NATIONAL EDUCATION POLICY 2020 INITIATIVES

MODEL CURRICULUM CONTENTS FOR

V SEMESTER AND VI SEMESTER

OF

B.A./B.SC. (Hons) MATHEMATICS, B.A./B.Sc. WITH MATHEMATICS AS MAJOR SUBJECT

D R A F T

KARNATAKA STATE HIGHER EDUCATION COUNCIL
30, PRASANNA KUMAR BLOCK,
BENGALORU CENTRAL UNIVERSITY CAMPUS,
Y RAMACHANDRA ROAD, GANDHINAGAR,
BENGALURU– 560009, KARNATAKA
2023

Courses for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Hons) Mathematics

(V and VI Semester)

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks in percentage	
					S. A.	I.A.
V	MATDSCT5.1	Theory	4	Real Analysis-II and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practical's on Real Analysis-II and Complex Analysis	25	25
	MATDSCT5.2	Theory	4	Vector calculus and Analytical geometry	60	40
	MATDSCP5.2	Practical	2	Theory based Practical's on Vector calculus and Analytical geometry	25	25
	MATDSCT5.3	Theory	4	Advanced algebra and Discrete Mathematics	60	40
	MATDSET5.1	Theory	3	(A) Mathematical Statistics (B) Mechanics (C) Mathematical logic	60	40
	Vocational -1*	Theory	3	(A) Programming with Python (B) Design and Analysis of Algorithm	60	40
VI	MATDSCT6.1	Theory	4	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practical's on Linear Algebra	25	25
	MATDSCT6.2	Theory	4	Numerical Analysis	60	40
	MATDSCP6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25
	MATDSCT6.3	Theory	4	Special Functions and Calculus of Variations	60	40
	MATDSET6.1	Theory	3	(A) Number Theory (B) Continuum Mechanics (C) Local Differential Geometry	60	40
	Vocational – 2*	Theory	3	(A) Machine Learning (B) Linear Programming	60	40

*The Board of Studies of the respective universities can introduce different courses for the *Vocational -1* and *Vocational-2* depending on the demand and expertise and also looking into the job opportunities after Graduation with Mathematics subject as Major.

Syllabus for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Hons) Mathematics

SEMESTER – V

MATDSCT 5.1: Real Analysis-II and Complex Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student builds a basic understanding on Riemann integration and elementary complex analysis. The broader course outcomes are listed as follow. At the end of this course, the student will be able to:

- Carry out certain computations such as computing upper and lower Riemann sums as well integrals
- Describe various criteria for Integrability of functions.
- Exhibit certain properties of mathematical objects such as integrable functions, analytic functions, harmonic functions and so on.
- Prove some statements related to Riemann integration as well as in complex analysis
- Carry out the existing algorithms to construct mathematical structures such as analytic functions
- Applies the gained knowledge to solve various other problems.

Real Analysis-II

Unit – I: Riemann Integration-I

Definition & examples for partition of an interval, refinement of a partition and common refinement. **Riemann Darboux Sums** - Upper and lower (Darboux) sums –definition, properties & problems.

Riemann Integral – Upper and Lower integrals (definition & problems), Darboux's theorem and Criterion for Integrability, Integrability of sum, difference, product, quotient and modulus of integrable functions. **Integral as a limit of sum (Riemann sum)** – Problems. **Some integrable functions** – Integrability of continuous functions, monotonic functions, bounded function with finite number of discontinuity. **15 Hour**

Unit –II: Riemann-Stieltjes Integral and Improper Integral

Fundamental theorem of Calculus–related problems, change of variables, integration by parts, first and second mean value theorems of integral calculus. Riemann-Stieltjes Integral– Definition & examples. Riemann Integral as a special case. Improper Integral-Improper integrals of the first, second and third kind with examples. Improper integral has the limit of the proper integral. Comparison test, Abel's test and Dirichlet's test for the convergence of the integral of a product of two functions. **15 Hours**

Complex Analysis

Unit – III: Complex numbers and functions of complex variables:

Complex numbers-Cartesian and polar form-geometrical representation-complex-Plane-Euler's formula- $e^{i\theta} = \cos\theta + i\sin\theta.$ Functions of a complex variable-limit, continuity and differentiability of a complex function. Analytic function, Cauchy-Riemann equations in Cartesian and Polar forms-Sufficiency conditions for analyticity(Cartesian form only)-Harmonic function-standard properties of analytic functions-construction of analytic function when real or imaginary part is given-Milne Thomson method. **15 Hours**

Unit –IV: Transformations and Complex integration:

Transformations: Definition- Jacobian of a transformation- Identity transformation-Reflection- Translation- Rotation- Stretching- Inversion- Linear transformation- Definitions-Bilinear transformations- Cross-ratio of four points- Cross-ratio preserving property-Preservation of the family of straight lines and circles- Conformal mappings- Discussion of the transformations $w = z^2$, $w = \sin z$, $w = e^z$, $w = \frac{1}{2}\left(z + \frac{1}{z}\right)$.

