COURSE CODE	COURSE TITLE	L	T	P	C
60191MA101	LINEAR ALGEBRA	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the algebraic structures such as Linear Transformation, Algebra of Linear Transformations, Representation of Linear Transformations by Matrices, Modules and Real Quadratic Forms and provide logical skill.

b. Prerequisite Courses:

Set Theory / Classical Algebra / Theory of Matrices

c. Related Courses:

Numerical Methods
Advanced Algebra
Functional Analysis

d. Course Educational Objectives:

The students would have developed their knowledge and understanding of the concepts of Linear Algebra such as basic concepts to the analysis of a linear transformation on a finite dimensional vector space, the analysis of characteristic values, canonical forms and quadratic forms.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	**Course Outcome**	Level of Learning domain (Based on revised Bloom's)
CO1	To understand the basic concepts of a vector space	K3
CO2	To grasp the emergence of linear transformations in the study of vector spaces	K3
CO3	To develop the techniques of nilpotent linear transformations Determination of Jordan blocks and understanding fundamental theorem on modules	K3
CO4	Development of the methodology for Jordan and rational canonical forms	K3
CO5	Appreciate Trace and Hermitian, Unitary and Normal transformations	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit-I Vector Spaces

Basic concepts – Vector Space and Examples – Subspace - Homomorphism of vector spaces – Isomorphism of vector spaces - Quotient space – Direct sum – Linear independence – Basis – Dual space – Annihilator of a subspace – System of homogeneous linear equations.

Unit-II Linear transformations, Characteristic roots and Matrices

The Algebra of Linear transformations - Characteristic roots - Similarity of linear transformations - Invariant subspaces and Matrices.

Unit-III Canonical forms

Reduction to triangular forms - Nilpotent transformations - Index of nil potency and Invariant of Nilpotent transformation.

Unit-IV Jordan and rational canonical forms

Jordan blocks - Jordan forms - Rational canonical form

Unit-V Trace and Hermitian, Unitary and Normal transformations

Trace – Jacobson lemma – Transpose – Adjoint mapping - Hermitian, Unitary and Normal transformations

Learning Resources

h. Text book:

i. Treatment and Content as in

I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, **1975**.

Sections – 4.1, 4.2 and 4.3

Sections – 6.1, 6.2 and 6.3

Sections – 6.4 and 6.5

Sections – 6.6 and 6.7

Sections - 6.8 and 6.10

ii. Reference books

1. M.Artin, Algebra, Prentice-Hall of India, New Delhi, **1991**
2. S. Kumaresan, Linear Algebra: A Geometric Approach, Narosa Publishing House Pvt. Ltd., New Delhi, **2018**.
3. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, 2nd Edition, Cambridge University Press, Indian edition, **1997**
4. E.G.Goodaire, Linear Algebra - Pure & Applied World Scientific, Cambridge University Press India Ltd, **2014**
5. K.Hoffman and R.Kunze, Linear Algebra, 2nd Edition, Prentice Hall of India, New Delhi, **1984.**
6. N.Jacobson, Basic Algebra, Volumes I & II, W.H.Freeman, **1980.**
7. S.Lang, Algebra, 3rd Edition, Addison-Wesley, **1993**
8. P.Lax, Linear Algebra, John Willey and Sons, **1997**.
9. H.E.Rose, Linear Algebra, Birkhauser, **2002**.
10. Stephen H. F., Arnold J. I. and Lawrence E. S., Linear Algebra, 4th Edition, Prentice Hall, **2003.**
11. Williams, G., Linear Algebra with Applications, Jones and Burlet Publishers, **2001.**

iii. **Online resources**:

1. https://www.britannica.com › science › linear-transformation
2. https://www.math.ucdavis.edu/~linear/linear.pdf
3. https://www.sciencedirect.com › topics › computer-science › characteristic-root
4. https://mathprelims.wordpress.com › 2009/06/25 › definition-of-similarity
5. math.uga.edu › ~pete › invariant_subspaces
6. https://en.wikipedia.org › wiki › Triangular_matrix

7 https://en.wikipedia.org › wiki › Nilpotent_matrix
8 http://vbu.ac.in/wp-content/uploads/2016/05/SEMESTER-1CBCS.docx
9 https://en.wikipedia.org › wiki › Jordan_matrix
10 https://en.wikipedia.org › wiki › Jordan_normal_form
11 mathworld.wolfram.com › Module
12 https://en.wikipedia.org › wiki › Cyclic_module
13 https://en.wikipedia.org › wiki › Structure_theorem_for_finitely_generated.
14 https://www.imsc.res.in/~knr/past/14mayafs/Notes/ps.pdf
15 https://faculty.math.illinois.edu › ~rotman › book

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA102	ADVANCED ALGEBRA	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the algebraic structures such as Groups, Rings, Fields and Polynomials and to provide a good understanding of Field Extensions, Perfect Field, Finite Field and Galois Theory and bestowing logical skill.

b. Prerequisite Courses:

Set Theory / Classical Algebra / Theory of Matrices

c. Related Courses:

Linear Algebra
Discrete Mathematics
Algebraic Coding Theory

d. Course Educational Objectives:

- To comprehend the idea of class equation of a finite group and Sylow's theory
- To appreciate the significance of polynomials.
- To familiarize with the extension of a field.
- To appreciate Galois theory
- To understand solvable groups

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Grasp the emergence of Sylow theorems and direct products of sub groups.	K3
CO2	Understand the methodology of polynomials	K3
CO3	Learn the fundamentals of a field extension and the types of extensions of a field	K3
CO4	Appreciate the Fundamental theorem of Galois Theory	K3
CO5	Development of the technique of solvability by radicals	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit-I Finite groups

The class equation of a finite groups - Sylow theorems - Direct products.

Unit-II Polynomial rings

Polynomial rings- Polynomials over the rational field – Polynomial rings over Commutative rings.

Unit-III Field Theory

Field extensions - Algebraic and transcendental extensions, and inseparable extensions – Normal extensions.

