DEPARTMENT OF MATHEMATICS

SEMESTER SCHEME

B.TECH. MATHEMATICS AND COMPUTING

1st TO 8th SEMESTER

2024-25 ONWARDS

SEMESTER SCHEME

B.TECH. MATHEMATICS AND COMPUTING

Semester-I

Course ID	Course Name	L	T	P	Credits
OR2301	Orientation	-	-	-	1
OR2302	Introduction to Mathematics and Computing	1	0	0	1
MA2301	Calculus	3	0	2	4
CH2301	Applied Chemistry-I (ECE, VLSI, M&C & AI)	3	0	2	4
GS2302	Universal Human Values	1	0	0	1
ES2302	Engineering Drawing with CAD Software	2	0	4	4
ES2303	Skill Development Workshop	0	0	4	2
ES2307	Introduction to Product Design	0	0	4	2
ES2304	Introduction to Mechatronics	3	0	2	4
Total					**23**

Semester-II

Course ID	Course Name	L	T	P	Credits
MA2302	Linear Algebra, Differential Equations and Vector Calculus	3	0	2	4
PY2301	Electromagnetic Theory and Quantum Physics (ECE, VLSI, M&C & AI)	3	0	2	4
ES2301	Introduction to Computer Programming	3	0	2	4
GS2301	Introduction to Environmental Sciences	1	0	0	1
HS2351	Communication Skills	2	0	2	3
ES2305	Introduction to Electronics & Electrical Engineering (Aero, ECE & VLSI, AI & M&C)	3	0	2	4
Total					**20**

Semester-III

Course ID	Course Name	L	T	P	Credits
MCN301	Real Analysis	3	1	0	4
MCN302	Discrete Mathematics	3	1	0	4
MCN303	Groups and Rings	3	1	0	4
MCN304	Object Oriented Programming	3	0	2	4
MCN305	Data Structures	3	0	2	4
	Open Elective-I (MOOCs course)	3	0	2	3
	Total				**23**

Semester-IV

Course ID	Course Name	L	T	P	Credits
MCN401	Differential Equations	3	1	0	4
MCN402	Probability and Statistics	3	1	0	4
MCN403	Numerical Analysis	3	0	2	4
MCN404	Operating System and Processor Architecture	3	0	2	4
MCN405	Design and Analysis of Algorithms	3	0	2	4
	EVC by Wadhwani Foundation (Humanities, Social Sciences and Mgmt. -II)				3
	Total				**23**

Semester-V

Course ID	Course Name	L	T	P	Credits
MCN501	Number theory and Cryptography	3	0	2	4
MCN502	Artificial Intelligence	3	0	2	4
MCN503	Data Base Management System	3	0	2	4
MCN504	Theory of Computation	3	1	0	4
MCP511	Minor Project	0	0	8	4
	Total				**20**

Semester-VI

Course ID	Course Name	L	T	P	Credits
MCN601	Internship Training Part-I	0	0	12	6
MCN602	Internship Training Part-II	0	0	4	2
MCN603	Internship Training Part-III	0	0	8	4
or					
Optional Course Work					
	Department Elective Course-V	3	0/1	2/0	4
	Open Elective	3	0	2	4
MCP601	Project Work	0	0	8	4
	Total				**12**

Department Elective Course-V

Course ID	Course Name	L	T	P	Credits
MCE101	Optimization Techniques	3	0	2	4
MCE102	Stochastic Processes	3	1	0	4
MCE103	Principles of Programming Languages	3	0	2	4
MCE104	Internet of Things	3	0	2	4

Semester-VII

Course ID	Course Name	L	T	P	Credits
	Humanities, Social Sciences and Mgmt. III/ Humanities, Social Sciences and Mgmt. -IV				3
	Department Elective Course-I	3	1	0	4
	Department Elective Course-II	3	0	2	4
	Open Elective -II	3	0	2	4
MCP701	Major Project-I	0	0	8	4
	Total				**19**

Department Elective Course-I

Course ID	Course Name	L	T	P	Credits
MCE105	Graph Theory	3	1	0	4
MCE106	Queuing Theory and Application	3	1	0	4
MCE107	Algebraic Coding Theory	3	1	0	4
MCE108	Applied Computational Methods	3	1	0	4

Department Elective Course-II

Course ID	Course Name	L	T	P	Credits
MCE109	Data Science and Machine Learning	3	0	2	4
MCE110	Software Engineering	3	0	2	4
MCE111	Computer Networks	3	0	2	4
MCE112	Computer Graphics	3	0	2	4

Semester-VIII

	Course Name	L	T	P	Credits
	Humanities, Social Sciences and Mgmt. -IV/ Humanities, Social Sciences and Mgmt. -III				3
	Department Elective Course-III	3	1	0	4
	Department Elective Course-IV	3	0	2	4
	Open Elective-III	3	0	2	4
	Proficiency	0	0	4	2
MCP801	Major Project-II	0	0	8	4
	Total				**21**

Department Elective Course-III

Course ID	Course Name	L	T	P	Credits
MCE113	Complex analysis	3	1	0	4
MCE114	Game Theory	3	1	0	4
MCE115	Operations Research	3	1	0	4
MCE116	Linear Algebra and Applications	3	1	0	4

Department Elective Course-IV

Course ID	Course Name	L	T	P	Credits
MCE117	Generative Artificial Intelligence	3	0	2	4
MCE118	Soft Computing	3	0	2	4
MCE119	Mobile Computing and Sensor Networks	3	0	2	4
MCE120	Image Processing	3	0	2	4

OPEN ELECTIVE COURSES

S. No.	Course ID	Course Name	L	T	P	Credits
1.	MCO101	Optimization Techniques	3	1	0	4
2.	MCO102	Algebra	3	1	0	4
3.	MCO103	Number Theory	3	1	0	4
4.	MCO104	Fourier Series and Integral Transforms	3	1	0	4
5.	MCO105	Algebraic Coding Theory	3	1	0	4
6.	MCO106	Topology	3	1	0	4
7.	MCO107	Numerical Analysis	3	1	0	4
8.	MCO108	Partial Differential Equations and Special Functions	3	1	0	4

MINOR SPECIALIZATION IN MATHEMATICS

S.No.	Course ID	Course Name	L	T	P	Credits
1.	MCM101	Operations Research	3	1	0	4
2.	MCM102	Complex Analysis	3	1	0	4
3.	MCM103	Probability And Statistics	3	1	0	4
4.	MCM104	Minor Specialization Project-I*	-	-	-	3
5.	MCM105	Minor Specialization Project-II*	-	-	-	3

*The students will be guided for interdisciplinary project.

HONOURS IN MATHEMATICS

Course ID	Semester	Course Name	L	T	P	Credits
MCH101	V	Honours Project – I	0	0	6	3
MCH102	VII	Honours Project – II	0	0	8	4
MCH103	VIII	Honours Project – III	0	0	10	5
	Total					**12**

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	OR2302	Introduction to Mathematics and Computing	1	0	0	1
2	MA2301	Calculus	3	0	2	4
3	MA2302	Linear Algebra, Differential Equations and Vector Calculus	3	0	2	4

Course Name	**:**	**Introduction to Mathematics and Computing**
Course Code	**:**	**OR2302**
Credits	**:**	**1**
L T P	**:**	**1 0 0**

Course Objectives:
Student should be able ● To analyze the basic concepts of proof techniques ● To explore the various disciplines in Mathematics and Computing

Total No. of Lectures – 14

Lecture wise breakup		**No. of Lectures**
Unit 1	Set theory, Introduction to mathematical structures, Introduction to various techniques of proof	**6**
Unit 2	Basics of number system, Introduction to algorithms, Basics of operating systems, Artificial intelligence, Computer networks	**5**
Unit 3	Emerging and future trends and challenges in various fields of mathematics and computing, along with an exploration of career and professional development opportunities.	**3**

Course Outcomes:	
1	Explain the mathematical proof techniques
2	Illustrate the various fields of Mathematics and Computing

Text Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Elementary Linear Algebra, Stephan Andrilli, & David Hecker, 5th edition, Elsevier India	2016
2	Mathematics for Computer Science, Eric Lehman, F Thomson Leighton & Albert R Meyer	2018
3	Computing Fundamentals, Peter Nortan, 4th Ed., Tata McRaw Hill	2000

Course Name	**:**	**CALCULUS**
Course Code	**:**	**MA2301**
Credits	**:**	**4**
L T P	**:**	**3-0-2**
Total No. of Lectures	**:**	**42**

Course Objectives:
At the end of the semester, the students should be able to

1	Understand the behavior of infinite series and their use.
2	Learn the concepts related to differential calculus of functions of several variables and their applications.
3	Learn the concept and methods of evaluating multiple integrals and their applications to various problems.

	Lecture wise breakup	**No. of Lectures**
1	**INFINITE SERIES** Limits of sequences of numbers, Theorems of calculating limits of sequences, Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series. (Scope as in Chapter 8, Sections 8.1 – 8.9 of Text Book 1).	12
2	**DIFFERENTIAL CALCULUS** Functions of several variables, Limits and continuity, Partial Derivatives, Euler's Theorem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula**.** (Scope as in Chapter 12, Sections 12.1 – 12.6, 12.8 – 12.10 of Text Book 1).	14
3	**INTEGRAL CALCULUS** Parametrization of plane curves, Polar coordinates, Graphing in Polar coordinates, Cylinders and Quadric surfaces, Double integrals in Rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical Coordinates, Substitutions in Multiple integrals. Applications to practical problems.	16

	(Scope as in Chapter 9, Sections 9.4, 9.6 and 9.7, Chapter10, Sections10.6 and 10.7 and Chapter 13, Sections 13.1, 13.3, 13.4,13.6 and 13.7 of Text Book 1).	

Course Outcomes:
At the end of the semester, the students are able to

1	Test the behavior of infinite series.
2	Apply the concepts of differential calculus of functions of several variables.
3	Evaluate multiple integrals and apply them to practical problems.

Text Books:

1	Calculus and Analytic Geometry, Thomas and Finney, 9th edition, Pearson Education Asia.	2006

Reference Books:

1	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	2003

Practical / Lab work to be performed using Mathematica/ Matlab

1. Study the convergence of sequences through plotting.
2. Analyze the convergence of infinite series by plotting their sequences of partial sums.
3. Study the convergence of infinite series using Cauchy's root test and Ratio test
4. Taylor and Maclaurin series of trigonometric, logarithmic, hyperbolic functions.
5. Plotting 2D curves in rectangular and polar coordinates.
6. Plotting 3D surfaces.
7. Find critical points and identify local maxima, local minima or saddle points
8. Draw the surfaces and analyze the existence of limits as they approach the specified points.
9. Check the continuity of functions
10. Draw the surfaces and find level curves at the given heights

Course Name	**:**	**LINEAR ALGEBRA, DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS**
Course Code	**:**	**MA2302**
Credits	**:**	**4**
L T P	**:**	**3-0-2**
Total No. of Lectures	**:**	**42**

Course Objectives:

At the end of the semester, the students should be able to

1	Learn the various concepts associated with real vector spaces and theory of matrices
2	Learn the methods to solve ordinary differential equations of various types.
3	Learn the various concepts of vector calculus and their applications to problems.