Complex integration– definition, Line integral, properties and problems. Cauchy's Integral theorem-proof using Green's theorem-direct consequences. Cauchy's Integral formula with proof-Cauchy's generalized formula for the derivatives with proof and applications for evaluation of simple line integrals. **15 Hours**

Reference Books:

1. S.C Malik, *Real Analysis,* New Age International (India) Pvt. Ltd.
2. S.C.Malik and Savita Arora, *Mathematical Analysis*, 2nd ed. New Delhi, India: New Age international (P) Ltd.
3. Richard R Goldberg, *Methods of Real Analysis*, Oxford and IBH Publishing
4. Ajit Kumr and S. Kumaresan - *A Basic Course in Real Analysis*, Taylor and Francis Group.
5. L. V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw Hill Education
6. Bruce P. Palka *, Introduction to the Theory of Function of a Complex Variable*, Springer
7. Serge Lang, *Complex Analysis*, Springer
8. Shanthinarayan, *Theory of Functions of a Complex Variable,* S. Chand Publishers.
9. S. Ponnuswamy, *Foundations of Complex Analysis*, 2nd Edition, Alpha Science International Limited.
10. R.V. Churchil & J.W. Brown, *Complex Variables and Applications*, 5th ed, McGraw Hill Companies

MATDSCP 5.1: Practical's on Real Analysis-II and Complex Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming
- Solve problem on Real Analysis and Complex Analysis studied in **MATDSCT 5.1 by** using FOSS software's.
- Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS.
- **Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software's**: Maxima/Scilab /Python/R.
  Suggested Programs:

1. Program to check whether a given set of real numbers attains supremum or infimum.
2. Program to find upper and lower Riemann sums with respect to given partition
3. Program to test Riemann Integrability.
4. Program to evaluate Riemann integral as a limit of sum.
5. Program on verification of Cauchy – Riemann equations (Cartesian form) or test for analyticity.
6. Program on verification of Cauchy – Riemann equations (Polar form) or test for analyticity.
7. Program to check whether a function is harmonic or not.
8. Program to construct analytic functions (through Milne–Thompson method)
9. Program to find Cross ratio of points and related aspects.
10. Program to find fixed points of bilinear transformations.
11. Program to verify De Moivre's theorem.

MATDSCT5.2: Vector Calculus and Analytical Geometry	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Get introduced to the fundamentals of vector differential and integral calculus.
- Get familiar with the various differential operators and their properties.
- Get acquainted with the various techniques of vector integration.
- Learn the applications of vector calculus.
- Recollect the fundamentals of Analytical Geometry in 3D.
- Interpret the geometrical aspects of planes and lines in 3D.

Vector Calculus

Unit – I: Vector Algebra

Vector Algebra –Multiple product – scalar triple product, vector triple product, geometrical interpretation, related problems; vector function of a scalar variable – interpretation as a space curve, derivative, tangent, normal and binormal vectors to a space curve; Curvature and Torsion of a space curve- definitions, derivation and problems, Serret-Frenet formulae.

Scalar field - Gradient of a scalar field, geometrical meaning, directional derivative, unit normal using surfaces - tangent plane and normal to the surface; Vector field - divergence and curl of a vector field, geometrical meaning, solenoidal and irrotational fields; Laplacian of a scalar field; Vector identities. **15 Hours**

Unit – II: Vector Integration

Vector Integration – Definition and basic properties, vector line integral, surface integral and volume integral; **Green's theorem in the plane** – Proof and related problems, Direct consequences of the theorem; **Gauss' Divergence theorem** – Proof and related problems, Direct consequences of the theorem; **Stokes' theorem** – Proof and related problems, Direct consequences of the theorem. . **15 Hours**

Analytical Geometry

Unit-III: Planes, Straight Lines and Spheres Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy. **15 Hours**

Unit-IV: Locus, Surfaces, Curves and Conicoids Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines. **15 Hours**

References:

1. Robert J. T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.
2. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.
3. Shanthi Narayan and P. K. Mittal, *Analytical Solid Geometry*, S. Chand Publications.

4. A. N. Das, *Analytical Geometry of Two and Three Dimensions*, New Central Book Agency Pvt. Ltd.
5. M. D. Raisinghania, *Vector Calculus*, S Chand Co. Pvt. Ltd., 2013.
6. M. Spiegel, *Vector Analysis*, 2nd Edition, Schaum's Outline Series, Mc-Graw Hill, Education, 2017.
7. C. E. Weatherburn, *Elementary Vector Analysis*, Alpha edition, 2019.
8. P. N. Wartikar and J. N. Wartikar, *A Textbook of Applied Mathematics*, Vol. II, Pune Vidyarthi Griha Prakashan, Pune, 2009.
9. C. E. Weatherburn, *Differential Geometry of Three Dimension*, Khosla Publishing House, 2020.
10. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers.
11. G. B. Thomas and R. L. Finney, *Introduction to Calculus and Analytical Geometry*, Narosa Publishing House, 2010.

MATDSCP5.2: Practical's on Analytical Geometry and Vector Calculus	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 60 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming
- Solve problems related to Analytical Geometry and Vector Calculus using FOSS software.

Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program on multiple product of vectors – Scalar and Cross product.
2. Program on vector differentiation and finding unit tangent.
3. Program to find curvature and torsion of a space curve.
4. Program to find the gradient and Laplacian of a scalar function, divergence and curl of a vector function.
5. Program to demonstrate the physical interpretation of gradient, divergence and curl.
6. Program to evaluate a vector line integral.
7. Program to evaluate a surface integral.
8. Program to evaluate a volume integral.
9. Program to verify Green's theorem.
10. Program to find equation and plot sphere, cone and cylinder
11. Program to find distance between a straight line and a plane.
12. Program to construct and plot some standard surfaces.

MATDSCT 5.3: Advanced Algebra and Discrete Mathematics	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to:

- Know the significance of normal subgroups and quotient groups.
- Understand structure preserving mapping between two algebraic structures of the same type.
- Know the algebraic structures having the same structure with different elements.
- Identify and analyze the algebraic structures such as ring, field and integral domain
- Learn the properties of the above-mentioned algebraic structures.
- Handle various mathematical operations like rules for counting, arrangements and selections with repetitions.
- Understand recurrence relation and solving them.
- Study the graphs which are used to model pair wise relations between the objects which helps in understanding the networking, optimization, matching and operation.