Unit-IV Galois Theory

Perfect Fields, Primitive elements, Algebraically closed fields, Galois extensions, Fundamental theorem of Galois Theory.

Unit-V Solvable groups and finite fields

Solvable groups - Solvability by radicals and insolvability of the general equation of degree 5 - Finite fields.

h. Learning Resources
i. Text book:
Treatment and Content as in

I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, **1975**.

Sections – 2.11, 2.12 and 2.13
Sections – 3.9, 3.10 and 3.11
Sections – 5.1, 5.3 and 5.5
Sections - 5.6
Sections – 5.7 and 7.1

ii. Reference books:

1. M. Artin, Algebra, Prentice-Hall of India, New Delhi, **1991**
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, 2nd Edition, Cambridge University Press, Indian edition, **1997**
3. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, Wiley Student Edition, **1999.**
4. J.A.Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa Publishing House, New Delhi, **1999**.
5. N.Jacobson, Basic Algebra, Volumes I & II, W.H.Freeman, **1980**
6. S.Lang, Algebra, 3rd Edition, Addison-Wesley, **1993.**
7. T.T.Moh, Algebra, World Scientific, **1992**.
8. J.Stillwell, Elements of Algebra, Springer Verlag, **1994**.

iii. **Online Resources:**

1. https://math.berkeley.edu/~kpmann/SylowNotes.pdf
2. https://www.math.uconn.edu/~kconrad/blurbs/grouptheory/sylowapp.pdf
3. https://en.wikipedia.org › wiki › Sylow_theorems
4. https://brilliant.org › wiki › sylow-theorems
5. mathworld.wolfram.com › Algebra › Group Theory › Finite Groups
6. https://yutsumura.com › tag › sylows-theorem
7. https://kconrad.math.uconn.edu › blurbs › grouptheory › sylowpf
8. mathonline.wikidot.com › the-sylow-theorems
9. http://home.iitk.ac.in/~chavan/alg3.pdf
10. http://www.math.tifr.res.in/~publ/ln/tifr05.pdf
11. https://www.jmilne.org/math/CourseNotes/FT.pdf
12. https://www.jmilne.org/math/CourseNotes/FT.pdf
13. https://pdfs.semanticscholar.org/de4c/0a1a2269ddee82bd2d21f1ae23cdadb09cd7.pdf
14. https://en.wikipedia.org › wiki › Galois_theory
15. https://nrich.maths.org

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA103	REAL ANALYSIS	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

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.

b. Prerequisite Courses:

Set Theory / Classical Algebra / Geometry / Calculus

c. Related Courses:

Measure & Integration
Topology
Approximation Theory
Fixed Point Theory
Complex Analysis
Theory of Probability

d. Course Educational Objectives:

The purpose of the course is to familiarize the students with the fundamental characteristics of real number system, sequences and series, differentiation, integration and mean value theorems

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Examining Sequence and Series for convergence	K3
CO2	Determine the limits of functions and continuous functions	K3
CO3	Understand L'Hospital's Rule and Taylor's Theorem	K3
CO4	Familiarize the concept of The Riemann-Stieltjes Integral	K3
CO5	Appreciate the Sequences and Series of Functions	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit- I Numerical Sequences and Series

Sequences – Convergent sequences Subsequences – Cauchy Sequences – Upper and Lower Limits. Series- Series of non- negative terms - The number e – The Root and Ratio Tests - Power Series - Summation by parts - Absolute convergence – Addition and Multiplication of series - Rearrangements of series .

Unit- II Continuity

Limits of Functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Unit- III Differentiation

The Derivative of a Real Function - Mean Value Theorems – The Continuity of Derivatives - L'Hospital's Rule - Derivatives of Higher Order - Taylor's Theorem - Differentiation of Vector – valued Functions.

Unit- IV The Riemann-Stieltjes Integral

Definition and Existence of the Integral - Properties of the Integral - Integration and Differentiation - Integration of Vector- valued functions - Rectifiable Curves.

Unit- V Sequences and Series of Functions

Discussion of Main Problem – Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration - Uniform Convergence and Differentiation – Equi-continuous Families of Functions – The Stone – Weierstrass theorem.

h. Learning Resources

i. Text book:

Treatment and Content as in:

Walter Rudin, Principles of Mathematical Analysis, McGraw Hill International Edition, Mathematics Series, Third Edition, **1964.**

Chapters 3 – 7

ii. Reference books:

1. P.M. Fitzpatrick, Advanced Calculus‖, AMS, Pine and Applied Undergraduate Texts, Indian Edition, **2006.**
2. Apostol, T. M. Mathematical Analysis, Narosa Publishing House, Indian edition, **1974.**
3. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, Chapman & Hall/CRC, **2014**.

iii. Online resources

1. www.math3ma.com › blog › stone-weierstrass-theorem
2. www.whitman.edu › mathematics › calculus_online › section11.06.html
3. www.britannica.com › science › Cauchy-sequence
4. https://www.transum.org/Software/SW/Starter_of_the_day/Similar.asp?ID_Topic=36
5. http://tutorial.math.lamar.edu/Classes/CalcI/Continuity.aspx
6. www.encyclopediaofmath.org › index.php › Monotone_function
7. www.math24.net › lhopitals-rule
8. www.whitman.edu › mathematics › calculus_online › section11.11.html
9. www.encyclopediaofmath.org › index.php › Rectifiable_curve
10. www.math.wisc.edu › ~angenent › UniformConvergence
11. https://www.math.ucdavis.edu/~emsilvia/math127/chapter7.pdf
12. https://www.techlearning.com/features/15-sites-for-differentiated-instruction
13. https://mat.iitm.ac.in/home/mtnair/public_html/calcul-1-ch-6.pdf
14. www.math3ma.com › blog › stone-weierstrass-theorem

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA104	MEASURE AND INTEGRATION	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is generalization of the concept of integration using measures and development of the concept of analysis in abstract situations.

b. Prerequisite Courses:

Set Theory / Real Analysis

c. Related Courses:

Functional Analysis
Theory of Probability
Stochastic Processes
Calculus of Variations and Integral Equations

d. Course Educational Objectives:

- The students 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.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	**Course Outcome**	Level of Learning domain (Based on revised Bloom's)
CO1	Understand Lebesgue Outer Measure and Borel and Lebesgue measurability.	K3
CO2	Grasp the idea of integration of functions of a real variable	K3
CO3	Familiarize with integration with respect to a measure	K3
CO4	Appreciate Signed Measures and the Hahn Decomposition	K3
CO5	Understand Measurability in a Product Space	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit – I Measure on the Real Line

Lebesgue Outer Measure –Measurable Sets – Regularity – Measurable Functions – Borel and Lebesgue Measurability.