	Lecture wise breakup	**No. of Lectures**
1	**ALGEBRA** Vector spaces over reals, Linear dependence, Basis, Dimension, Co-ordinates with respect to a basis, Change of basis, Subspace, Linear transformation $R^n \rightarrow R^m$, Range space and Rank, Null space and Nullity, Rank and Nullity relation, Matrix representation of a linear transformation, Similar matrices, Invertible linear transformation, Eigenvalues and eigenvectors, Cayley Hamilton theorem, Diagonalization of a matrix.	16
2	**ORDINARY DIFFERENTIAL EQUATIONS** First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian. .	12

3	**VECTOR CALCULUS** Gradient, Divergence and Curl – their physical interpretation, Line, Surface and Volume integrals, Green's theorem in the plane, Stoke's theorem, Divergence theorem, Applications to Science and Engineering.	14

Course Outcomes:

At the end of the semester, the students are able to

1	Solve the various problems related to real vector spaces and theory of matrices
2	Solve ordinary differential equations of various types
3	Apply various concepts of vector calculus to problems.

Text Books:

1	Introductory Linear Algebra with Applications, Kolman, B. and Hill,D.R., 7th edition, Pearson Education	2001
2	Advanced Engineering Mathematics, Kreyszig, 8th edition, John Wiley and Sons.	2005

Reference Books:

1	Differential Equations, S. L. Ross, John Wiley and Sons, India	2004
2	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	2003
3	Differential Equations, Frank Ayers, SI edition, Mc Graw Hill.	1972

Practical / Lab work to be performed using Mathematica/ Matlab

1. Perform basic Matrix operations.
2. Find rank, eigenvalues and eigenspace of matrices.
3. Check diagonalizability of matrices.
4. Solve ordinary differential equation.
5. Plotting of second order solution family of differential equation.

6. Plotting of third order solution family of differential equation.
7. Plotting of vector fields.
8. Find Gradient, Divergence and Curl.
9. Computation of line integrals and surface integrals.
10. Verify Green's theorem in the plane, Stoke's theorem, Divergence theorem.

Detailed Syllabus

B.TECH. MATHEMATICS AND COMPUTING

3rd TO 8th SEMESTER

2024-25 ONWARDS

Semester-III

Course ID	Course Name	L	T	P	Credits
MCN301	Real Analysis	3	1	0	4
MCN302	Discrete Mathematics	3	1	0	4
MCN303	Groups and Rings	3	1	0	4
MCN304	Object Oriented Programming	3	0	2	4
MCN305	Data Structures	3	0	2	4
	Total				**20**

Course Name	**REAL ANALYSIS**
Course Code	**MCN301**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:
Students should be able • To develop the deep understanding of fundamental concepts of real numbers • To explore the concepts of sequence and their limits • To analyze the concept of continuity of functions • To analyze the concept of differentiability of functions

Lecture wise breakup		**No. of Lectures**
Unit 1	**Fundamental Properties of Real Numbers:** The algebraic and order properties of R, suprema and infima, the completeness property of $\mathbb{R}$, the Archimedean property, density of rational numbers in $\mathbb{R}$, characterization of intervals, neighborhoods, open sets, closed sets, limit points of a set, isolated points, closure, complements, idea of uncountability of $\mathbb{R}$	**12**
Unit 2	**Sequences and their Limits**: Sequences and their limits, Convergent sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion	**12**
Unit 3	**Continuous Functions and their Properties**: Limits of functions, sequential criterion for limits, divergence criteria, review of limit theorems and one-sided limits, Continuous functions and its properties on closed and bounded intervals, Uniform continuity	**10**
Unit 4	**Differentiability and related Theorems**: Differentiability of a real-valued function, Algebra of differentiable functions, Chain rule, Relative extrema, Interior extremum theorem, Rolle's theorem, Mean-value theorem and its applications, Intermediate value theorem for derivatives	**8**

Course Outcomes:	
1	Understand the fundamental properties of the real numbers, including completeness and Archimedean and density property of rational numbers in $\mathbb{R}$
2	Interpret the behavior of sequences and their limits
3	Analyze the concept of limits of functions and explain various properties of continuous functions
4	Illustrate the basic concepts of differentiation and explain various properties of differentiable functions

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Introduction to Real Analysis, R. G. Bartle and D. R. Sherbert, 4th edition, John Wiley and Sons, Inc.	2011
2	Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Ross, Kenneth A., 2nd edition, Springer. Indian reprint	2013
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Elementary Real Analysis, Thomson, B. S., Bruckner, A. M. & Bruckner, J. B., Prentice Hall.	2001

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	https://archive.nptel.ac.in/courses/111/106/111106053/	NPTEL
2	https://archive.nptel.ac.in/courses/111/106/111106142/	NPTEL
3	https://archive.nptel.ac.in/courses/111/101/111101134/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	-	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	-	1
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	-	1
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	-	1

1-Low, 2-Medium, 3-High

Course Name	**Discrete Mathematics**
Course Code	**MCN302**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:
Students should be able • To explore different proof techniques • To analyze certain discrete structures and their theory • To develop the role of discrete structure in modelling applications • To apply the applications of discrete structures in computing

Lecture wise breakup		**No. of Lectures**
Unit 1	Logic: Propositional and predicate and proof techniques.	**09**
Unit 2	Generating function of a sequence, construction of generating function for a sequence finding coefficients of X^n in an expression, Introduction to recurrence relations Recurrence relation models, homogeneous and non homogeneous recurrence relations	**11**
Unit 3	Basics of graphs and their representations: undirected graphs, example of graphs, degree of vertex, connected graphs, regular graphs, adjacency matrices of graphs, graph isomorphism, trees, MST problem, vertex connectivity and edge connectivity.	**13**
Unit 4	Hamiltonian, Eulerian, and planar graphs, Coloring, matching and max. flows	**09**

Course Outcomes:	
1	Discuss the concept of predicates and quantifiers
2	Interpret the basic concept recurrence relation and generating functions
3	Apply the basics of graph theory and find the minimum number of spanning trees by using MST algorithm
4	Analyze the graph theoretic properties such as Hamiltonian graphs, Eulerian graphs and give some examples.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Mott , Kandel, & Baker : Discrete Mathematics for Computer Scientists & Mathematicians PHI	2003
2	G. Chartrand and P. Zhang, A First Course in Graph Theory (Dover Publications).	2012
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**

		/ Reprint
1	Trembly and Manohar, Discrete Mathematical Structures with applications to computer science, TMH.	1997
2	D. B. West, Introduction to Graph Theory, 2nd edn. (Prentice Hall)	1996

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Discrete Mathematics https://onlinecourses.nptel.ac.in/noc20_cs82/preview	NPTEL
2	Discrete Mathematical Structures https://www.digimat.in/nptel/courses/video/106106094/L01.html	NPTEL
3	Discrete Mathematics https://archive.nptel.ac.in/courses/111/107/111107058/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	-	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	-	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	2	2	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	2	2	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Groups and Rings**
Course Code	**:**	**MCN303**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Student should be able

- To explore the basic concepts of group theory
- To apply the Lagrange's and Euler's theorems to solve problems related to groups
- To analyze the normal subgroups, quotient groups, and homomorphisms
- To develop a deep understanding of the fundamental concepts of ring theory

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Groups:** Definition and examples of groups, Elementary properties of groups, Order of a group, Order of an element, Subgroups and examples of subgroups, Center of a group, Properties of cyclic groups, Classification of subgroups of cyclic groups.	**12**
Unit 2	**Properties of Groups:** Permutation groups, Properties of permutations, Isomorphisms, Cayley's theorem, Properties of isomorphism, Automorphisms, Properties of cosets, Lagrange's theorem and consequences, Normal subgroups and factor groups, Cauchy's theorem for finite abelian groups, Group homomorphism, Properties of homomorphism, First isomorphism theorem.	**16**
Unit 3	**Rings:** Definition and examples of rings, Subrings, Integral domain, Fields, Characteristic of a ring, Ideals, Factor rings, Prime ideals and maximal ideals.	**14**

Course Outcomes:	
1	Define and illustrate the concept of groups, subgroups, and cosets
2	Explain the application of Lagrange's theorem in group theory
3	Interpret the significance of normal subgroups, quotient groups, and homomorphisms
4	Analyze the concept of isomorphisms
5	Discuss the fundamental concepts of ring theory

Text Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Contemporary Abstract Algebra, Joseph A. Gallian, (4th Edition), Narosa Publishing House, New Delhi	1999
2	Topics in Algebra, Herstein, I.N., 2nd edition, Wiley Eastern Limited, New Delhi.	1981

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Modern Algebra, Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
2	Rings and Modules, Musili, C, Narosa Publishing House, 2nd Edition, New Delhi.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Introduction to abstract group theory, https://archive.nptel.ac.in/courses/111/106/111106113/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	1
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	1
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	1
CO5	1	2	3	1	1	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Object Oriented Programming**
Course Code	**:**	**MCN304**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able

- To differentiate between procedure-oriented programming and object-oriented programming and to specify simple abstract data types
- To recognize features of object-oriented design such as encapsulation, polymorphism,inheritance and composition of systems based on object identity.
- To use object-oriented programming language like C++ and associated library todevelop object-oriented programs.
- To understand and to use basic fundamentals of object-oriented programming.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Introduction to Object Oriented Programming and Design** Abstraction, Object, Encapsulation, Information hiding, Method,Signature, Classes and Instances, Polymorphism, Inheritance.	5
2	**Programming Basics** Fundamentals: Variables and assignments, Input and Output, Data Types and Expressions, Flow of control, Subprograms: Top down design, Predefined functions, user defined functions, Procedural abstractions, Local variables, Parameter passing, arrays.	5
3	**Classes** Defining classes and member functions, public and private members, constructors for initializations, destructors, copy constructors, staticfunctions, friend functions, this pointer.	8
4	**Overloading** Overloading unary operations, Overloading binary operators, Overloading the assignment operator, data conversion, pitfalls of operator overloading and conversion.	5
5	**Inheritance** Concept of inheritance, derived class and based class, derived class constructors, member function, class hierarchies, types of inheritance,aggregation: Classes within classes.	7
6	**Pointers and virtual functions** The address of operator, pointer, dynamic memory management-new and delete, pointers to objects, virtual function, Assignment and copyinitialization	7