Advanced Algebra

Unit I: Groups-II

Normal Subgroups – properties, examples and problems, **Quotient group**, **Homomorphism and Isomorphism of groups** – properties examples and problems, Kernel and image of a homomorphism, Normality of the kernel, Fundamental theorem of homomorphism, Properties related to isomorphism, **Permutation group** – Cayley's Theorem. **15 hours**

Unit II: Rings, Integral Domains, Fields

Rings – definition and properties of rings, Rings of integers modulo n, Subrings, Ideals - Principal, Prime and Maximal ideals in a commutative ring - examples and standard properties following the definition, **Homomorphism**, **Isomorphism** – properties, **Quotient rings, Integral Domain**, **Fields** – properties following the definition, Fundamental Theorem of Homomorphism of Rings, Every field is an integral domain, Every finite integral domain is a field with examples. **15 hours**

Discrete Mathematics

Unit III: Counting Techniques and Recurrence Relations

Counting Techniques – The product rule, The sum rule, The inclusion–exclusion principle, The Pigeonhole principle and examples. Simple arrangements and selections. Arrangements and selections with repetitions, distributions, binomial Coefficients. Recurrence relations **-** examples of Fibonacci numbers and the tower of Hanoi problem, Solving recurrence relations. Divide-and-Conquer relations with examples (no theorems). generating functions, definition with examples, solving recurrence relations using generating functions, exponential generating functions. **15 Hours**

Unit IV: Graph theory

Introduction to graph theory - Types of graphs, basic terminology, Subgraphs, representing graphs as incidence matrix and adjacency matrix. Graph isomorphism. Connectedness in simple graphs. Paths and cycles in graphs. **Distance in graphs** - Eccentricity, Radius, Diameter, Centre, Periphery. Weighted graphs. Euler and Hamiltonian graphs. Paths - Necessary and sufficient conditions for Euler circuits and paths in simple, undirected graphs. Hamiltonicity - noting the complexity of hamiltonicity, Travelling Salesman's problem, Nearest neighbor method.

15 hours

Reference Books

1. I N Herstein(1990), Topics in Algebra, 2nd Edition, Wiley Eastern Ltd., New Delhi.
2. Vijay K Khanna and S K Bhambri (1998), A Course in Abstract Algebra, Vikas Publications.
3. Michael Artin (2015), Algebra, 2nd ed., Pearson.
4. Joseph A, Gallian (2021), Contemporary Abstract Algebra, 10th ed., Taylor and Francis Group.
5. C. L. Liu (200), Elements of Discrete Mathematics, Tata McGraw-Hill.
6. Hari Kishan and Shiv Raj Pundir (2015), Discrete Mathematics, Pragathi Prakashan, 10th ed.
7. W D Wallis (2017), A Beginner's Guide to Discrete Mathematics for Computer Science, Wiley Publishers.
8. Kenneth H. Rossen, Discrete Mathematics and its Applications, Mc-Graw Hill, 8th ed., 2021.
9. Frank Harary (1969), Graph Theory, Addison-Wesley Pub. Company.
10. N. Deo(1990), Graph Theory: Prentice, Hall of India Pvt. Ltd. New Delhi.

Electives

MATDSET 5.1(A) : Mathematical Statistics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On the completion of this course the students will be able to:

1. Understand distributions in the study of the joint behaviour of two random variables.
2. Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.

Unit-I: Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function. **15 Hours**

Unit-II: Univariate Discrete and Continuous Distributions

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. **15 Hours**

Unit-III: Bivariate Distribution, Correlation and Regression

Bivariate Distribution – Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Correlation- The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables,

Regression – Linear regression for two variables, The method of least squares, Bivariate normal distribution, **15 Hours**

References:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). Introduction to Mathematical Statistics (7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2015). John E. Freund's Mathematical Statistics with Applications (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). Probability, Springer-Verlag.
4. Sheldon M. Ross (2015). Introduction to Probability Models (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

MATDSET 5.1(B): Mechanics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On the completion of this course the students will be able to:

1. Understand the subject matter which has been the single center, to which were drawn mathematician physicists, astronomers and engineers together.
2. Understand the necessary condition for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a body.
3. Determine the Centre of Gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.

Unit – I: Statics

Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted in forming the equations of virtual work. **15 Hours**

Unit-II: Centres of Gravity and Common Catenary

Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution; Flexible strings, Common catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of the catenary.

15 Hours

Unit-III: Rectilinear Motion

Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass. Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates. **15 Hours**

References:

1. S. L. Loney (2006). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies. Read Books.
2. P. L. Srivatsava (1964). Elementary Dynamics. Ram Narin Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). Principles of Mechanics. McGraw-Hill.
4. A. S. Ramsey (2009). Statics. Cambridge University Press.
5. A. S. Ramsey (2009). Dynamics. Cambridge University Press.
6. R. S. Varma (1962). A Text Book of Statics. Pothishala Pvt. Ltd.

MATDSET 5.1(C) : Mathematical Logic	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On successful completion of this course, the student will be able to :

1. Define various mathematical structures like logical statements, tautologies, contradictions, graphs (varieties of graphs and), Boolean algebra
2. Able to describe and deduce various properties of mathematical structures like that of Boolean algebra and graphs (like distance, radius, and diameter).
3. Able to apply the rules of logic in arriving at inferences (like that of Modus ponens, Modus Tollens and so on).
4. Able to apply the rules, principles and algorithms in solving problems like that of solving recurrence relations, minimizing the Boolean expression through Karnaugh Map method, solving problems based on counting principles.
5. Will be able prove the mathematical statements related to Boolean algebra, mathematical logic.