Unit-II Integration of Functions of a Real Variable

Integration of Non-negative Functions – The General Integral – Integration of Series – Riemann and Lebesgue Integrals.

Unit-III Abstract Measure Space

Measures and Outer Measures – Measure Spaces – Integration with respect to a Measure

Unit-IV Signed Measures and Their Derivatives

Signed Measures and the Hahn Decomposition – The Jordan Decomposition – The Radon – Nikodym theorem – Some applications of the Radon – Nikodym theorem.

Unit-V Measure and Integration in a Product Space

Measurability in a Product Space –The Product Measure and Fubini's theorem.

h. Learning Resources

i. Text book

G. de Barra, Measure Theory and Integration, New Age International, **2003.**

Unit – I - Sections 2.1 to 2.5
Unit – II - Sections 3.1 to 3.4
Unit - III – Section 5.1, 5.5, 5.6

Unit - IV – Sections 8.1 to 8.4
Unit - V – Sections 10.1 and 10.2

ii. Reference books

1. P.R. Halmos, Measure Theory, D. Van Nostrand Company, Inc. Princeton, N.J., **1950.**
2. P. K. Jain and V. P. Gupta, Lebesgue Measure & Integration; New Age International (P) Limited, New Delhi, **1986**.
3. M.E. Munroe, Measure and Integration. Addison-Wesley, Mass.**1971**.
4. I.K.Rana, An Introduction to Measure and Integration; Narosa Publishing House, **1997**.
5. H.L. Royden, Real Analysis, Macmillan Publishing Company, **1988**
6. W.Rudin, Real and Complex Analysis, 10th Reprint, McGraw Hill Publishing Co. Ltd, New Delhi. **1986**
7. C.Schwartz, Measure, Integration & Function Spaces; World Scientific, **1994**.

iii. **Online Resources**:

1. www.cmi.ac.in › ~prateek › measure_theory
2. www.math.ucdavis.edu › measure_theory › measure_notes_ch2
3. https://www.math.unl.edu/~gmeisters1/papers/Measure/measure.pdf
4. www.math.harvard.edu › lectures › week_11 › lecture_20 › lecture_20
5. http://www.math.harvard.edu/~shlomo/docs/Real_Variables.pdf
6. www3.nd.edu › ~nancy › Math30750 › Notes › riemann-integral
7. http://www.math.uwaterloo.ca/~beforres/PMath451/Course_Notes/Chapter2.pdf
8. www.math.uwaterloo.ca › PMath451 › Course_Notes › Chapter4
9. www.sciencedirect.com › topics › mathematics › hahn-decomposition
10. www.math.purdue.edu › ~zhang24 › RadonNikodym
11. https://www.math.cuhk.edu.hk/course_builder/1617/math5012/Real%20Analysis_Chapter_6.2017.pdf
12. https://nptel.ac.in/courses/111101005/downloads/Lecture24-32.pdf
13. www.uio.no › math › MAT4400 › product-measure-12oct2014
14. web.math.ucsb.edu › ~labutin › real_analysis_Fubin

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA105	TOPOLOGY	3	2	0	4

Course Category: **PROGRAMME CORE**

a. Preamble:

The students will learn the concepts concerned with such of those properties which are preserved under continuous deformations of objects. The aim of this course is to introduce the basic notions of a topological space such as continuous mappings between topological spaces, compactness and connectedness of a topological space. The students will be introduced to the development of analytical thinking

b. Prerequisite Courses:

Set Theory

c. Related Courses:

Real Analysis
Functional Analysis

d. Course Educational Objectives:

The students will acquire good foundation for undertaking study of the subjects like analysis, geometry, etc. in future.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	**Course Outcome**	Level of Learning domain (Based on revised Bloom's)
CO1	To know the properties of Metric Spaces.	K3
CO2	To familiarize with the concept of topological spaces.	K3
CO3	To understand the properties of a compact space	K3
CO4	To learn the principle of separation in a topological space	K3
CO5	To appreciate the properties of a connected space	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit-I Metric Spaces

Metric spaces – Definition and examples – Open sets - Closed sets – Convergence, completeness and Baire's theorem – Continuous mappings

Unit –II Topological Spaces

Topological spaces -- Definitions and examples -- Elementary concepts – Open bases and open sub-bases – Weak topologies.

Unit-III Compactness

Compact spaces – Product of spaces – Tychonoff's theorem and locally compact spaces – Compactness for metric spaces.

Unit – IV Separation

T_1 spaces and Hausdorff spaces – Completely regular spaces and normal spaces – Urysohn's lemma and Tietze extension theorem-Urysohn imbedding theorem.

