demand – transportation problem – assignment problem – shortest route problem – maximum flow problem cuts in a network.

BLOCK II: INTEGER PROGRAMMING

Introduction – Integer Programming Formulations – Gomory's construction–Fractional cut method(all integer)–The Cutting – Plane Algorithm – Branch–and–Bound Technique – Zero–One Implicit Enumeration Algorithm.

BLOCK III: DYNAMIC PROGRAMMING

Introduction – Application of Dynamic Programming: Capital Budgeting Problem – Reliability Improvement Problem – Stage–coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem – Optimal Subdividing Problem – Solution of Linear Programming Problem through Dynamic Programming.

BLOCK IV: INVENTORY AND QUEUING THEOR INVENTORY

Introduction–Inventory Decisions–Cost Associated– with Inventories –Factors Affecting inventory–Economic Order Quantity–Deterministic Inventory Problems with No Shortages–Deterministic inventory Models with shortages–EOQ with Price Breaks–Multi Item Deterministic problems–Inventory Problems with Uncertain Demand.

QUEUING THEORY

Introduction–Queuing System–Elements Of Queuing System–Operating Characteristics of Queuing System–Classification of Queuing Models–Model–I(M/M/1):(∞/FIFO),Model–II(M/M/1) : (N/FIFO), Model–III(M/M/C):(∞/FIFO), Model–IV(M/M/C):(N/FIFO).Problems in above four models.

BLOCK V: NON LINEAR PROGRAMMING

Introduction – Lagrangean Method –Jacobi Method– Kuhn–Tucker Method – Quadratic Programming – Separable Programming – Chance–Constrained Programming or Stochastic Programming.

REFERENCE BOOKS :

1. Hamdy A. Taha, Operations Research,(sixth edition)Prentice–Hall of India private Limited ,New Delhi,1997.
2, Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, Educational Publishers, New Delhi.
3. Panneerselvam.R, Operations Research, 2nd Edition, PHI LearningPrivate Limited, Delhi, 2015
4. Hiller.F.S & Lieberman.J Introduction to Operation Research ,7th Edition, Tata– MCGraw Hill Publishing Company, NewDelhi, 2001.
5. Prem Kumar Gupta.Er, Hira.D.S. Operations Research,7th Edition,S.Chand

& Company Pvt.Ltd.2014.