Unit – I: Mathematical Logic

Introduction to propositional logic - Definition of statements (propositions), **Logical operators** - $\wedge$, $\vee$, $\sim$, $\Rightarrow$, $\Leftrightarrow$ (definitions, truth tables, logical equivalence, properties and problems); **Some terminologies** – converse, inverse and contrapositive (definitions and problems); **Tautology and Contra-diction** (Definition and related problems); **Theory of inferences** – Modus Ponens, Modus Tollens, Hypothetical syllogism and Disjunctive syllogism (Meanings, examples and underlying tautologies); Predicate Calculus: Definitions of predicates and quantifiers; **Methods of mathematical proofs**: Introduction to proof philosophy (Axiom, postulates and propositions – just discussion); **Methods of proofs:** Direct proof, contra-positive proof, proof through contradiction) and counter examples (Explanation with suitable examples). **15 Hours**

Unit - II: Syntax and Semantics of Logic and Propositional Logic

First-order languages, Terms of language, Formulas of language, First order theory. Unit-II: Semantics of First-order Languages Structures of first order languages, Truth in a structure, Model of a theory, Embeddings and isomorphism. Propositional Logics Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for propositional logic, Proof in propositional logic, Meta theorem in propositional logic, Post tautology theorem. **15 Hours**

Unit – III: Boolean Algebra

Boolean Algebra - Definition and examples, some properties related to Boolean algebra and Miscellaneous problems; **Some terminologies** - Definition of atoms, literals, minterms, maxterms and examples to each and simple problems; **Boolean forms -** Definition and problems on Disjunctive Boolean forms, Minimal forms, Normal Disjunctive Boolean forms, The Karnaugh Map method and applications to circuits. **15 Hours**

Reference Books:

1. Richard E. Hodel (2013). An Introduction to Mathematical Logic. Dover Publications. 2. Yu I. Manin (2010). A Course in Mathematical Logic for Mathematicians (2nd edition). Springer. 3. Elliott Mendelson (2015). Introduction to Mathematical Logic (6th edition). Chapman & Hall/CRC. 4. Shashi Mohan Srivastava (2013). A Course on Mathematical Logic (2nd edition). Springer.
2. Kenneth H. Rosen (2021), *Discrete Mathematics and its Applications*, Mc-Graw Hill (8th Edition).
3. W. D. Wallis (2002), *A beginner's guide to Discrete Mathematics*, Springer (Birkhauser).
4. David Liben- Nowell (2017), *Discrete Mathematics for Computer Science*, Wiley Publications.
5. Howard Pospesel (2003), *Introduction to Logic: Predicate Logic*, Person..
6. Kolman B., Busby R.C., Ross S.C.(2002), *Discrete Mathematical Structures*, PHI

Vocational – 1

MATDSVOC 5.1(A): Programming with Python	
Teaching Hours : 3 Hours/Week	**Credits: Theory : 2** **Practical: 1**
Total Teaching Hours: Theory : 30 Hours **Practical : 30 Hours**	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On the completion of this course the students will be able to

1. Learn the syntax and semantics of Python programming language.
2. Write Python functions to facilitate code reuse and manipulate strings.
3. Understand the use of built-in functions to navigate the file system
4. Apply the concepts of file handling.

Unit-1: Introduction, Basics and Program flow (15 Hours)

Python character set, Tokens, Variables and assignments, print statement, comments, Python data structure and data types, string operation in Python, Simple input and output (including simple output-formatting, operators in Python, expressions, standard library modules, Debugging, indentation, Flow of control (if, if-else, if-elif, nested if), range function, iteration/looping statements, String and list manipulation, Tuples, dictionaries, sorting techniques

Unit-2: Functions, libraries and File handling (15 Hours)

Understanding and creating your own functions, Function parameters, Flow of execution in a function call, passing parameters, Returning values from functions, Scope of a function, Importing modules in a Python, Using standard library functions and Modules, Creating a Python library, Data files, Operating and closing files, working with text files, Standard, input, output and error streams, Working with binary and CSV files.

UNIT-3: Practical Implementation of Python (30 Hours)

1. Write python programs using the concepts of control structures.
2. Implement Python programs using functions and strings.
3. Implement methods to create and manipulate lists, tuples and dictionaries.
4. Apply the concepts of file handing and regExusing packages.
5. Illustrate the working of scraping websites with CSV.

References

1. Automate the Boring Stuff with Python -, Al Sweigart, Willam Pollock, 2015
2. Python Cook Book-, David Beazely and Brain K. Jones 2022.
3. Basic Python Programming for Beginners- Varada Rajkumar, Marapalli Krishna, Jaya Prakash, Blue Rose Publishers, 2022.
4. Python- John Shovic and Alan Simpson, Paperback, 2020.
5. Learning Python- Mark Lutz, O'Reilly Media, Paperback, 2nd edition, 2020.
6. Programming and Problem Solving Through Python- Satish Jain and Shashi Singh, BPB Publications, 2020

MATDSVOC 5.1(B): Design and Analysis of Algorithm	
Teaching Hours : 3 Hours/Week	**Credits: Theory : 3**
Total Teaching Hours: Theory : 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning outcomes: On the completion of this course the students

1. Will become familiar with various computational problem solving techniques.
2. Are able to apply appropriate method to solve a given problem.
3. Will be able to describe various methods of algorithm analysis.
4. Will be able estimate the computational complexity of different algorithms.