Unit -V Connectedness

Connected spaces –The components of a space – Totally disconnected spaces.

h. Learning Resources:

i. Text book:

Treatment and Content as in:

G.F.Simmons, An Introduction to Topology and Modern Analysis, McGraw-Hill Kogakusha, Tokyo, **1963**

Unit I - Chapter 2 – Sections 9 - 13
Unit II – Chapter 3 – Sections 16 - 19
Unit III - Chapter 4 – Sections 21 -- 24
Unit IV - Chapter 5 – Sections 26 - 29
Unit V - Chapter 6 – Sections 31 – 33

ii. Reference books:

1. G.E.Bredon, Topology and Geometry, Graduate Texts in Mathematics Vol. 139, Springer Verlag, New York, **1993**.
2. J.Dugundgi, Topology, Allyn and Bacon, Boston, **1966**
3. J.R.Munkres, Topology, Pearson Education Inc., Second Edition, **2000**
4. S.Willard, General Topology, Dover Publication, **2004.**
5. S. Kumaresan, Topology of Metric Spaces, Alpha Science International, **2011**.

iii**. Online Resources:**

1. http://www-history.mcs.st-and.ac.uk/~john/MT4522/Lectures/L5.html
2. www.emathzone.com › tutorials › general-topology › completely-reg
3. www.math.mcgill.ca › gantumur › baire
4. http://www.nptel.ac.in/courses/111106054/Chapter1.pdf
5. www.iith.ac.in › ~rameshg › weaktopologies
6. www.maths.tcd.ie › ~dwilkins › Courses › Compact
7. www.morebooks.de › store › book › tychonoff-space
8. https://www.google.com/search?biw=1366&bih=608&ei=dHQdXbbLM8vnvgS8r7LICQ&q=Compactness&oq=Compactness&gs_l=psy-ab.12..0i70i249j0l3j0i67j0l5.25589.25589..27427...0.0..0.107.107.0j1.....0....2j1..gws-wiz.....0i71.7dKpxdgyCUk#
9. https://wiki.clicklaw.bc.ca/index.php/Separation
10. www.math.toronto.edu › ivan › mat327 › docs › notes › 09-separation
11. www.math3ma.com › blog › compact-hausdorff-normal
12. www.math.toronto.edu › ivan › mat327 › docs › notes › 13-urysohn
13. www1.maths.leeds.ac.uk › ~matpsh › ShaferRMTietzeExtension
14. www.morebooks.de › store › book › tietze-extension-theorem
15. https://www.emathzone.com/tutorials/general-topology/connectedness-and-compactness/

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA106	COMPLEX ANALYSIS	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the concept of Complex integration, Cauchy theorem, the fundamentals of conformal mappings. The emphasis is on Hadamard's theorem.

b. Prerequisite Courses:

Trigonometry / Classical Algebra / Vector Algebra & Vector Calculus

c. Related Courses:

Real Analysis
Functional Analysis

d. Course Educational Objectives:

The student will get good foundation in complex analysis as well as motivation to take up studies at advanced level.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Understand complex integration	K3
CO2	Know calculus of residues and contour integration	K3
CO3	Learn conformal mappings	K3
CO4	Appreciate the basic properties of harmonic functions	K3
CO5	Familiarize with meromorphic and entire functions	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

UNIT I COMPLEX INTEGRATION

Analytic functions - Cauchy's theorem for rectangle - Cauchy's theorem for disk - Integral formula Local properties of analytic functions - Schwartz lemma - Maximum Modulus principle.

UNIT II CALCULUS OF RESIDUES

Homology - Homologous form of Cauchy's theorem - Calculus of Residues - Contour integration through residues.

UNIT III DOMAIN CHANGING MAPPINGS

Conformality - Normal family - Riemann mapping theorem.

UNIT IV HARMONIC FUNCTIONS

Properties - The mean-value property - Poisson's Formula - Schwarz's theorem - Harnack's principle.

UNIT V MEROMORPHIC AND ENTIRE FUNCTIONS

Meromorphic functions – Mittag Leffler's theorem - Partial fraction - Infinite product - Canonical Product - Gamma Functions - Jensen's formula - Order and Genus of an Entire function - Hadamard's theorem - Riemann Zeta function.

h. Learning Resources

i. Text book

L.V. Ahlfors, Complex Analysis, 3rd Edition, McGraw-Hill International, New York, **1979**.

ii. Reference books

1. R.P. Boas, Invitation to Complex Analysis, The Random House, **1987.**
2. J.B.Conway, Functions of one Complex variables, 2nd edition, Springer International Student Edition, Second Edition, **2000**.
3. T.W. Gamelin, Complex Analysis, Springer International Edition, **2001.**
4. J.H.Mathews and R.W.Howell, Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa Publishing House, **1998**.
5. B.C Palka, An Introduction to the Complex Function Theory, Springer, **1991.**
6. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi**, 1995.**
7. H. A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, **1990**.
8. R.Remmert, Theory of Complex Functions, Springer Verlag, **1991.**
9. E.B. Staff, A.D.Snider, Fundamentals of Complex Analysis with applications to Engineering and Science, 3rd edition, Pearson Education, **2008**
10. E. M. Stein and R. Shakarchi, Complex Analysis, Princeton University Press, Princeton, New Jersey, **2003**.

iii. **Online Resources**:

1. www.impan.pl › ~pmh › teach › algebra › additional › Riemann
2. www.math.ubc.ca › ~feldman › cauchyRiemann
3. www.maths.ed.ac.uk › ~jmf › Teaching › ComplexAnalysis
4. www.yumpu.com › document › view › cauchys-theorem-for-rectangles
5. www.math.utah.edu › ~yplee › teaching › Cauchy_Theorem
6. www.encyclopediaofmath.org › index.php › Cauchy_integral
7. https://www.kcl.ac.uk/noneqsys/events/online-resources/complex-integration-and-residue-theorem.pdf
8. https://www.khanacademy.org/math/multivariable-calculus/multivariable-derivatives/laplacian/v/harmonic-functions

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA107	FUNCTIONAL ANALYSIS	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the fundamentals of Functional Analysis. Emphasis will be laid on Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Riesz-Representation theorem, etc.

b. Prerequisite Courses:

Real Analysis

c. Related Courses:

Linear Algebra
Complex Analysis
Fixed Point Theory
Operator Theory

d. Course Educational Objectives:

The purpose of this course is to augment the analytical skill of the students by the gradual development of the concepts. The students will be motivated to take up advance courses in analysis.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	**Course Outcome**	Level of Learning domain (Based on revised Bloom's)
CO1	Learn the basic concepts of Banach Spaces	K3
CO2	Grasp the Fundamental theorems in normed linear spaces	K3
CO3	Appreciate the properties of Hilbert Spaces	K3
CO4	Understand the Operator on a Hilbert space	K3
CO5	Acquaint with the application of spectral theorem	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**										**M**
CO2	**H**	**H**										**M**
CO3	**H**	**H**										**M**
CO4	**H**	**H**										**M**
CO5	**H**	**H**										**M**

H – High; M – Medium; L - Low

g. Course Content

Unit-I Banach spaces

Normed linear space, Banach Spaces - Definition and examples, Finite Dimensional non-linear space, Continuous linear transformations.