7	**Stream and Classes** Streams classes, Stream Errors, Disk File I/O with streams, filepointers.	5

List of Experiments:		**Number of Turns**
1	Program to define the data types, variable, operators, arrays and control structures.	2
2	Program to define class and constructors and demonstrate constructors.	2
3	Program to define class, methods and objects and demonstrate method overloading.	2
4.	Program to define inheritance and show method overriding.	2
5.	Program to demonstrate run time polymorphism	2
6.	Program to demonstrate Exception Handling	2
7.	Program to demonstrate I/O operations	2

Course Outcomes: At the end of the course, students will be able to:	
1	Able to differentiate between structure oriented programming and object oriented programming and to specify simple abstract data types and design implementations
2	Recognize features of object-oriented design such as encapsulation, polymorphism,inheritance and composition of systems based on object identity.
3	Able to use object oriented programming language like C++ and associated library to develop object oriented programs
4	Able to understand and to use basic fundamentals of object oriented programming

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Herb Schildt: C++ - The Complete Reference, TMH, Delhi	1998

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	R.Venugopal :Mastering C++,TMH, Delhi	2015
2.	Bruce Eckel : Thinking in C++ Volume I , Pearson Education, Delhi.	2000
3.	Horstmann: Computing Concepts with C++ Essentials, John Wiley.	2004

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1.	https://archive.nptel.ac.in/courses/106/105/106105151/	NPTEL
2.	https://www.coursera.org/learn/concepts-of-object-oriented-programming	Coursera
3.	https://www.coursera.org/specializations/object-oriented-programming-s12n	Coursera

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	1	1	-	-	1	1	1	-	2	-	3	2
CO2	3	3	3	1	1	-	-	1	2	1	-	2	-	3	2
CO3	2	2	3	1	1	-	-	1	1	1	-	2	-	3	2
CO4	3	1	3	1	1	-	-	1	2	1	-	2	-	3	2
1-Low, 2-Medium, 3-High															

Course Name	**:**	**Data Structures**
Course Code	**:**	**MCN305**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
Students should be able - • To learn and understand efficient storage mechanisms of data for an easy access. • To design and implement various basic and advanced data structures. • To get familiar with basic data structures and their use in fundamental algorithms • To improve the efficiency of algorithm by using suitable data structure.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Review:** Classes, Pointers, Recursion, Time and Space Complexity of Algorithms, Recurrence relations, Solving recurrence relations using Substitution Method	**5**
Unit 2	**Linked Lists:** Introduction to linked list, Insertion-Deletion-Search in linked list, Doubly Linked List and Circular Linked List, **Applications of linked list:** Sparse Matrix Storage, Polynomial operations etc.	**5**
Unit 3	**Stacks:** Introduction to Stacks, implementation of stack using arrays and linked list **Applications of Stacks:** Balanced brackets, Infix to postfix conversion, postfix evaluation etc.	**5**
Unit 4	**Queues:** Introduction to queues, implementation of queue using arrays and linked list **Application of queues:** Job scheduling in CPU etc.	**5**
Unit 5	**Trees:** Introduction to trees and related terminologies, representations and implementations of trees in a program, Binary Tree, Traversals in binary tree, BFS-DFS in binary tree	**5**
Unit 6	**Binary Search Tree (BST):** Insertion-Deletion-Search in BST, AVL and B-Tree	**5**
Unit 7	**Graphs:** Introduction to graphs & related terminologies, representations and implementations of graphs in a program, Graph traversals, Dijkstra's Algorithm for Single Source Shortest Path, Minimum Spanning Tree using Prim's and Kruskal's Algorithms, Union-Find Data Structure	**6**
Unit 8	**Advanced Data Structures:** Heaps, implementations of priority queue using heaps; Hashing; Indexing	**6**

List of Experiments:		**Nos of Turns**
1.	Write programs implementing pointers	1
2.	Write programs implementing recursion	1
3.	Write programs implementing singly linked list	1
4.	Write programs implementing doubly and circular linked list	1
5.	Write programs implementing stacks	1
6.	Write programs implementing applications of stacks	1
7.	Write programs implementing queues	1
8.	Write programs implementing applications of queues	1
9.	Write programs implementing binary trees	1
10.	Write programs implementing different traversals in binary tree	1
11.	Write programs implementing insertion-deletion-search in BST	1
12.	Write programs implementing insertion-deletion-search in AVL	1
13.	Write programs implementing different representations of graphs	1
14.	Write programs implementing Prim's and Kruskal's Algorithms	1

Course Outcomes: At the end of the course, students will be able to	
1.	Understand and compare different data structures for solving a programming problem
2.	Implement various data structures in programs to solve computational problems
3.	Compute time and space requirements of a solution and compare different solutions
4.	Modify data structures to design solutions for programming problems

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Fundamentals of Data Structures in C++ by Ellis Horowitz, Sartaj Sahni, and Dinesh Mehta, W. H. Freeman	2nd edition, 2006
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	An introduction to data structures with applications, By J.P. Tremblay and P.G. Sorensen, TMH.	2nd edition, 2007
2.	Data Structures and Algorithm Analysis in C++ by M.A.Weiss, Pearson Education	3rd edition, 2007

3.	Data Structures and Algorithms, by A.V. Aho, J.E. Hopcroft and J.D. Ullman	1st edition, 1982

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1.	https://onlinecourses.swayam2.ac.in/cec23_cs09/preview	Swayam
2.	https://www.coursera.org/learn/data-structures	Coursera
3.	https://www.udemy.com/course/datastructurescncpp/	Udemy

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	–	–	–	–	–	1	1	–	3	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	–	3	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	–	3	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	–	3	2
1-Low, 2-Medium, 3-High															

Semester-IV

Course ID	Course Name	L	T	P	Credits
MCN401	Differential Equations	3	1	0	4
MCN402	Probability and Statistics	3	1	0	4
MCN403	Numerical Analysis	3	0	2	4
MCN404	Operating System and Processor Architecture	3	0	2	4
MCN405	Design and Analysis of Algorithms	3	0	2	4
	Humanities, Social Sciences and Mgmt. -II				3
	Total				**23**

Course Name	**DIFFERENTIAL EQUATIONS**
Course Code	**MCN401**
Credits	**4**
L T P	**3-1-0**

Course Objectives:

Students should be able –

- To explore the differential Equations, and their systems
- To enable students to form and solve partial differential equations
- To analyze simultaneous system of ODEs
- To apply the concepts of differential equations to check the stability and nature of equilibrium point
- To develop the understanding of the Sturm-Liouville boundary value problem

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Differential Equations:** Basic definitions (linearity, order, homogeneous and nonhomogeneous, explicit and implicit solution, general solution, particular solution). Existence and uniqueness theorem for linear ODE. Review of First order ODE Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, First order higher degree equations solvable for x, y, p. Singular solution and envelopes.	**12**
Unit 2	System of first order ODEs, Sturm-Liouville boundary value problem, system Non-Linear Differential Equations, Phase plane, critical points and their various types, stability, Limit Cycles, Periodic Solutions. Partial differential equations – Basic concepts and definitions. Formation of PDE, Mathematical problems. First order equations: classification, construction and geometrical interpretation,	**16**
Unit 3	Lagrange's and Charpit's method for solving PDE. Method of characteristics for obtaining general solution of quasi linear equations. Classification of second order linear equations as hyperbolic, parabolic or elliptic, Canonical forms of first-order linear equations. Method of separation of variables for solving first order partial differential equations.	**14**

Course Outcomes:	
1	Discuss the systems of first-order ordinary differential equations (ODEs), including Sturm-Liouville boundary value problems.
2	Analyze first-order higher degree equations for x, y, and p and understand the

	concepts of singular solutions and envelopes
3	Interpret nonlinear differential equations and their behavior in phase planes.
4	Apply the Lagrange's and Charpit's methods for solving PDEs and understanding the method of characteristics.
5	Discuss the classification of second-order linear PDEs as hyperbolic, parabolic, or elliptic and understand their canonical forms.

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004	2017
2	Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.	2006

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	L. Perko, Differential Equations and Dynamical Systems, Texts in Applied Mathematics, Vol. 7, 2nd Edition, Springer Verlag, New York, 1998	1998
2	Differential Equations, Dynamical Systems and Introduction to Chaos, Academic Press,2004	2004

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	3	–	–	–	–	–	1	1	3	–	2
CO2	1	1	2	1	3	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	3	3	1	2
CO5	2	2	1	1	3	–	–	–	–	–	2	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	PROBABILITY AND STATISTICS
Course Code	MCN402
Credits	4
L T P	3-1-0

Total No. of Lectures – 42

Course Objectives

Students should be able –

- To develop understanding of the theoretical foundations of random variables and probability theory.
- To analyze the different types of probability distributions and their properties.
- To explore random variables in statistics, machine learning, and other fields.
- To apply statistical estimation procedures to estimate population parameters from sample data.
- To apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters.

Lecture wise breakup		No. of Lectures
Unit 1	**Random Variables:** Random variables, Discrete, Continuous and Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Expectation, Variance and Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality.	**10**
Unit 2	**Probability Distributions:** Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial, Moments, Moment generating function.	**10**
Unit 3	**Sampling Distributions:** Population, Sample, Sampling distributions, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution.	**7**
Unit 4	**Estimation:** Estimation of parameters, Point estimate, Confidence interval for mean, Difference of means and proportions.	**6**
Unit 5	**Tests of Hypotheses:** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and two samples tests for mean and proportion.	**9**

Course Outcomes:	
1	Define and explain the key concepts of random variables and probability theory, including discrete and continuous random variables, probability distributions, expectation, variance, and covariance.
2	State the different types of hypothesis tests and estimation procedures, and identify the appropriate test or procedure to use for a given problem.
3	Calculate the expectation, variance, and covariance of random variables.