Unit – I

Introduction: Definition of Algorithm, Algorithm Specification, Analysis Framework. Performance Analysis: Space complexity, Time complexity.), and Little-ohΘAsymptotic Notations: Big-Oh notation (0), Omega notation (Ω), Theta notation (notation (o), Mathematical analysis of Non-Recursive and recursive Algorithms with Examples. Important Problem Types: Sorting, Searching, String processing, Graph Problems, Combinatorial Problems. Fundamental Data Structures: Stacks, Queues, Graphs, Trees, Sets and Dictionaries. Divide and Conquer: General method, Binary search, Recurrence equation for divide and conquer, Finding the maximum and minimum, Merge sort, Quick sort, Strassen's matrix multiplication, Advantages and Disadvantages of divide and conquer. **(15 Hours)**

Unit – II

Decrease and Conquer Approach: Topological Sort. Greedy Method: General method, Coin Change Problem, Knapsack Problem, Job sequencing with deadlines. Minimum cost spanning trees: Prim's Algorithm, Kruskal's Algorithm. Single source shortest paths: Dijkstra's Algorithm. Optimal Tree problem: Huffman Trees and Codes. Transform and Conquer Approach: Heaps and Heap Sort. Dynamic Programming: General method with Examples, Multistage Graphs. Transitive Closure: Warshall's Algorithm. **(15 Hours)**

Unit – III

All Pairs Shortest Paths: Floyd's Algorithm, Optimal Binary Search Trees, Knapsack problem, BellmanFord Algorithm, Travelling Sales Person problem, Reliability design. Backtracking: General method, N-Queens problem, Sum of subsets problem, Graph coloring , Hamiltonian cycles. Branch and Bound: Assignment Problem, Travelling Sales Person problem. NP-Complete and NP-Hard problems: Basic concepts, non- deterministic algorithms, P, NP, NP-Complete, and NP-Hard classes **(15 Hours)**

References:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin:, 2rd Edition, 2009. Pearson.

2. Computer Algorithms/C++, Ellis Horowitz, Satraj Sahni and Rajasekaran, 2nd Edition, 2014, Universities Press.

3. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.

4. Design and Analysis of Algorithms , S. Sridhar, Oxford (Higher Education)

SEMESTER – VI

MATDSCT 6.1: Linear Algebra	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will build a basic understanding in few areas of linear algebra such as vector spaces, linear transformations and inner product spaces. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Understand the concepts of Vector spaces, subspaces, bases dimension and their properties.
2. Become familiar with the concepts Eigen values and eigen vectors, minimal polynomials, linear transformations etc.
3. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
4. Prove various statements in the context of vectors spaces.
5. Realise importance of adjoint of a linear transformation and its canonical form.

Unit – I: Vector spaces

Vector spaces - Definition, examples and properties; **Subspaces** - Examples, criterion for a sub- set to be a subspace and some properties; **Linear Combination** - Linear span, Linear dependence and Linear independence, basic properties of linear dependence and independence, techniques of determining linear dependence and independence in various vector spaces and related problems; **Basis and dimension** - Co-ordinates, ordered basis, some basic properties of basis and dimension and subspace spanned by given set of vectors; **Quotient space.** Dimension of quotient space (derivation in finite case); **Sum and Direct sum of subspaces** - Dimensions of sum and direct sum spaces (Derivation in finite case).

15 Hours

Unit – II: Linear Transformations

Linear transformation - Definition, examples, equivalent criteria, some basic properties and matrix representation and change of basis and effect on associated matrix, similar matrices; **Rank - Nullity theorem** - Null space, Range space, proof of rank nullity theorem and related problems. **15 Hours**

Unit – III: Isomorphism, Eigenvalues and Diagonalization

Homomorphism, Isomorphism and automorphism - Examples, order of automorphism and Fundamental theorem of homomorphism; **Eigenvalues and Eigenvectors** - Computation of Eigenvalues, algebraic multiplicity, some basic properties of eigenvalues, determination of eigenvectors and eigenspace and geometric multiplicity. **Diagonalizability of linear transformation** - Meaning, condition based on algebraic and geometric multiplicity (mentioning) and related problems (Only verification of diagonalizability).

15 Hours

Unit – IV: Invertible Transformation and Inner product spaces

Invertible transformation - some basic properties of Invertible, singular and non-singular trans- formations and conditions for existence of inverses; Minimal polynomial of a transformation**.** Relation between characteristic and minimal polynomials and related problems.

Inner product and normed linear spaces - Definitions, examples, Cauchy-Schwartz inequality (with proof) and related problems; Gram-Schmidt orthogonalization - Orthogonal vectors, orthonormal basis, Gram-Schmidt orthogonalization process: both proof and problems; Orthogonal projection - Orthogonal projection of a vector and a subspace on another subspace, problems related to the same. **15 Hours**

Reference Books:

1. I. N. Herstein, *Topics in Algebra*, 2nd Edition, Wiley.
2. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra (4th Edition), Printice-Hall of India Pvt. Ltd.
3. F. M. Stewart, *Introduction to Linear Algebra*, Dover Publications.
4. S. Kumaresan, *Linear Algebra*, Prentice Hall India Learning Private Limited.
5. Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2nd Edition), Prentice Hall India Leaning Private Limited.
6. Gilbert. Strang (2015), Linear Algebra and its applications, (2nd Edition), Elsevier.
7. Vivek Sahai & Vikas Bist (2013), Linear Algebra (2nd Edition) Narosa Publishing.
8. Serge Lang (2005), Introduction to Linear Algebra (2nd Edition), Springer India.
9. T. K. Manicavasagam Pillai and K S Narayanan, Modern Algebra Volume 2.

MATDSCP 6.1: Practical's on Linear Algebra	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming
- Solve problem on Linear Algebra studied in **MATDSCT 6.1 by** using FOSS software's.
- Acquire knowledge of applications of Linear Algebra through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS)

Suggested Software's: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program on linear combination of vectors.
2. Program to verify linear dependence and independence.
3. Program to find basis and dimension of the subspaces.
4. Program to verify if a function is linear transformation or not.
5. Program to find the matrix of linear transformation.
6. Program to find the Eigenvalues and Eigenvectors of a given linear transformation.
7. Program on Rank – nullity theorem.

8. Program to verify if the given linear transformation is singular/non-singular.
9. Program to find the minimal polynomial of given transformation.
10. Program to find the algebraic multiplicity of the Eigenvalues of the given linear transformation.
11. Program on diagonalization
12. Program on diagonalization.