Unit-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.

Unit-III Hilbert spaces

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

Unit- IV Operator on a Hilbert space

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

Unit-V Spectral and fixed point theories

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

h. Learning Resources

i. Text book:

Treatment and Content as in:

Simmons G.F, Introduction to Topology and Modern Analysis, International Student Edition, Mc-Graw Hill, New York, **1983**.
Sections: 46-51, 52-59 and 60 – 62 in Chapters 9-11, and Appendix one.

ii. Reference books:

1. Bollobas B., Linear Analysis, Cambridge University Press, Indian Edition, **1999.**
2. Coffman C. and Pedrick G., First Course in Functional Analysis, Prentice-Hall of India, New Delhi, **1995**.
3. Conway J.B., A Course in Functional Analysis, Springer-Verlag, New York, **1985**.
4. Kreyszig E., Introductory Functional Analysis with Applications, John Wiley & Sons, **1978**.
5. Limaye B.V., Functional Analysis, 2nd Edition, New Age International Ltd. Publishers, **1996.**
6. Nair M.T., Functional Analysis, A First course, Prentice Hall of India, New Delhi, **2002.**

iii. Online Resources:

1. www-personal.acfr.usyd.edu.au › spns › cdm › resources › Kreyszig
2. www1.maths.leeds.ac.uk › ~kisilv › courses
3. www.math.uwaterloo.ca › ~lwmarcou › notes › pmath453
4. wwwu.uni-klu.ac.at › cpoetzsc › Publications_files
5. www.isibang.ac.in › ~jay › notes › TSSK
6. www.cambridge.org › core › books › an-introduction-to-functional-anal.
7. https://www.techopedia.com/definition/17852/banach-space9.
8. www.encyclopediaofmath.org › index.php › Banach_space
9. www.dynamics-approx.jku.at › lena › Cooper › banachsp
10. www.pitt.edu › ~hajlasz › Notatki › Functional Analysis2
11. http://www-personal.acfr.usyd.edu.au/spns/cdm/resources/Kreyszig%20-%20Introductory%20Functional%20Analysis%20with%20Applications.pdf
12. http://cseweb.ucsd.edu/~gill/CILASite/Resources/16Chap12.pdf
13. https://www.isibang.ac.in/~jay/notes/VSS.pdf
14. 14.http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.563.854&rep=rep1&type=pdf16
15. www.math.lsu.edu › ~sengupta › hahnban

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA108	ORDINARY DIFFERENTIAL EQUATIONS	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce ordinary differential equations from both theoretical and applied points of view.

b. Prerequisite Courses:

Calculus

c. Related Courses:

Real Analysis
Theory of Matrices
Classical Mechanics
Non-linear Differential Equations

d. Course Educational Objectives:

The students will be inspired to formulate and solve some practical problems as ordinary differential equations

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Understand the qualitative properties of solutions of an O.D.E.	K3
CO2	Know the singular points which arise in the study of O.D.E.	K3
CO3	Appreciate the properties of Legendre Polynomials and Bessel Functions	K3
CO4	Understand a system of O.D.E.	K3
CO5	Grasp the idea of the Existence and Uniqueness of Solutions	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO2	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO3	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO4	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO5	**H**	**H**	**M**	**M**		**M**	**M**					**M**

H – High; M – Medium; L - Low

g. Course Content

Unit-I Qualitative properties of solutions

Qualitative properties of Solutions – The Sturm Comparison Theorem – Eigen values and Eigen functions and Vibrating String.

Unit-II Series solutions and singular points

Series Solutions of First Order Equations – Second Order Linear Equations – Ordinary points - Regular Singular Points – Gauss Hyper Geometric Equations.

Unit-III Special functions

Legendre Polynomials – Properties of Legendre Polynomials – Bessel Functions- The Gamma Function - Properties of Bessel Function.

Unit-IV Systems of first order equations

Linear Systems – Homogeneous Linear System with Constant Coefficients.

Unit-V Existence and uniqueness of Solutions

The Existence and uniqueness of Solutions – The method of Successive Approximations – Picards's theorem.

h. Learning Resources

i. Text book:

Treatment and Content as in:

G.F.Simmons, Differential Equations with Applications and Historical Notes, Taylor and Francis, Boca Raton, Florida, USA, **2017.**
Sections 24-25, 27-31, 44-47, 55-56 and 69-70

ii. Reference books:

1. G.Birkhoff and G.C.Rota, Ordinary Differential Equations, John Wiley and Son
2. C.Chicone, Ordinary Differential Equations with Applications, 2nd Edition, Springer Verlag, New York, **2006**.
3. E.A.Coddington, An Introduction to Ordinary Differential Equations, 3rd Print, Prentice-Hall of India Ltd., New Delhi, **1987**.
4. P.Hartman, Ordinary Differential Equations, 2nd Edition, SIAM, **2002**.
5. B.Rai, D.P.Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, **2002**.
6. W.T.Reid, Ordinary Differential Equations, John Wiley and Sons, New York, **1977.**
7. Sundarapandian, Ordinary & Partial Differential Equations, Tata Mcgraw-Hill Education, **2013.**

iii. **Online Resources:**

1. http://www.math.iitb.ac.in/~siva/ma41707/ode8.pdf
2. https://www.jstor.org/stable/2322698
3. https://universe.bits-pilani.ac.in/uploads/hypergeometric.pdf
4. https://www.staff.science.uu.nl/~beuke106/GaussHF.pdf
5. https://dlmf.nist.gov/15.10
6. https://www.hindawi.com/journals/jam/2014/128787/
7. https://www.efunda.com/math/Legendre/index.cfm
8. http://www.mhtlab.uwaterloo.ca/courses/me755/web_chap5.pdf
9. https://www.encyclopediaofmath.org/index.php/Legendre_polynomials
10. https://nptel.ac.in/content/storage2/courses/122104018/node86.html
11. https://www.britannica.com/science/Bessel-function
12. http://www.mhtlab.uwaterloo.ca/courses/me755/web_chap4.pdf
13. https://www.math24.net/bessel-differential-equation/
14. https://www.math.usm.edu/lambers/mat415/lecture12.pdf
15. http://mathworld.wolfram.com/GammaFunction.html

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA109	PARTIAL DIFFERENTIAL EQUATIONS	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the concepts and techniques for solving partial differential equations. Emphasis will be on Laplace equation and heat conduction equation.

b. Prerequisite Courses:

Calculus / Ordinary Differential Equations

c. Related Courses:

Fluid Mechanics
Boundary Value Problems

d. Course Educational Objectives:

The students will be in a position to solve partial differential equations arising in various branches of Science and Engineering.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Apply Charpit's method and Jacobi's method to solve first order P.D.E	K3
CO2	Grasp the idea of Cauchy's method of characteristics	K3
CO3	Understand Second Order PDEs	K3
CO4	Learn the method of solving a Laplace equation	K3
CO5	Appreciate the applications of P.D.E	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO2	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO3	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO4	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO5	**H**	**H**	**M**	**M**		**M**	**M**					**M**

H – High; M – Medium; L - Low

g. Course Content

Unit – I: First Order PDEs
Genesis of First order PDE, Linear equations of first Order, Pfaffian Differential equations, Compatible systems, Charpit‘s method, Jacobi‘s method, Integral surfaces through a given curve, Quasi linear equations

Unit – II: Non-linear first order PDEs.
Cauchy‘s method of characteristics, Compatible systems, Special types of first order equations

Unit – III: Second Order PDEs
Genesis of Second order PDEs. Classification of second order PDEs, One – dimensional wave equations, Vibrations of a string of Infinite length, semi-infinite length and finite length, Riemann‘s Method, Method of separation of variables

Unit – IV: Laplace equations
Boundary value problems, Maximum and minimum principles, Cauchy Problem, Dirichlet problem, Neumann problem, Harnack‘s theorem, Green‘s function

Unit – V: Heat Conduction
Heat Conduction Problem in infinite rod case and finite rod case, Duhamel‘s Principle, Wave equation, Heat conduction equation, Classification in n-variables, Families of equi potential surfaces, Kelvin‘s Inversion Theorem.

h. Learning Resources

i. Text book:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, International Edition, Singapore, **1986**

ii. Reference books:

1. T. Amarnath, An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, **2010.**
2. E.Di Benedetto, Partial Differential Equations, Birkhauser, **1995**.
3. E.T.Copson, Partial Differential Equations, Cambridge University Press
4. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19. American Mathematical Society, **1998**.
5. G. B. Folland, Introduction to Partial Differential Equations, Princeton University Press, **1995**.
6. F. John, Partial Differential Equations, 3rd Edition, Narosa Publishing House, New Delhi,
7. **1979**.
8. S. Kesavan, Topics in Functional Analysis and Applications, John Wiley & Sons, **1989.**
9. K. Shankara Rao, Introduction to Partial Differential Equations, PHI Publications, New Delhi, **2005.**
10. Sundarapandian, Ordinary & Partial Differential Equations, Tata Mcgraw-Hill Education, **2013.**
11. W.E.Williams, Partial Differential Equations, Clarendon Press Oxford
12. E.Zauderer, Partial Differential Equations of Applied Mathematics, 2nd Edition, John Wiley and Sons, **1989**.

iii. **Online Resources**:

1. https://math.stackexchange.com/questions/550483/how-to-write-pfaffian-differential-equation
2. https://www.coursehero.com/file/17139298/Topic-4-pde-note/
3. http://www.fen.bilkent.edu.tr/~gurses/math443exam20111solutions.pdf
4. https://www.scribd.com/doc/157614782/5-Charpit-s-Method
5. http://www.sci.brooklyn.cuny.edu/~mate/misc/charpits_method_compl_int.pdf
6. https://brainly.in/question/2376418
7. https://pdfs.semanticscholar.org/0b3c/4e0e512f3df1e502443478d1b05211793fbf.pdf
8. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111107111/lec41.pdf
9. https://www3.nd.edu/~atassi/teaching/ame60612/notes/pde.pdf
10. https://reference.wolfram.com/language/tutorial/DSolveLinearAndQuasiLinearFirstOrderPDEs.html
11. https://math.stackexchange.com/questions/2425413/quasilinear-pde-definition
12. https://mat.iitm.ac.in/home/sryedida/public_html/caimna/pde/first/partial.html
13. https://www.encyclopediaofmath.org/index.php/Quasi-linear_equation

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA110	DIFFERENTIAL GEOMETRY	3	2	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the fundamentals of Differential Geometry. Emphasis will be on the notion of surfaces and their properties, geodesics and differential geometry of surfaces.

b. Prerequisite Courses:

Calculus / Geometry

c. Related Courses:

Topology

d. Course Educational Objectives:

The modern engineers have to included several measurements of surfaces in their practical problems. This course seeks to fulfill the requirement of engineers in their computations.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Broadly understand the space curves and their properties	K3
CO2	Know the intrinsic properties of a surface	K3
CO3	Appreciate the normal property of geodesics	K3
CO4	Understand the developable associated with space curves and with curves on surface.	K3
CO5	Grasp the Fundamental Existence Theorem for surfaces	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO2	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO3	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO4	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO5	**H**	**H**	**M**	**M**		**M**	**M**					**M**

H – High; M – Medium; L - Low

g. Course Content

UNIT - 1 Space curves

Definition of a space curve – Arc length – tangent – normal and bi-normal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helices.