4	Apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7th edition, Pearson Education	2006
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Miller and Freund's: Probability and Statistics for Engineers, Richard A. Johnson, C.B. Gupta, Pearson Education.	2006
2	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education.	2004
3	A First Course in Probability, Sheldon Ross, 6th edition, Pearson Education Asia	2002

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Probability Theory and Applications https://nptel.ac.in/courses/111104079	NPTEL
2	Introduction to Probability Theory and Statistics https://nptel.ac.in/courses/111102160	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	3
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	3
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	1	2

1-Low, 2-Medium, 3-High

Course Name	**NUMERICAL ANALYSIS**
Course Code	**MCN403**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:
Students should be able – • To explore various computational techniques to find approximate value for possible root(s) of non-algebraic equations, • To analyze the approximate solutions of system of linear equations and ordinary differential equations. • To apply numerical techniques to find the value of an Integration • To explore the convergence of various methods for finding the root

Lecture wise breakup		**No. of Lectures**
Unit 1	Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation. Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-Falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods	**12**
Unit 2	System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis, Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation: Methods based on interpolations, methods based on finite differences	**15**
Unit 3	Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Boole's Rule. midpoint rule, Composite trapezoidal rule, composite Simpson's 1/3rd rule, Gauss quadrature formula. Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four	**15**

Course Outcomes:	
1	Define and discuss about sources of error in numerical computations and techniques for error analysis, including round-off error, truncation error, and propagation of errors.
2	Apply various numerical methods to solve mathematical problems, including root finding, interpolation, approximation of functions, numerical integration, and solving ordinary differential equations.
3	Analyze the roots of equations using methods such as bisection method, Newton-Raphson method, secant method, and fixed-point iteration.

4	Illustrate techniques for interpolating data points using methods such as Lagrange interpolation, Newton interpolation,
5	Apply the various numerical methods to approximate definite integrals and to solve the initial value problems of ordinary differential equations.

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). *Numerical Methods for Scientific and Engineering Computation*. (6th ed.). New Age International Publisher, India, 2016.	2016
2	Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007	2007

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Süli, Endre, and David F. Mayers. *An introduction to numerical analysis*. Cambridge university press, 2003.	2003
2	Sastry, Shankar S. *Introductory methods of numerical analysis*. PHI Learning Pvt. Ltd., 2012.	2012

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	3	–	–	–	–	–	1	1	3	1	2
CO2	1	1	2	1	3	–	–	–	–	–	1	1	3	1	3
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	3	3	1	3
CO5	2	2	1	1	3	–	–	–	–	–	2	1	3	1	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Operating Systems and Processor Architecture**
Course Code	**:**	**MCN404**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Total No. of Lectures – 42

Course Objectives:
Students should be able – • Describe the purpose, structure and functions of operating system. • Understand system calls • Understand the file system, processes synchronization, process scheduling • Explore the common C constructs, such as loops, procedures, control flow are represented in hardware.

Lecture wise breakup		**Number of Lectures**
1	**CONCEPTS OF OPERATING SYSTEMS:** Computer system overview, concept of an operating system, multiprogramming, multiprocessing, multi user, time sharing, Multitasking, personal system, parallel system, real time system, general system architecture, System components, operating system services, system calls,system programs, system structure, Approaches to OS design and implementation	**10**
2	**PROCESSES MANAGEMENT:** Concept of process, process states, process state transitions, process control block, operations on processes, Process scheduling , scheduling criteria, Inter process Communication, Concurrent processes	**4**
3	**MEMORY MANAGEMENT:** Logical and physical address space, storage allocation and management techniques, swapping concepts of multi programming, paging, segmentation, virtual Memory, demand paging,	**4**
5	**INPUT/OUTPUT AND DATA MANAGEMENT:** Directory structure and implementation, protection file system structure, allocation methods, free space management, Storage management, buffering, swap space management, RAID Technologies.	**4**
6	**Concepts of processor architecture and Representing and manipulating information:** Representation of a program as bits, compilation system: source – assembly – executable, processor reading and interpreting instructions stored in memory, hardware organization of a system: buses, I/O devices, main memory, processor, steps involved in running “hello world” program on the hardware, caching. Binary, decimal, hexadecimal notation for representing code and data, Boolean algebra, computer arithmetic.	**5**

7	**Machine level representation of programs and Processor Architecture:** Machine level code, data formats, operand specifiers, data movement instructions, control flow, loops, procedures, run-time stack. X86 or similar instruction set architecture, instruction encoding, logic gates, clock cycle, stages of processor processing (fetch, decode, execute), pipelining, pipeline hazards.	**9**
8	**CASE STUDIES:** Linux/Unix/Windows/Android OS design and architecture, Unix shell, Unix operating system services, user Interfaces, representation of files in Unix system processes and their structure, input-output system, memory management in Unix.	**6**

List of Experiments:		**No. of Turns**
1	Execution of various scripts using shell programming	**4**
2	Application development in Android	**4**
3	Use the system calls of UNIX/Linux operating system: mkdir, rmdir, link, unlink, mount, chown, chmod, getuid, setuid, fork,wait, exec, exit, kill, getpid,brk, nice, sleep, trace, open, close,read, write, lseek, stat, sync	**4**
4	Use the following system calls of UNIX operating system: signals, pipe, socket, accept, snd, recv, connect	**2**
5	Use processor simulators, such as Y86-64, to code and execute a variety of programs.	**2**

Course Outcomes:	
1	Understanding of design issues associated with operating systems
2	Analyze the working of an operating system and its components.
3	Analyze the synchronization in processes
4	Understand how common C constructs, such as loops, procedures, control flow are represented in hardware.
5	Understand how a processor executes and optimizes C programs.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Operating system, Galvin & Silberschatz, John Willey	Latest edition

2.	Computer Systems: A programmer's perspective, by Randal E. Bryant and David R. O'Hallaron, third edition, Pearson India.	2015

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Operating Systems-A Concept Based Approach By Dhamdhare, TMH	Latest edition
2.	Operating systems Internals and design principles By William Stallings,Pearson Education	Latest edition
3.	Operating Systems –A Design Oriented approach By Crowley, TMH	Latest edition
4.	Operating systems Design and Implementation By Andrew S. Tanenbaum, Pearson Education	Latest edition

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1.	https://onlinecourses.nptel.ac.in/noc20_cs04/preview	NPTEL
2.	https://www.udacity.com/course/introduction-to-operating-systems-- ud923	UDACITY

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	3	-	-	-	-	-	-	-	3	3
CO2	2	1	1	3	3	-	-	-	-	-	-	-	-	3	1
CO3	2	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO4	2	2	3	2	-	-	-	-	-	-	-	-	-	3	3
CO5	2	2	3	2	-	-	-	-	-	-	-	-	-	3	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Design and Analysis of Algorithms**
Course Code	**:**	**MCN405**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
Students should be able - • To analyze various algorithms mainly for time and space complexity • To develop algorithm for solving various computational problems by applying variousalgorithm design strategies • To understand the effect of choice of data structures on the complexity of algorithm • To understand about P, NP, NP-H and NP-C class problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Review:** Notion of Algorithms, Pseudocode, Time and Space Complexity of Algorithms, Analysis of recursive and non-recursive algorithms	**5**
Unit 2	**Brute Force:** Selection sort, Bubble sort, Insertion Sort, Sequential searching (Linear Search), Brute force string matching	**5**
Unit 3	**Divide and Conquer:** General method, Merge sort, Quick Sort, Binary Search, Strassen's matrix multiplication	**5**
Unit 4	**Greedy Approach:** General method, Fractional Knapsack problem, Minimum cost spanning tree: Prim's and Kruskal's algorithm, SingleSource Shortest Path problem	**5**
Unit 5	**Dynamic Programming:** General method, Principle of optimality, Multi-stage graph problem, All pair shortest path problem, 0/1 Knapsackproblem, Traveling salesperson problem	**7**
Unit 6	**Backtracking:** General method, N-Queen problem, 0/1 Knapsack problem	**5**
Unit 7	**Branch and Bound:** General method, 0/1 Knapsack problem, Traveling sales person problem	**5**
Unit 8	**Lower Bound Theory and Complexity Classes:** Lower bounds, Decision trees, P, NP and NP Complete problems	**5**

List of Experiments:		**No. of Turns**
1.	Write programs implementing Brute Force algorithms	2
2.	Write programs implementing Divide and Conquer algorithms	3
3.	Write programs implementing Greedy algorithms	2
4.	Write programs implementing Dynamic Programming	3
5.	Write programs implementing Backtracking	2
6.	Write programs implementing Branch and Bound	2

Course Outcomes: At the end of the course, students will be able to	
1.	Demonstrate the ability to select the best data structure for designing an algorithm to solve a given problem
2.	Demonstrate the ability to compare algorithms with respect to time and space complexity
3.	Develop algorithms to solve various computational problems
4.	Analyze and compare various possible solutions to any given problem

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Algorithm Design by Jon Kelinberg and Eva Tardos, Pearson Education	1st Edition, 2014
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Fundamentals of Algorithms by Horowitz E, Sahini S and Rajasekaran S., University Press	2008
2.	Introduction to Algorithms by Cormen, Leiserson, Rivest, Stein, PHI.	3rd edition, 2012
3.	An Introduction to Analysis of Algorithms by R. Sedgewick, Pearson Education	1st edition, 1996

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1.	https://onlinecourses.swayam2.ac.in/cec20_cs03/preview	Swayam
2.	https://www.edx.org/learn/algorithms/stanford-university-algorithms- design-and-analysis-part-1 https://www.edx.org/learn/algorithms/stanford-university-algorithms- design-and-analysis-part-2	edX

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO2	1	3	1	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	1	3	1	-	-	-	-	-	-	-	1	-	3	2
CO4	-	1	3	2	1	-	-	-	-	-	-	2	-	3	2

1-Low, 2-Medium, 3-High

Semester-V

Course ID	Course Name	L	T	P	Credits
MCN501	Number theory and Cryptography	3	0	2	4
MCN502	Artificial Intelligence	3	0	2	4
MCN503	Data Base Management System	3	0	2	4
MCN504	Theory of Computation	3	1	0	4
MCP511	Minor Project	0	0	8	4
	Total				**20**

Course Name	NUMBER THEORY AND CRYPTOGRAPHY
Course Code	MCN501
Credits	4
L T P	3-0-2

Total No. of Lectures – 42

Course Objectives:
Students should be able – • To develop understanding of the fundamental concepts, including divisibility, primes, and congruences. • Analyze Euler's theorem, Wilson's theorem, and quadratic reciprocity, and their applications in cryptography. • Explore public key cryptography, Diffie-Hellman key exchange, and RSA cryptosystem, and their practical implications. • Apply number theory and cryptography to designing secure communication protocols and digital signature schemes.