MATDSCT 6.2: Numerical Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will get equipped with certain numerical techniques for various computations such as finding roots, finding the integrals and derivatives, and finding solutions to differential equations. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Describe various operators arising in numerical analysis such as difference operators, shift operators and so on.
2. Articulate the rationale behind various techniques of numerical analysis such as in finding roots, integrals and derivatives.
3. Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.
4. Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis.
5. Solve problems using suitable numerical technique
6. Appreciate the profound applicability of techniques of numerical analysis in solving real life problems and also appreciate the way the techniques are modified to improve the accuracy.

Unit – I: Algebraic and Transcendental Equations

Errors - Significant digits, absolute, relative, percentage errors, rounding off and truncation errors (meanings and related problems), general error formula (derivation of formula and problems based on it), error in series approximation: Taylor series approximations (problems only), Solutions to algebraic and transcendental equations - Bisection method, Regula-Falsi method, iterative method Newton-Raphson method and secant method (Plain discussion of the rationale behind techniques and problems on their applications). **15 Hours**

Unit – II: System of Linear Algebraic Equations

Direct Methods – Gauss elimination method, Gauss-Jordan elimination method and Tringularization method; Iterative methods – Jacobi method, Gauss-Jacobi method, Gauss-Seidal method, Successive-Over Relaxation method (SOR) method**.** **15 Hours**

Unit – III: Polynomial Interpolations

Finite differences**.** Forward, backward and central differences and shift operators: definitions, properties and problems; Polynomial interpolation - Newton-Gregory forward and backward interpolation formulas, Gauss's Forward and backward interpolation formulas, Lagrange interpolation polynomial, Newton's divided differences and Newton's general interpolation formula (Discussion on setting up the polynomials, differences between them and problems on their applications). **15 Hours**

Unit-IV: Numerical Differentiation an Integration

Formula for derivatives (till second order) based on Newton-Gregory forward and backward interpolations (Derivations and problems based on them). Numerical Integration - General quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule and Weddell's rule (derivations for only general quadrature formula, trapezoidal rule and Simpson's 1/3rd rule and problems on the applications of all formulas). **15 Hours**

Reference Books :

1. E. Isaacson and H. B. Keller, *Analysis of Numerical methods*, Dover Publications.
2. S. S. Sastry, *Introductory methods of Numerical Analysis*, 5th Edition, PHI Learning Private Limited.
3. E Kreyszig, *Advanced Engineering Mathematics*, Wiley India Pvt. Limited
4. B. S. Grewal, *Numerical Methods for Scientists and Engineers*, Khanna Publishers.
5. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering computation*, 4th Edition, New Age International
6. H. C. Saxena, *Finite Difference and Numerical Analysis,* S. Chand Publishers
7. B. D. Gupta, *Numerical Analysis*, Konark Publishers Pvt. Ltd.

MATDSCP 6.2: Practical's on Numerical Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming
- Solve problem on numerical Analysis studied in **MATDSCT 6.2 by** using FOSS software's.
- Acquire knowledge of applications of Numerical Analysis through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS)

Suggested Software's: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program to find root of an equation using bisection and Regula-Falsi methods.
2. Program to find root of an equation using Newton-Raphson and Secant methods.
3. Program to solve system of algebraic equations using Gauss-elimination method.
4. Program to solve system of algebraic equations using Gauss-Jordan method.
5. Program to solve system of algebraic equation using Gauss-Jacobi

method.

6. Program to solve system of algebraic equation using Gauss-Seidel method.
7. Program to solve the system of algebraic equations using SOR method
8. Program to evaluate integral using Simpson's 1/3 and 3/8 rules.
9. Program to evaluate integral using Trapezoidal and Weddle rules
10. Program to find the sums of powers of successive natural numbers using Newton – Gregory technique.
11. Program to find differentiation at specified point using Newton-Gregory interpolation method.
12. Program to find the missing value of table using Lagrange method.

MATDSCT 6.3: Special Functions and Calculus of Variations	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student develops basic understanding about some special functions such as beta, gamma, Bessel, Legendre, Laguerre, Hermite and Chebyshev polynomials. The broader course outcomes are listed as follow. At the end of this course, the student will be able to

1. Recall the definitions of various special functions such as beta, gamma, Bessel, Legendre, Laguerre, Hermite and Chebyshev.
2. Reproduce certain mathematical techniques to solve problems such as finding the convergence, divergence of improper integrals and finding series solution for second order linear differential equations
3. Set up recurrence relations and generating functions for various special functions
4. Apply the knowledge gained to various situations inside and outside mathematics.

Unit – I: Beta-Gamma Functions

Definitions, Properties and examples, relations between beta and gamma functions, standard theorems, applications of evaluations of definite integrals, duplication formula and applications. **15 Hours**

Unit – II: Bessel's and Legendre's Functions

Solution to differential equation - Ordinary, singular and regular points of second order linear differential equation, series solution when $x = 0$ is an ordinary point, Frobenious method.

Bessel's differential equation- Definition and discussion of its solutions; **Bessel's function** $J_n(x)$ - Definition, various recurrence relations for Bessel function (derivation), Generating function for $J_n(x)$ (derivation), value of $J1/2$ and expansions for J_0 and J_1 and related problems.