UNIT - 1I Intrinsic properties of a surface

Definition of a surface – curves on a surface – Surface of revolution – Helicoids.

UNIT - 1II Geodesics

Geodesics – Canonical geodesic equations – Normal property of geodesics- Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature surface of constant curvature.

UNIT - IV Non Intrinsic properties of a surface

The second fundamental form- Principle curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface.

UNIT - V Differential Geometry of Surfaces

Fundamental Existence Theorem for surfaces -Compact surfaces whose points are umblics- Hilbert's lemma – Compact surface of constant curvature.

h. Learning Resources:

i. Text book:

Treatment and Content as in:

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

ii. Reference books:

1. M.doCarmo, Differential Geometry of Curves and Surfaces, Prentice Hall, **1976**.
2. W.Klingenberg, A Course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag, **1978.**
3. B.O'Neill, Elementary Differential Geometry, Academic Press, **1966**.
4. A.Pressley, Elementary Differential Geometry, Springer International Edition**, 2004.**
5. J.J.Stoker, Differential Geometry, Wiley Inter-Science, **1969**.
6. D.T.Struik, Lectures on Classical Differential Geometry, Addison – Wesley, Mass. **1950.**
7. A. Thorpe, Elementary Topics in Differential Geometry, Springer (India), New Delhi, **2004**.

iii. **Online resources**:

1. http://alpha.math.uga.edu/~shifrin/ShifrinDiffGeo.pdf
2. https://www.math.upenn.edu/~shiydong/Math501X-2-Surfaces.pdf
3. http://home.iiserb.ac.in/~kashyap/MTH%20406/lp.pdf
4. http://web.mit.edu/hyperbook/Patrikalakis-Maekawa-Cho/node190.html
5. https://quod.lib.umich.edu/u/umhistmath/ABN6101.0001.001?rgn=main;view=fulltext
6. https://www.whitman.edu/mathematics/calculus_online/section13.01.html
7. https://math.stackexchange.com/questions/2206328/intrinsic-vs-extrinsic-properties-of-surfaces/
8. https://pages.uoregon.edu/koch/math433/Final.pdf
9. http://www.math.titech.ac.jp/~kotaro/class/2016/geom-e/lecture-04.pdf
10. www.math.titech.ac.jp › ~kotaro › class › geom-e › lecture-04
11. www.cis.upenn.edu › ~cis610 › gma-v2-chap20
12. www.math.brown.edu › ~deigen › chern
13. www.revolvy.com › page › Hilbert's-lemma
14. www.wikiwand.com › Gaussian_curvature
15. www.morebooks.de › hilbert-s-theorem-differential-geometry

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA111	CLASSICAL MECHANICS	3	2	0	4

Course Category: **PROGRAMME CORE**

a. Preamble:

The aim of this course is to introduce the fundamentals of the mechanical system of particles. Emphasis will be on the dynamics in space and the applications of Lagrange's and Hamilton's equations.

b. Prerequisite Courses:

Calculus

c. Related Courses:

Ordinary Differential Equations
Partial Differential Equations
Fluid Mechanics
Electrodynamics

d. Course Educational Objectives:

This subject emphases the analysis of problems concerning the motion of particles and rigid bodies

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	Course Outcome	Level of Learning domain (Based on revised Bloom's)
CO1	Know the kinematics of particles and rigid bodies	K3
CO2	Understand the methods of dynamics in space	K3
CO3	Appreciate the applications of dynamics in space	K3
CO4	Learn the equations of Lagrange and Hamilton	K3
CO5	Grasp Hamilton's Principle	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO2	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO3	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO4	**H**	**H**	**M**	**M**		**M**	**M**					**M**
CO5	**H**	**H**	**M**	**M**		**M**	**M**					**M**

H – High; M – Medium; L - Low

g. Course Content

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

UNIT II Methods of dynamics in space
Motion of a particle – Motion of a system – Motion of a rigid body.

UNIT III Applications of dynamics in space
Motion of a rigid body with a fixed point under no forces – Spinning top – General motion of top.

UNIT IV Equations of Lagrange and Hamilton
Lagrange's equation for a particle – Simple dynamical system – Hamilton's equations.

UNIT V Hamiltonian methods
Natural Motions – Space of events – Action – Hamilton's principle - Phase space – Liouville's theorem.

h. Learning Resources

i. Text book:
Treatment and Content as in:

L.Synge and B.A.Griffith, Principles of Mechanics, McGraw Hill, **1984**,
Chapters 11,12,14,15,16. (excluding articles : 12.3,12.5,14.3,14.4, 15.2 & 16.2).

ii. Reference books:

1. V.D.Berger and M.G.Olsson, Classical Mechanics - a modern perspective, McGraw Hill International, **1995**.
2. V.B.Bhatia, Classical Mechanics with Introduction to Non-linear Oscillations and Chaos, Narosa Publishing House, **1997**.
3. D.T.Greenwood, Principles of Dynamics, Prentice Hall of India Pvt. Ltd, New Delhi, **1988**.
4. H.Goldstein, Classical Mechanics, 2nd edition, Narosa Publishing House, New Delhi.
5. N.C.Rana and P.S.Joag, Classical Mechanics, Tata McGraw Hill, **1991**.
6. K.Sankara Rao, Classical Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, **2005**