Lecture wise breakup		No. of Lectures
Unit 1	**Foundations of Number Theory:** Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, Primes, Fundamental theorem of arithmetic.	**8**
Unit 2	**Congruences and Residue Classes:** Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson theorem, Solution of congruences, Congruences of degree 1, Chinese remainder theorem with applications. Euler's φ-function, Primitive Roots, Quadratic reciprocity, Arithmetic functions.	**13**
Unit 3	**Primality Testing and Cryptography:** Primality Testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization, Continued fractions, Continued fraction method Hash Functions, Public Key cryptography, Diffie-Hellmann key exchange, Discrete logarithm-based crypto-systems, RSA crypto-system, Signature Schemes, Digital signature standard, RSA Signature schemes, Knapsack problem.	**13**
Unit 4	**Elliptic Curves and Cryptography:** Introduction to elliptic curves, Group structure, Rational points on elliptic curves, Elliptic Curve Cryptography, Applications in cryptography and factorization, Known attacks.	**08**

List of Practicals	
1.	Euclidean Algorithm for GCD: Implement the Euclidean algorithm to find the greatest common divisor (GCD) of two integers using software.
2.	Prime Factorization: Write a program to factorize a given integer into its prime factors.
3.	Solving Linear Congruences: Solve linear congruences of the form $ax \equiv b \ mod \ (m)$.
4.	Chinese Remainder Theorem (CRT): Implement the Chinese Remainder Theorem to solve systems of simultaneous congruences.

5.	Miller-Rabin Primality Test: Implement the Miller-Rabin primality test in to check the primality of numbers.
6.	Pollard's Rho Algorithm for Factorization: Write a program to implement Pollard's rho algorithm for factorizing composite numbers.
7.	RSA Encryption and Decryption: Implement RSA encryption and decryption algorithms.
8.	Diffie-Hellman Key Exchange: Implement the Diffie-Hellman key exchange protocol in Mathematica to simulate a key exchange.
9.	Elliptic Curve Operations: Implement basic elliptic curve operations such as point addition and scalar multiplication in Mathematica.
10.	Elliptic Curve Cryptography (ECC): Implement a simple elliptic curve cryptography scheme to encrypt and decrypt messages.

Course Outcomes:	
1	Define and explain concepts like divisibility, greatest common divisor, and the Euclidean algorithm.
2	Explain congruences, residue classes, reduced residue classes, and solve congruences using the Chinese remainder theorem.
3	Define and apply modern cryptographic techniques to secure communication and digital signatures.
4	Apply knowledge to analyze and design cryptographic algorithms, considering security and efficiency.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	I. Niven, H.S. Zuckerman, H.L. Montgomery, An Introduction to theory of numbers, Wiley.	2006
2	N. Koblitz, A Course in Number Theory and Cryptography, Springer.	2006
3	L. C. Washington, Elliptic curves: number theory and cryptography, Chapman & Hall/CRC.	2003
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Elementary Number Theory". David M.Burton. Wm.C.brown Publishers, Dubuque. lvova.	1989
2	J. Silverman and J. Tate, Rational Points on Elliptic Curves, Springer-Verlag.	2005
3	J. Pipher, J. Hoffstein and J. H. Silverman, An Introduction to Mathematical Cryptography, Springer-Verlag.	2008
4	G.A. Jones and J.M. Jones, Elementary Number Theory, Springer-Verlag.	1998.
5	R.A. Mollin, An Introduction to Cryptography, Chapman & Hall.	2001.

Equivalent MOOCs courses

Sr. No.	Course Links	Offered by
1	A basic course in number theory https://archive.nptel.ac.in/courses/111/101/111101137/	NPTEL
2	Number Theory https://archive.nptel.ac.in/courses/111/103/111103020/	NPTEL
3	Foundation of Cryptography https://archive.nptel.ac.in/courses/106/106/106106221/	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	-	3
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	-	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	1	3
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	1	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Artificial Intelligence**
Course Code	**:**	**MCN502**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
Students should be able - • To learn the basic concepts and techniques of Artificial Intelligence • To develop AI algorithms for solving practical problems • To represent the knowledge in logical form for further processing by algorithms • To develop reasoning and planning models by using the data presented

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction:** Artificial Intelligence and its applications, criteria of success, Intelligent Agents, Nature of Agents, Learning Agents,advantages & limitations of AI	**6**
Unit 2	**Uninformed Search:** State space search, BFS, DFS, IterativeDeepening, Bidirectional Search **Informed Search:** Best first search, greedy best first search, A* search,	**6**
Unit 3	**Local Search:** Hill climbing, variants of hill climbing, SimulatedAnnealing **Adversarial Search:** Min-Max Search, Alpha-Beta Pruning, MarkovDecision Processes **Constraint Satisfaction problems, backtracking**	**9**
Unit 4	**Logic:** Propositional logic, predicate logic, Resolution and Refutation, Clause form, unification algorithm	**6**
Unit 5	**Reasoning:** Bayesian Networks, Fuzzy Logic, Knowledge Representation And Reasoning through fuzzy logic and Bayesian Network	**8**
Unit 6	**Planning:** The Planning problem, planning with state space search, partial order planning, planning graphs, planning with propositionallogic, planning algorithms	**7**

Lab Work:

Sr. No.	**Lab contents**	**No. of Turns**
1.	Write programmers to conduct uninformed and informed search, local search,adversarial search, constraint satisfaction, backtracking	6
2.	Mini project work based on AI problems	8

Course Outcomes: At the end of the course, students will be able to	
1.	Solve problems by applying suitable AI techniques
2.	Apply knowledge representation schemes for designing knowledge base
3.	Apply reasoning and planning approaches to derive conclusions using the knowledge Base
4.	Design end-to-end solutions for real world problems

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Artificial Intelligence: A Modern Approach by Stuart Russell & Peter Norvig, Prentice-Hall	4th edition, 2021
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Artificial Intelligence: A New Synthesis by Nils J. Nilsson, Morgan- Kaufmann	1st edition, 1998
2.	Artificial Intelligence: Foundations for Computational Agents by David Poole and Alan Mackworth, Cambridge Univ. Press	2010
3.	Knowledge Representation and Reasoning by Ronald Brachman, Morgan Kaufmann	2004
Equivalent MOOCs courses:		
Sr. No.	**Course Links**	**Offered by**
1.	https://onlinecourses.nptel.ac.in/noc22_cs56/preview	Swayam
2.	https://www.edx.org/learn/algorithms/stanford-university-algorithms-design-and-analysis-part-1 https://www.edx.org/learn/algorithms/stanford-university-algorithms-	edX

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	2
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	3	1
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	3	2
CO4	1	2	3	1	-	1	-	-	-	-	-	1	-	3	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Data Base Management System**
Course Code	**:**	**MCN503**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
Students should be able - • To analyze the components/ requirements of DBMS • To explore the role of storage and file structure in database management. • To apply their knowledge of normalization theory to the normalization of a database • To develop various SQL queries related to any given situation. • To enable them think for transactions and concurrency in database applications invarious scenarios

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**INTRODUCTION** Introduction and application of DBMS, Data Independence, Database System Architecture – levels, Mapping, Databaseusers and DBA, Database Languages: DDL, DML. **DATABASE MODELS:** Entity – Relationship model, constraints, keys, Design issues, E-R Diagram, Weak and Strong entity types, Extended E-R features-Generalization, Specialization, Aggregation, Translating E-R model into Relational model. hierarchical and network models	**8**
Unit 2	**RELATIONAL MODE**L: Introduction to relational model, basic structure, Types, Keys, views in a relational database. **SQL:** Fundamentals, basic structure, set operations, aggregateoperations, DDL, DML, DCL, nested queries, complex queries, Integrity Constraints, PL/SQL Concepts, triggers	**8**
Unit 3	**RELATIONAL ALGEBRA AND RELATIONAL CALCULUS** Relational Algebra: Fundamental operations, Additional Operations Relational calculus: Tuple Relational calculus, Domain Relational calculus **STORAGE AND FILE STRUCTURE** Overview of physical storage media, magnetic disks, RAID, file organization, organization of records in files, indexing and hashing	**6**
Unit 4	**RELATIONAL DATABASE DESIGN:** Functional Dependencies, Non-loss Decomposition, First, Second, Third Normal Forms, Dependency Preservation, Boyce/Codd Normal Form, Multi-valued Dependencies and Fourth Normal Form, Join Dependencies and	**8**

	Fifth Normal Form, 6th Normal Form.	
Unit 5	**TRANSACTION MANAGEMENT** Transaction concept, transaction state, ACID properties, serializability, Recoverability, Implementation of Isolation, Testing for serializability, **CONCURRENCY CONTROL** Basic Concept, Lock based concurrency control, Time stamping methods, Dealing with Deadlocks, Recovery techniques based on deferred update and recovery techniques based on Immediate Update. Introduction to Checkpoints and Shadow Paging, Introduction to Database Security, Discretionary access control based on granting and revoking privileges	**7**
Unit 6	**DISTRIBUTED DATABASES** Introduction, data mining, Big Data, NoSQL, New SQL, Modern databases based on these concepts. Object orienteddatabases	**5**

List of Experiments:		**Number of Turns**
1	For a given scenario of database application, Create the required tables using SQL Commands	1
2	Write Sql queries to apply the constraints i.e. Primary Key, Foreign key, UNIQUE to the tables.	2
3	SQL queries for Null values and different clauses	2
4	Usage of SELECT, rename, tuple operations, DELETE etc.	2
5	SQL queries for implementing various String operations, Set operations	2
6	SQL queries for implementing JOINs and types of joins with conditions.	2
7	SQL nested queries for a particular scenario.	1
8	SQL queries to create the views, triggers	1
9	SQL queries to create indexes and apply on a database.	1

Course Outcomes:	
1	Describe DBMS architecture, physical and logical database designs, database modeling, relational, hierarchical and network models
2	explain basic database storage structures and access techniques such as file organizations, indexing methods, Understand the normalization of databases
3	Analyse /contrast the realtional algebra, calculus , other latest modern databases like data mining, no sql, etc
4	Design , implement, test and debug using Sql ,transaction processing, concurrency control mechanism
5	Design a database and Sql queries , triggers etc in various environments.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Database System Concepts", Abraham Silberschatz, Henry F.Korth, S. Sudharshan, Tata McGraw Hill,	2006
	"Fundamentals of Database Systems", Elmsari and Navathe, Pearson Education	2013
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Database Management Systems , Ramakrishnan and Gehrke, McGrawHill	2003
2	"An Introduction to Database Systems", C.J.Date, A.Kannan, S.Swamynathan, Pearson Education	2006
3	J. D. Ullman, "Principles of Database Systems", 2nd Ed., Galgotia Publications	1999