Legendre function - Discussion of solutions to Legendre's differential equation and Legendre polynomials $P_n(x)$ - Various recurrence relations (derivations), Generating function for $P_n(x)$ (derivation) –Orthogonality of Legendre Polynomials. **15 Hours**

Unit-III: Calculus of Variations

Introduction, Problem of Brachistochrone problem, problem of geodesics, isoperimetric problem, variation and its properties, functions and functionals, Variational Problems with Fixed Boundaries Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation. **15 Hours**

Unit-IV: Variational Problems with Moving Boundaries

Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation. **15 Hours**

Reference books:

1. G. E. Andrews, R. Askey and R. Roy, *Special Functions*, Cambridge University Press
2. S. Kanemitsu and H. Tsukada, *Vistas of special functions*, World Scientific.
3. G. B. Thomas, *Thomas Calculus*, 13th Edition, Pearson publication.
4. B. S. Grewal, *Higher Engineering mathematics*, Khanna Publications
5. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering*, Third Edition, Cambridge University Press.
6. H. K. Das, *Higher Engineering Mathematics*, S. Chand publishers.
7. A. S. Gupta (2004). Calculus of Variations with Applications. PHI Learning.
8. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications. CBS Publishers.
9. S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.
10. L. E. Elsgolc Calculus of Variations, Pergamon Press Ltd 1962.
11. R. Weinstock (1974), Calculus of Variations with applications to Physics and Engineering, Dover.

Electives

MATDSET 6.1(A): Number Theory	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student builds a basic understanding on Theory of Numbers. The broader course outcomes are listed as follow. At the end of this course, the student will be able to:

1. Achieve command of the definitions and concepts of Number Theory.
2. Exhibit certain properties of Divisibility, Congruence, GCD, LCM and so on.
3. Applies the gained knowledge to solve various other problems.

Unit – I: Basics of Number Theory

Mathematical Induction – Problems. Binomial Theorem (With Proof). Divisibility – Division Algorithm, Greatest Common Divisor, Least Common Multiple, Euclidean Algorithm & Euclid's Lemma, the Diophantine equation $ax + by = d$. Primes and their Distribution – The Fundamental Theorem of Arithmetic, The Sieve of Eratosthenes, Goldbach Conjecture & other famous conjectures in Number Theory. Congruence's – Basic Properties, Linear Congruence, Chinese Remainder Theorem (with proof), Fermat's Little Theorem (with proof), Wilson's Theorem (with proof). **15 Hours**

Unit –II: Arithmetical Functions

Arithmetical Functions - Multiplicative Functions **-** The Sum and Number of Divisors Function, Mobius Function; Properties and Mobius Inversion Formula, Euler's phi function **–** Properties, Euler's theorem, Relation between Euler's phi function and Mobius function. **15 Hours**

Unit – III: Primitive Roots and Quadratic Reciprocity Law

The order of an integer modulo n **–** properties. Primitive roots of primes. Qudratic Congruence – Quadratic residues and non-residues, Euler's criteria(with proof), Legendre Symbol – Properties & Problems, Gauss Lemma(with proof), Quadratic Reciprocity Law (with proof). **15 Hours**

Reference Books:

1. David M. Burton, Elementary Number Theory, Mc Graw Hill Publication.
2. Ivan Niven, Herbert S. Zuckerman and Hugh L. Montgomery, An Introduction to the theory of numbers, 5th edition, John Wiley & Sons, Inc.
3. Tom M.Apostol, Indroduction to Analytic Number Theory, Springer International Student edition.
4. Heng Huat Chan, Analytic Number Theory for Undergraduates, Singapore, World Scientific,Vol.3, 2009.
5. Dickson, Leonard Eugene, History of the Theory of Numbers, Washington, D. C. New York, 1966.

MATDSET 6.1(B): Continuum Mechanics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On completion of this course the students will be able to

1. Will develop basic understanding about continuum Mechanics in a sufficiently manner.
2. Will be able to appreciate a wide variety of advanced course in solid and fluid mechanics.
3. Derive conservation laws for mass, momentum and energy on local and global form.

UNIT-1.- Algebra of Tensors

Range and summation conventions, free and dummy suffixes, the symbol δ_{ij} *and* ε_{ij}.

Co-ordinate transformations, Cartesian tensors, Basic properties, Transpose of a tensor, Symmetric and Skew tensors, Dual vector of a skew tensor, scalar, vector and tensor functions, Comma notations, Gradient, Divergence and curl in tensor calculus, integral theorems for tensors . (15 hours)

UNIT-2- Continuum Hypothesis

Continuum Hypothesis, Deformation gradient, Stretch and rotation, Strain tensors, Strain- displacement relations, Infinitesimal strain tensor, compatibility conditions, Principalstrains. Material and local time derivatives, path lines, stream lines and vortex lines, Transport formulas. Vorticity and Circulation. (15 hours)

UNIT-3–Stress and Fundamental Laws of Continuum Mechanics

Body forces and surface forces, Stress components and stress tensor, Normal and shear stresses, Principal stresses. Stress deviator, Boundary condition for the stress tensor. Lawsof conservation of mass, Principles of Linear and angular momentum, Balance of energy. (15 hours)

Reference Books:

1. D. S. Chandrasekharaiah and L.Debanath: Continuum Mechanics, Academic Press,USA, 1994.
2. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
3. L. E. Malvern : Introduction to the Mechanics of a Continuous Media, Prentice Hall,1969.
4. T. J. Chung: Applied Continuum Mechanics, Cambridge University Press, 1996.
5. J N Reddy: An Introduction to Continuum Mechanics.
6. Rabindranath Chatterjee:Mathematical Theory of Continuum Mechanics .
7. John W. Rudnicki: Fundamentals of Continuum Mechanics ,Wiley.

MATDSET 6.1(C): Local Differential Geometry	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On completion of this course the students will

4. Will learn the fundamental notions and properties of curves and surface, as well as surface in three dimensions and
5. Learn some important basic structure of curvature and its properties towards the preparation for the further study of global properties of Differential Geometry.
6. Be able to recognize a wide range of advanced and application of Differential Geometry in Physics, Chemistry, Computer Sciences, Information Sciences, Architectural designs and in Engineering.