iii. **Online resources:**

1. https://www.google.com/search?q=KINEMATICS++++web+resources&ei=f3EdXaX9HpukwgPph76wBQ&start=10&sa=N&ved=0ahUKEwjluN-oqJrjAhUbknAKHemDD1YQ8NMDCJIB&biw=1366&bih=608#
2. https://crmbook.powerobjects.com/extending-crm/introduction-to-extending-microsoft-dynamics-crm/microsoft-dynamics-crm-web-resources/
3. https://www.tutorialspoint.com/microsoft_crm/microsoft_crm_web_resources.htm
4. http://www.cambridge.org/9781107042889
5. https://physics.stackexchange.com/questions/135726/any-good-resources-for-lagrangian-and-hamiltonian-dynamics7.
6. www.merriam-webster.com › dictionary › angular momentum
7. www.britannica.com › science › angular-momentum
8. www.wired.com › story › what-is-angular-momentum
9. www2.eng.cam.ac.uk › ~hemh1 › gyroscopes › spinningtop
10. www.nyu.edu › tuckerman › stat.mech › lectures › lecture_1 › node3
11. www.iitg.ac.in › physics › fac › padmakumarp › Courses › Lecture7
12. www.physics.usu.edu › torre › 3550_Fall_2013 › Lectures
13. www.unishivaji.ac.in › uploads › distedu › SIM2013

COURSE CODE	COURSE TITLE	L	T	P	C
60191MA112	MATHEMATICAL STATISTICS	4	0	0	4

Course Category: PROGRAMME CORE

a. Preamble:

The aim of this course is to introduce the fundamentals of statistical distributions, tests of significance, estimation and analysis of variance.

b. Prerequisite Courses:

Set Theory

c. Related Courses:

Measure and Integration
Combinatorics

d. Course Educational Objectives:

This course will be helpful for the students, who want to apply the various modern statistical tools in Science, Engineering, Industry, Operations Research, Biomedical and Public policy. They will be trained in the statistical tools of decision making.

e. Course Outcomes:

After the successful completion of the course, students will be able to:

CO No.	**Course Outcome**	Level of Learning domain (Based on revised Bloom's)
CO1	Identify Small Sample distributions and their properties	K3
CO2	Extract the concept of theory of Estimation	K3
CO3	Identify the suitable sample to test the significance level	K3
CO4	Interpret the concept of basic principle of a analysis of Variance	K3
CO5	Identify and apply non-parametric test to classified the data	K3

f. Correlation of Cos with POs:

Co.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**H**	**M**		**M**	**M**				**M**	**M**
CO2	**H**	**H**	**H**	**M**		**M**	**M**				**M**	**M**
CO3	**H**	**H**	**M**	**M**		**M**	**M**				**M**	**M**
CO4	**H**	**H**	**H**	**M**		**M**	**M**				**M**	**M**
CO5	**H**	**H**	**H**	**M**		**M**	**M**				**M**	**M**

H – High; M – Medium; L - Low

g. Course Content

UNIT I: Exact Sampling Distribution

$\chi 2$ Distribution – Derivation – Some properties of $\chi 2$ distribution – Mean – Variance – Mode - β_1,β_2, Additive property of independent $\chi 2$ variates. Student's t distribution – properties – F distributions – Properties.

UNIT II: Theory of Estimation

Characteristic of Estimator – Consistency – Unbiasedness – Sufficiency – Efficiency – Methods of point Estimation: Maximum Likelihood Estimator (MLE), Methods of Moments – Rao Cramer Inequality. – Interval Estimation for μ when σ is known – Mean σ is unknown – For population proportion p – Confidence interval forσ^2.

UNIT III: Sampling and Test of Significance

Types of Sampling – Purposive sampling – Satisfied Sampling – Random sampling – Parameters and statistic – Sampling distribution and Standard Error – Tests Significance – Type I and Type II errors – Critical region and level of significance.

UNIT IV: Analysis of Variance

Analysis of variance – One way and two way classification – Design of Experiments – Basic principles of design of Experiments – CRD, RBD and LSD.

UNIT V: Non parametric Methods

Advantages and disadvantages of non-parametric methods – WALD – Wolfowitz Run test- Test for randomness – Median test – Run test – Mann Whitney U test – Two sample sign test – Kolmogrov – Smirnov – Goodness of fit test.

h. Learning Resources

i. Text Book:

1. Kapur,J.N. and Saxena H.C., Mathematical Statistics, Academic Press, New York, **1972.**
2. V.K. Kapoor and S.C. Gupta. Mathematical Statistics , Sultan Chand & Sons, 1st Edition, New Delhi, 1986.

ii. Reference Books:

1. E.J.Dudewicz and S.N.Mishra, Modern Mathematical Statistics, John Wiley and Sons, New York, **1988.**
2. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, 3rd Print, Wiley Eastern Ltd, New Delhi, **1988.**
3. S. S. Wilks, Mathematical Statistics, Princeton University Press Princeton, New Jersey **1947**.

iii. **Online Resources**:

1. https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Two-Sample_T-Test.pdf
2. http://www2.psychology.uiowa.edu/faculty/mordkoff/GradStats/part%201/I.07%20normal.pdf
3. http://ads.harvard.edu/books/1990fnmd.book/chapt8.pdf
4. https://www.investopedia.com/terms/a/anova.asp
5. http://onlinestatbook.com/2/analysis_of_variance/intro.html
6. https://www.analyticsvidhya.com/blog/2018/01/anova-analysis-of-variance/
7. https://www.statisticssolutions.com/anova-analysis-of-variance/
8. http://onlinestatbook.com/2/analysis_of_variance/anova.pdf
9. http://cba.ualr.edu/smartstat/topics/anova/example.pdf
10. https://www.calvin.edu/~scofield/courses/m143/materials/handouts/anova1And2.pdf
11. https://pdfs.semanticscholar.org/33dd/9a33ed00d197b13dfa7eeb108023d2f1827d.pdf
12. http://www.cimt.org.uk/projects/mepres/alevel/fstats_ch7.pdf
13. https://www.researchgate.net/publication/272311020_Analysis_of_Variance_The_Fundamental_Concepts
14. https://www.fil.ion.ucl.ac.uk/~wpenny/publications/spm-book/anova.pdf
https://arxiv.org/pdf/1605.04772.pdf