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	Database Management Essentials https://www.coursera.org/learn/database-management	coursera
2	Data Base Management System By Prof. Partha Pratim Das https://archive.nptel.ac.in/courses/106/105/106105175/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	-	1	1	1	2	1	2	1	1	-	3	2
CO2	1	1	1	-	1	1	1	2	1	2	1	1	-	3	3
CO3	1	2	1	1	2	1	1	2	1	2	1	1	-	3	2
CO4	2	1	2	1	2	1	1	2	1	2	2	2	-	3	3
CO5	2	1	3	1	3	2	1	3	1	2	2	3	-	3	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Theory of Computation**
Course Code	**:**	**MCN504**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able - • To understand fundamental mathematical and computational principles thatare foundations of computer science. • To learn about abstract models of computation, finite representations for languages. • Distinguish different computing languages and classify their respective types. • To gain formal understanding of algorithms and procedures.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**AUTOMATA AND LANGUAGE THEORY** Introduction to formal proofs, Finite Automata (FA), Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), Finite Automata with Epsilon transitions	8
Unit 2	**REGULAR EXPRESSIONS AND LANGUAGES** Regular Expression, FA and Regular Expressions, Proving languages not to be regular, Closure properties of regular languages, Equivalence and minimization of Automata	9
Unit 3	**CONTEXT-FREE GRAMMARS AND LANGUAGES** Context-Free Grammar (CFG), Parse Trees, Ambiguity in grammars andlanguages, Definition of the Pushdown automata, Languages of a Pushdown Automata, Equivalence of Pushdown automata and CFG Deterministic Pushdown Automata, Normal forms for CFG, Pumping Lemma for CFL, Closure Properties of CFL	10
Unit 4	**COMPUTABILITY THEORY** Turing Machines, Programming Techniques for TM, Variations of TM, Non-Universal TM, Universal TM, decidability, halting problem, reducibility.	8
Unit 5	**UNDECIDABALITY** Complexity classes P, NP, L, NL, PSPACE, BPP and IP, A language that is not Recursively Enumerable (RE), An undecidable problem that is RE, Undecidable problems about Turing Machine, Post's Correspondence Problem	7

Course Outcomes:	
1	Recognize and comprehend formal reasoning about languages
2	Express computer science problems as mathematical statements
3	Distinguish different computing languages and classify their respective types
4	Develop a competent understanding of the basic concepts of complexity theory

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computations", second Edition, PearsonEducation	2007
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	H.R. Lewis and C.H. Papadimitriou, "Elements of the theory of Computation", Second Edition, Pearson Education	2003
2	Thomas A. Sudkamp," An Introduction to the Theory of Computer Science, Languages and Machines", Third Edition, Pearson Education.	2007
3	J. Martin, "Introduction to Languages and the Theory of computation" Third Edition, Tata Mc Graw Hill.	2007

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	Theory of Computation https://onlinecourses.nptel.ac.in/noc19_cs79/preview	Swayam+ IIT Kanpur
2	The complete theory of computation https://www.udemy.com/course/the-complete-theory-of-computation/	Udemy

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	3	1	1		-	-	1	-	3	1
CO2	3	3	2	2		2	2	1	1	-	-	-	-	3	2
CO3	3	2	3	3	1	1	1	-	-	-	-	1	-	3	1
CO4	1	2	2	3	2	2	-	-	-	-	-	-	-	3	2

1-Low, 2-Medium, 3-High

Semester-VI

Course ID	Course Name	L	T	P	Credits
MCN601	Internship Training Part-I	0	0	12	6
MCN602	Internship Training Part-II	0	0	4	2
MCN603	Internship Training Part-III	0	0	8	4
or					
Optional Course Work					
	Department Elective Course-V	3	0/1	2/0	4
	Open Elective	3	0	2	4
MCP601	Project Work	0	0	8	4
	Total				**12**

Department Elective Course-V

Course ID	Course Name	L	T	P	Credits
MCE101	Optimization Techniques	3	0	2	4
MCE102	Stochastic Processes	3	1	0	4
MCE103	Principles of Programming Languages	3	0	2	4
MCE104	Internet of Things	3	0	2	4

Course Name	**OPTIMIZATION TECHNIQUES**
Course Code	**MCE101**
Credits	**4**
L T P	**3-0-2**

Total No. of Lectures – 42

Course Objectives:

Students should be able

- To explore different methods to solve linear models of optimization problems.
- To analyze duality theory in the linear programming.
- To develop the ability to apply classical methods to solve nonlinear models for unconstraint problems and equality constraint
- To explore and deal with non-linear programming problems with inequality constraints.

Lecture wise breakup		**No. of Lectures**
Unit 1	**Linear Programming:** Characteristics and Scope of Optimization problems. Formulation of Linear Programming model, Convex sets, Convex Functions and their properties, Graphical solution, Simplex method, Relation between graphical and simplex method, Unrestricted variables, Artificial variables, M-method and Dual phase method.	**14**
Unit 2	**Duality Theory:** Duality in linear Programming, fundamental properties of dual Problems, Primal-dual relationship, Dual Simplex Algorithm, Sensitivity analysis. **Integer Linear Programming Problem:** Formulation, Branch and Bound method, Cutting Plane method.	**14**
Unit 3	**Non – Linear programming:** **Unconstrained problems:** (single and multivariable optimization) necessary and sufficient conditions for extreme points. **Constrained problems:** Equality constraints: Lagrangian methods, Application of Lagrangian methods. Inequality constraints: Karush Kuhn Tucker conditions. Separable Programming, Quadratic Programming.	**14**

List of Practicals	
1.	Formulate and solve a linear programming model graphically.
2.	Implement the Simplex method for solving linear programming problems.
3.	Visualize and analyze convex sets and convex function.
4.	Solve a dual linear programming problem and analyze the primal-dual relationship.
5.	Implement the Dual Simplex Algorithm and perform sensitivity analysis.
6.	Formulate and solve integer linear programming problems using the Branch and Bound method.
7.	Implement the Cutting Plane method for integer linear programming.
8.	Solve unconstrained non-linear programming problems for extreme points.
9.	Apply the Lagrangian method to solve constrained optimization problems with equality constraints.
10.	Implement the Karush-Kuhn-Tucker (KKT) conditions to solve constrained optimization problems with inequality constraints in Mathematica.

11.	Solve a separable programming problem.
12.	Implement quadratic programming to solve optimization problems

Course Outcomes:	
1	Formulate and solve linear models of optimization problems.
2	Understand the duality theory and solve the linear programming problems using duality theory.
3	Solve nonlinear models for unconstraint problems and equality constraints.
4	Formulate and solve non-linear programming problems for inequality constraints.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Taha, H.A, 10th edition, Pearson.	2017
2	Linear Programming and Network Flows, Bazaraa, M.S., Jarvis, J.J, and Sherali, H.D.,2nd edition, ohn Wiley and Sons.	2004
3	Operations Research, Ravindran, Phillips, and Solberg, 2nd edition, John Wiley & sons.	2000
4	Engineering Optimization, S S Rao, 4nd edition, New Age.	2009
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007
2	Operations Research, Sharma S.D., Kedarnath, Ramnath & Company.	1994
3	Operations Research, Bronson R, Shaum's Outline Series.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL
3	Advanced Operations Research https://nptel.ac.in/courses/112106131	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	1	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	1	3
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	2	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	2	3

1-Low, 2-Medium, 3-High

Course Name	STOCHASTIC PROCESSES
Course Code	MCE102
Credits	4
L T P	3-1-0

Total No. of Lectures – 42

Course Objectives
Students should be able • To develop a comprehensive understanding of random variables, probability distribution functions and evaluates their statistical properties. • To explore the concepts of discrete parameter Markov Chains and analyze Gambler's Ruin as a Markov Chains. • To apply the concepts of Poisson process in Queuing Theory and Birth-Death processes. • To analyze the probability of extinction and distribution of population size.

Lecture wise breakup		No. of Lectures
Unit 1	**Introduction to stochastic processes:** Random variables, discrete probability distribution, continuous probability distribution, expected value, mean, variance, moment generating functions, conditional expectations; Bernoulli process, Poisson process, Gaussian process; Markov and Chebyshev inequalities; central limit theorem	**10**
Unit 2	**Markov Chains:** Chapman-Kolmogorov equations, Classification of states and chains, absorption probabilities, n-step transition probabilities and limit theorems, Random Walks, Gambler's Ruin.	**14**
Unit 3	**Poisson processes:** Definitions, and properties: inter arrival and waiting time distributions, Non-homogeneous Poisson process, Compound Poisson process, Birth-Death processes, Kolmogorov backward and forward equations, Limiting probabilities, Time reversibility; Queuing models: $M(\lambda)/M(\mu)/1$, $M(\lambda)/M(\mu)/n$, $M(\lambda)/D(\Gamma)/1$.	**16**
Unit 4	**Renewal and branching** Renewal process, elementary renewal theorem, key Renewal theorem, Branching process: Martingales, stopping time, Galton-Watson branching process, probability of ultimate extinction, distribution of population size.	**12**

Course Outcomes:	
1	Define important class of probability distribution functions, and calculate their expectation, variance, and covariance, moment generating functions.
2	Classify states of Markov chains, evaluate transition probability matrices and discuss Random walk, Gambler's Ruin as a Markov chain.
3	Analyse Birth-Death Process and Queuing theory using concepts of Poisson processes.
4	Analyse the concept of Elementary Renewal theorem and Key Renewal theorem in Renewal theory. Learn basics of Branching process and

	Martingales.
5	Evaluate the distribution of population size and probability of extinction considering Random walks.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Sheldon M. Ross: Stochastic Processes, Wiley; Second edition	2008
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Peter Watts Jones, Peter Smith, Stochastic Processes, An Introduction, Second edition	2017
2	Karlin and Taylor, A first course in Stochastic Processes, Academic Press; 2nd edition	1975
3	Gregory F. Lawler, Introduction to Stochastic Processes; Second edition	2006

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Introduction to Stochastic Processes https://nptel.ac.in/courses/111102014	NPTEL
2	NOC: Stochastic Processes https://archive.nptel.ac.in/courses/111/102/111102098	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	3	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	3	–	–	–	–	–	1	1	3	1	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	–
CO4	1	2	3	1	2	–	–	–	–	–	2	3	3	–	–
CO5	2	2	1	1	3	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Principles of Programming Languages**
Course Code	**:**	**MCE103**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

- To understand the various ways to describe syntax and semantics of programming languages
- To understand data, data types, and basic statements of programming languages
- To understand parameter passing and function call mechanisms
- To understand object-orientation, concurrency, and event handling in programming languages
- To acquire knowledge about functional and logic programming paradigms