UNIT- I: Curves in the plane and in space:

What is curve? Arc-length, Reparameterization, Level curves, Level curves v/s parametric curves, curvature, Plane curves, Space curves and problems, **Curves in space-** Curves in space, Tangent line, order of contact of curves and surface, osculating plane, Principal and normal curvature, Fundamental theorem for space curves, osculating circle, Osculating sphere and Involutes and Evolutes and problems. **(15 hours)**

UNIT- II: Surface in three dimensions:

What is a surface? Smooth surface, Tangents, Normals, Orientability of surfaces, Examples of surface and quadric surface and problems. **(15 hours)**

UNIT- III: Curves on surface

Introduction, Curvilinear equations of the curve on surfaces, 1st Fundamental forms, 2nd Fundamental forms.

Curvature of surfaces: - Definition of curvature, Curvature of curves on a surface, Normal and principal curvature and problems **(15 hours)**

Reference Books

[1] K. K. Dube, *Differential Geometry and Tensors*, I. K. International Publishing House.

[2] Andrew Pressley, Elementary *Differential geometry*, Springer Undergraduate Mathematics series.

[3] Christian Bär, *Elementary Differential geometry*, Cambridge University Press.

[4] G. P. Sharma, *SolidGeometry*, Arise Publishers and Distributers, New Delhi.

Vocational - 2

MATDSVOC 6.1(A): Machine Learning	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On the completion of this course the students will

1. Understand the theory of machine learning and its types.
2. Learn the methods of supervised learning using regression.
3. Learn the concept of Neural network and unsupervised learning.
4. Become familiar with methods of deep learning and Convolution Neural Networks (CNN).

Unit – I :

Introduction to Machine Learning : Introduction to Machine Learning, Applications of Machine Learning, Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning, Dataset formats, Features and observations. **(6 Hours)**

Supervised Learning: Linear Regression, Logistic Regression**-** Linear Regression, Logistic Regression: Single and Multiple variables, Sum of squares error function, The Gradient descent algorithm: Application, The cost function, Classification using logistic regression, one-vs-all classification using logistic regression, Regularization. **(9 Hours)**

Unit – II

Supervised Learning: Neural Network**-** Introduction to Neural Network, Model representation, Gradient checking, Back propagation algorithm, Multi-class classification, Support vector machines, Applications & Use-cases. **(7 Hours)**

Unsupervised Learning: Clustering and Dimensionality Reduction**-** Introduction to Clustering, K means Clustering Algorithm, Cost function, Application, Dimensionality reduction, PCA- Principal Component Analysis Applications, Clustering data and PCA. **(8 Hours)**

Unit – III

Introduction to Deep Learning & CNN : What is deep learning? Difference between Machine Learning and Deep Learning, When to use Deep Learning? Deep Feed forward Networks, Example: Learning XOR, Convolution Neural Networks (CNN) – Convolutional Layer: Filters, Stacking Multiple Feature Maps, Tensor Flow Implementation, Pooling Layer, CNN Architectures. **(15 Hours)**

References:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition by Aurélien Géron, October 15, 2019, O'REILLY
2. Python Machine Learning Third Edition, 2019 Packt Publishing, Sebastian Raschka

Vahid Mirjalili, December 2019.

3. The Hundred-Page Machine Learning Book, Andriy Burkov, January 13, 2019.
4. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition by Andreas Müller, Sarah Guido, O'Reilly Media, November 15, 2016

List of Activities:

1. Introduction to Scikit, Numpy, Scipy and Tensor Flow
2. Linear Regression – Single Variable Linear Regression
3. Linear Regression – Multi Variable Linear Regression
4. Classification – Logistic Regression
5. Classification – Support Vector Machines (SVM)
6. Classification using Neural Networks
7. Unsupervised Learning – Principal Component Analysis (PCA)
8. Unsupervised Learning – K-Means Clustering
9.

MATDSVOC 6.1(B): Linear Programming	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 45 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: On successful completion of this course, the student will be able to :

1. Analyze solve the linear programming models of real life problems.
2. Able solve the Linear Programming Problems(LPP) involving two decision variable by graphical method by illustrating the concept of convex set and extreme points.
3. Understand the theory of simplex method solve LPP.
4. Understand the concepts of Primal and Dual LPP and sensitivity analysis
5. Learn the application of LPP to solve Transportation problems..

Unit – I: Linear Programming Problem (LPP)

Formulation, canonical and standard forms of LPP, Graphical method; Convex and Polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic feasible solutions, Reduction of feasible solution to basic feasible solution, correspondence between basic feasible solution and extreme points. Related Problems. **13 Hours**

Unit – II: Simplex and dual simplex method

Optimality criterion, improving a basic feasible solution, unboundedness, unique and alternate optimal solutions; simplex algorithm and its tableau format; Artificial variables, Two-Phase method and Big-M method. Examples on each method. Duality - Formulation of the dual LPP, Duality theorems, Complementary slackness theorem, Economic interpretation of the dual, Dual simplex method **15 Hours**

Unit – III: Sensitivity Analysis and Transformation Problems

Sensitivity Analysis – Change in the cost vector, right-hand side vector and the constraint matrix of LPP. Transportation Problem – Definition and formulation, methods of finding initial basic feasible solution: North-West Corner rule, Least cost method, Vogel's Approximation method; Transportation algorithm for obtaining optimal solution. **17 Hours**

References:

1. Hamdy A. Taha (2017), Operations Research: An Introduction (10th Edition), Pearson
2. G. Hadley (2002), Linear Programming, Narosa Publishing
3. S.D. Sharma (2017), Operations Research: Theory, Methods & Applications,(8th Revised Edition), Kedarnath Ram Nth, Delhi
4. Kanti Swarup; P.K. Gupta and Manmohan, Operations Research, S Cand & Sons