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Syntax and Semantics and Basic Statements:**-Evolution of programming languages - describing syntax & semantics - lexical analysis - parsing - recursive-decent bottom up parsing - primitive data types – strings - array types - associative arrays - record types - union types - pointers and references - Arithmetic expressions - relational and Boolean expressions - assignment statements - mixed-mode assignments - control structures - selection - iterations - branching - guarded statements.	**10**
Unit 2	**Subprograms and Implementations:**-Subprograms - design issues - local referencing - parameter passing - overloaded methods - generic methods - design issues for functions - semantics of call and return - implementing simple subprograms - stack - dynamic local variables - nested subprograms - blocks - dynamic scoping.	**8**
Unit 3	**Object-Orientation, Concurrent, and Event Driven Programming:**- Object-orientation design issues for OOP languages - implementation of object-oriented constructs - concurrency - semaphores - monitors - message passing - threads - statement level concurrency - exception handling - Event driven control - Event Handling	**8**
Unit 4	**Functional Programming:**- Introduction to lambda calculus-fundamentals of functional programming languages - Programming with Scheme	**8**

	-Introduction to LISP - Lists - Storage allocation for lists - Some useful functions - Error handling.	
Unit 5	**Logic Programming:**- Introduction to logic and logic programming - Computing with relations - Programming with Prolog - Data structures in Prolog - Programming techniques - Control in Prolog - Cuts - multi-paradigm languages.	**8**

List of Experiments:		**Number of Turns**
1	• Simple test programs to determine type compatibility rules of a C compiler. • Simple test program to determine the scope of variables having the same name and different names declared within a while / for loop. • Program that behaves differently if name equivalence is used against structural equivalence. • Write a program to convert one form of comments in C to alternate comments form.	4
2	• Write a program to determine the ratio of the time required to pass a large array by reference and the time required to pass the same array by value. • Write a program that determines whether it is legal to call a function that has been passed by passing a pointer to it to another function. • Devise a subprogram and calling code in which pass-by-reference and pass-by-value-result of one or more parameters produces different results. • Design a skeletal program and a calling sequence that results in an activation record instance in which the static and dynamic links point to different activation recorded instances in the run-time stack.	4
3	• Chess / checkers game using object oriented programming – C++/Smalltalk / Python / Java. • Design a Tic-tac-toe game that uses even driven programming concepts.	2
4	• Scheme functions to compute mathematical formula, roots of a quadratic equation, count of characters in a string, set computation like, Union, Intersection, complementation, etc. • Lisp recursive function to return 'nth' item from a list, diagonal of a matrix, sum of the diagonal of matrix, a sub-string from a string, etc.	2

5	Prolog program to find the factorial of a number, simplification of arithmetic expression involving additive, multiplicative identity, solve Sudoku puzzle, etc.	2

Course Outcomes: Upon completion of this course, the students will be able to:	
1	Define data types, functions, syntax and semantics of all programming languages
2	Use the various styles of programming languages for any given problem
3	Compare and use appropriate parameter passing technique for solving problems
4	Distinguish between the usage of all programming languages
5	Apply the appropriate programming language to solve real-world problems

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/Reprint**
1	Robert W. Sebesta, "Concepts of Programming Languages", Tenth Edition, Addison Wesley,.	2012
2	Michael L. Scott, "Programming Language Pragmatics", Third Edition, Morgan Kaufmann.	2009
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/Reprint**
1	Allen B Tucker, and Robert E Noonan, "Programming Language Principles and Paradigms", Second Edition, Tata McGraw Hill	2007
2	R. Kent Dybvig, "The Scheme Programming Language", Fourth Edition, MIT Press	2009
3	Jeffrey D. Ullman, "Elements of ML Programming", Second Edition, Prentice Hall, 1998.	1998

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	http://nptel.ac.in/course/106102067 by Prof. S. Arun Kumar "Principles of Programming Languages" IIT Delhi	NPTEL
2	https://www.coursera.org/learn/programming-language by Dan Grassman university of Washington	Coursera

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	1	1	-	2		-	-	-	-	-	1	2	-
CO3	-	2	-	-	3	-	-	-	2	-	-	-	1	-	-
CO4	3	-	-	-	-	-	-	-	-	1	-	1	-	-	-
CO5	1	-	3	2	-	3	-	-	-	-	-	-	-	-	-

1-Low, 2-Medium, 3-High

Course Name	**:**	**Internet of Things**
Course Code	**:**	**MCE104**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

The main objectives of this course are:

- Understanding of core technology, applications, sensors used and IOT architecture alongwith the industry perspective.
- Design and implement real time solutions using IOT.
- To Understand Advanced concept like SDN, NFV, CPS and Industry 4.0
- To understand and Practice Integration of cloud services with IoT application

Total No. of Lectures - 42

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to IOT** Understanding Internet of Things, Internet of People and Services, Enabling Building blocks and Technologies, Embedded and IOT device, IoT Ecosystem (from thinking things to Distributed collective Wisdom), IoT Decision Framework, IoT Solution Architecture Models, IoT data management Framework. Challenges and Issues for IoT	6
2.	**Setting IoT Raspberry Pi/Arduino and Introduction to Sensors** Major IoT Boards in Market, Exploring Raspberry Pi, Secure Shell (SSH) Client and Team Viewer, understanding Sensing, Actuators actions and Micro-electromechanical Systems (MEMS). **Sensors:** Types of sensors, Calibration, - noise modelling and characterization, noise filtering and sensor data processing. Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras Global positioning sensors: Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), Indian Regional Navigation Satellite System (IRNSS), Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope	6
3.	**IoT Networking** IoT Network architecture and Sublayers: Access Network, Backhaul network, Transport network and Network Management Sublayer. Short range Communication Technologies and Protocols: Bluetooth (Smart and Ready), 802.15.4, ZigBee, Zwave, (6LoWPAN) and Mac layer protocol	10

	Long Rang Communication Technologies and Protocols: WiFi 802.11 ah, Thread Low-Power Wide-Area Network (LPWAN), Cellular IoT Networks (SigFox, LoRa, LTE-M) IoT Messaging Protocols: Incompatibility of HTTP in IoT, Publisher Subscriber Model, MQTT and CoAP	
4.	**Modern Networking for IoT and Advanced Industrial Evolution** Issues with traditional networks for IoT, Software Defined Networks (SDN) for IoT, Introduction to Network Function Virtualization (NFV) Industrial IoT: Cyber Physical Systems, Industrial Evolutions and Industry 4.0, Smart Factories (PLC, SCADA, MES), Web 3.0, Social Implication and Society 5.0.	**8**
5.	**Cloud Computing and Security issues in IoT** Introduction to GCP, AWS, Microsoft Azure, IoT Integration of IoT service with the cloud, IoT Data Analytics, SDN based Claud Computing. Security Issues: Security Requirement analysis for IoT network, devices and applications, Security services for IoT communication, Issue of Privacy, User and Location privacy preservation, Privacy Vs Personalization.	**6**
6.	**Futuristic IoT Application** Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Agriculture, Smart Homes, Wearables, Smart Grids, Connected Car, Connected digital health, Telemedicine), smart retail etc.	**6**

Lab Work:

Sr. No.	**Lab contents**	**No. of Turns**
1.	Project based lab work: Design and build systems that will use sensors, communication protocols and actuators	8
2.	To learn Connecting Raspberry Pi with remote desktop using VNC client	1
3.	To basics of learn Microsoft Azure platform	1
4.	To Create IoT hub, cloud data store and stream analytical function on Azure	2
5	Connecting and passing data to azure IoT hub from raspberry pi client	2

Course Outcomes:

At the end of the course, students will be able to:	
1.	Understand the concept of IoT
2.	Study IoT architecture and Networking fundamentals
3.	Study the Cloud application and security/privacy issues in IoT.
4.	Understand various applications of sensor in Industrial, healthcare, commercial, and building automation.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", VPT, 1st Edition.	2014
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition.	2013
2.	CunoPfister, "Getting Started with the Internet of Things", OReilly Media.	2011
3.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing.	2015

Equivalent MOOCs Courses:

Sr No	Course Link	Offered by
1	https://www.coursera.org/specializations/iot	Coursera
2	https://www.edx.org/course/introduction-to-the-internet-of-things- iot	EDX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	1	1	-	-	-	-	-	1	-	2	1
CO2	2	1	1	-	1	1	-	-	-	-	-	1	-	2	1
CO3	2	1	1	1	1	2	1	-	1	-	-	1	-	3	2
CO4	2	2	1	1	1	2	2	-	1	1	-	2	-	3	2

1-Low, 2-Medium, 3-High

Semester-VII

Course ID	Course Name	L	T	P	Credits
	Humanities, Social Sciences and Mgmt. III/ Humanities, Social Sciences and Mgmt. -IV				3
	Department Elective Course-I	3	1	0	4
	Department Elective Course-II	3	0	2	4
	Open Elective-I	3	0	2	4
	Open Elective -II	3	0	2	4
MCP701	Major Project-I	0	0	8	4
	Total				**23**

Department Elective Course-I

Course ID	Course Name	L	T	P	Credits
MCE105	Graph Theory	3	1	0	4
MCE106	Queuing Theory and Application	3	1	0	4
MCE107	Algebraic Coding Theory	3	1	0	4
MCE108	Applied Computational Methods	3	1	0	4

Department Elective Course-II

Course ID	Course Name	L	T	P	Credits
MCE109	Data Science and Machine Learning	3	0	2	4
MCE110	Software Engineering	3	0	2	4
MCE111	Computer Networks	3	0	2	4
MCE112	Computer Graphics	3	0	2	4

Course Name	**GRAPH THEORY**
Course Code	**MCE105**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

Students should be able

- To explore introduction to the fundamentals of Graph Theory
- To enable the students to model various applications from Science and Engineering using Graphs
- To develop the problem solving skills.
- To apply the concepts of graph theory with other branches of mathematics.

Lecture wise breakup		**No. of Lectures**
Unit 1	Introduction to Graphs and Digraphs: Definitions of some basic terms, representation of graphs, Degree Sequence, characterization of graphical sequence; Trees: Characterizations, MST, counting of 4 trees;	**09**
Unit 2	Paths and distance in Graphs: Basic Definitions, center and median of Graphs, activity digraphs and critical paths; Eulerian Graphs: Characterization, Chinese postman problem; Hamiltonian Graphs: Necessary conditions, sufficient conditions, Planar Graphs: Properties, Characterization	**14**
Unit 3	Graph Coloring: vertex coloring, chromatic polynomials, edge coloring, planar graph coloring, Constraint Graph coloring,, Matching and Factorizations: maximum matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization	**10**
Unit 4	Networks: The Max-flow min-cut theorem, max-flow algorithm, connectivity and edge connectivity, Menger's theorem, Graph and Matrices	**09**

Course Outcomes:	
1	Discuss fundamental definitions and concepts of graph theory.
2	Apply the core theorems and algorithms, generating examples as needed, and asking the next natural question.
3	Analyse goals of graph theory: classification, extremality, optimization and sharpness, algorithms, and duality
4	Apply basic graph theory proof techniques such as bijections, minimal counterexamples, and loaded induction.

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	G. Chartrand and P. Zhang, A First Course in Graph Theory (Dover Publications).	2012

2	D. B. West, Introduction to Graph Theory, 2nd edn. (Prentice Hall)	1996
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	J A Bondy and USR Murty, Graph Theory, Springer	2008
2	Diestel, Graph Theory, Springer, 3rd edition	2005

Equivalent MOOCs courses

Sr. No.	Course Links	Offered by
1	Graph theory https://archive.nptel.ac.in/courses/111/106/111106050/#	NPTEL
2	Advanced Graph theory https://onlinecourses.nptel.ac.in/noc21_cs48/preview	NPTEL
3	Graph Theory and Graph Algorithms Coimbatore https://nptel.ac.in/courses/128106001	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	1	1
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	1
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	Queueing Theory and Applications
Course Code	MCE106
Credits	4
L T P	3-1-0

Total No. of Lectures – 42

Course Objectives:

Students should be able

- To analyze the fundamental components and scope of queueing systems.
- To understand the characteristics of queuing theory and Markovian and Non-Markovian queues.
- To explore open and closed queue networks.
- To understand and apply concepts of queues with vacations.

Lecture wise breakup		No. of Lectures
Unit 1	**Fundamentals of Probability and Markov Processes:** Review of probability, random variables, distributions, generating functions, Poisson distribution, exponential distribution, Markov chains and Markov processes, renewal and semi-Markov processes.	08
Unit 2	**Characteristics and Analysis of Queueing Systems:** Description of Queueing models, Characteristics of queueing systems, Little's law, Birth & Death queueing models, Single server and multi server queues, Erlang's Loss Formula. Markovian and non-Markovian queueing systems, embedded Markov chain applications to M/G/1, G/M/1 and related queueing systems.	18
Unit 3	**Networks of Queues: Structure and Performance:** Networks of queues, open and closed queueing networks.	8
Unit 4	**Specialized Queueing Systems and Applications:** Queues with vacations, priority queues, queues with modulated arrival process, discrete time queues.	8

Course Outcomes:

1	Describe the characteristics and various models of queues.
2	Understand Markovian and Non-Markovian queueing systems.
3	Explain the open and close network of queues.
4	Solve the cases of queues with vacations and queues with modulated arrival process.

Text Book:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	D. Gross and C. Harris, Fundamentals of Queueing Theory, 3rd Edition, Wiley (WSE Edition, 2004).	1998
2	L. Kleinrock, Queueing Systems, Vol. 1: Theory, Wiley.	1975

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	J. Medhi, Stochastic Models in Queueing Theory, 2nd Edition, Academic Press. (Elsevier India Edition, 2006).	2003
2	J.A. Buzacott and J.G. Shanthi kumar, Stochastic Models of Manufacturing Systems, Prentice Hall.	1992
3	R.B. Cooper, Introduction to Queueing Theory, 2nd Edition, North-Holland.	1981
4	L. Kleinrock, Queueing Systems, Vol. 2: Computer Applications, Wiley.	1976
5	R. Nelson, Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modelling, Springer.	1995

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Introduction to Queueing Theory https://onlinecourses.nptel.ac.in/noc22_ma17/preview	NPTEL
2	NPTEL :: Electronics & Communication Engineering - Queuing Systems https://archive.nptel.ac.in/courses/117/103/117103017/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	1
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MCE107**
Credits	**:**	**4**
L T P		**3-1-0**

Course Objectives:

Students should be able

1. To explore the significance of coding theory in modern engineering applications.
2. To apply fundamental concepts of error detection and correction codes to identify and correct errors
3. To apply algebraic techniques to encode and decode messages using linear codes and cyclic codes
4. To analyze basic coding techniques and algorithms to translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit I	**INTRODUCTION TO CODING THEORY** Source and Channel coding, Error detecting and error correcting codes	2
Unit II	**ERROR DETECTION, ERROR CORRECTION AND DECODING** Communication Channels, maximum likelihood decoding, Hamming distance, Nearest neighbour/ minimum distance decoding, distance of a code	6
Unit III	**FINITE FIELDS** Fields, Polynomial rings, Structure of finite fields, Minimal polynomials	10
Unit IV	**LINEAR CODES** Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome Decoding, Weight Enumerator of a Code, Macwilliam's Identity	16
Unit V	**CYCLIC CODES** Definition, Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes:

1. Define the fundamental concepts of coding theory, including error detection and correction codes.
2. Apply basic encoding and decoding schemes in a communication channel.
3. Apply the principles of algebra to construct codes such as linear codes and cyclic codes.
4. Analyze encoding and decoding schemes, including nearest neighbor decoding and syndrome decoding for linear codes.
5. Discuss the simple error detecting and correcting linear or cyclic codes.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Coding Theory", San Ling & Chaoping Xing , Cambridge University Press	2004
2	"Introduction to the 'Theory of Error Correcting Codes", Vera Pless, Cambridge University Press	2003
3	"Introduction to Error Correcting Codes", Raymond Hill, Clarendon Press, Oxford	1986
4	"Theory of Error Correcting Codes Part I & II", F.J.Macwilliams & NJA Sloane	1977
5	An Introduction to Coding Theory - Course (nptel.ac.in)	2020

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	3	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	3	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	3
CO4	1	2	3	1	2	–	–	–	–	–	2	3	3	–	1
CO5	2	2	1	1	3	–	–	–	–	–	2	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Applied Computational Methods**
Course Code	**:**	**MCE108**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Student should be able

- To explore the algorithms for solving linear systems of equations and eigenvalue computations.
- To analyze the interpolation methods
- To develop a deep understanding of the finite difference methods for various types of PDEs.
- To analyze the numerical solution of hyperbolic PDE systems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Linear Equations and Eigenvalue Computations:** Algorithms for the solution of linear systems of equations – Direct Methods, LU Decomposition, Thomas Algorithm, Block matrix, Iterative methods, Basic theory of linear fixed-point iteration, Successive overrelaxation (SOR), Conjugate gradients, Iterative methods for Block matrix, Eigenvalue and vector computations including the power method, QR iteration	**14**
Unit 2	**Interpolation Techniques:** Solution of system of nonlinear algebraic equations –Picard's and Newton-Raphson, Interpolation using Fourier transform, orthogonal polynomials and splines, least square method	**10**
Unit 3	**Finite Difference Methods and Stability Analysis:** Numerical solution of linear and non-linear PDEs by Finite Difference Methods, Iterative Methods, Eigenvalue Stability of Finite Difference Methods	**10**
Unit 4	**Hyperbolic PDE Systems:** System of hyperbolic PDEs, Conservation laws, Lax-Wendroff theorem, Godunov's method, Roe's linearization, TVD schemes, high-resolution schemes	**08**

Course Outcomes:	
1	Explain the principles underlying the algorithms for solving linear equation and, eigenvalue computations
2	Analyze the interpolation Techniques
3	Apply the appropriate algorithms and techniques to solve PDEs
4	Discuss the concepts hyperbolic PDE systems

Text Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Lloyd N. Trefethen and D. Bau, Numerical Linear Algebra,	1997

	SIAM, 1st Edition	
2	Uri Ascher and Chen Greif, A First Course in Numerical Methods, SIAM, 5th Edition	2011
3	D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, American Mathematical Society, 3rd Ed	2009
4	Sandip Majumder, Numerical Methods for Partial Differential Equations: Finite Difference and Finite Volume Methods, Academic Press; 1st edition	2015

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Burden and Faires, Numerical Analysis, Cangene Learning, Brooks/Cole, 10th Edition.	2015

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	https://onlinecourses.nptel.ac.in/noc23_ma30/preview	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	2
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	1
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Data Science & Machine Learning**
Course Code	**:**	**MCE109**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able -

- To analyze and apply mathematical concepts in the context of data science and machinelearning.
- To explore various data acquisition, cleaning, and preprocessing techniques.
- To develop skills in applying machine learning algorithms and predictive modeling onvarious datasets.
- To prepare students for lifelong learning in the rapidly evolving field of data science andmachine learning.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Data Science:** Basics of python for data science and machine learning, Types of data:structured data, unstructured data, other data types, the data science process, Explore and visualize data, features, Linear algebra,correlation	**6**
Unit 2	**Data Acquisition and Preprocessing:** Data sources and collection, Data storage and management, Data Preparation: handling missing data, feature encoding, feature scaling, Data Cleaning, Dataset division: train, test and validation sets	**7**
Unit 3	**Machine Learning Fundamentals:** Applications of Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, bias-variance tradeoff, overfitting- underfitting, Evaluation Measures: SSE, R2, confusion matrix, precision, recall, F-Score, ROC-Curve, cross-validation.	**7**
Unit 4	**Regression and Classification:** Simple Linear Regression, Multiple Linear Regression, Logistic Regression, gradient descent algorithm, K-Nearest Neighbor, Support Vector Machine (SVM), Naïve Bayes, Decision Trees.	**12**
Unit 5	**Dimensionality Reduction and Clustering:** Feature selection, Principal Component Analysis, K-means clustering,Hierarchical clustering, Density based clustering.	**10**

List of Experiments:		**Number of Turns**
1	Explore various python libraries used for data handling and machine learning techniques: numpy, pandas, matplotlib , scikit-learn etc.	**2**
2	Implementation of data handling and preprocessing techniques	**2**

3	Implementation of various classification and regression algorithms – Linear and logistic regression, KNN, SVM, Naïve Bayes, Decision Trees	**6**
4	Implementation of Dimensionality Reduction and Clustering techniques: PCA, K-means clustering, Density based clustering algorithms	**4**

Course Outcomes: After completion of course, students would be able to:	
1	Explore and apply mathematical and engineering knowledge to analyze complex data science problems.
2	Apply modern tools and techniques to solve data science problems.
3	Apply different machine learning models on various datasets.
4	Analyze the trade-off of various machine learning models for real-life applications.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Data Science" by Jeffrey Stanton, SAGE Publications	2017
2	"Introduction to Machine Learning with Python: A Guide for Data Scientists", Andreas Müller, Sarah Guido, O'Reilly Media	2016
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"The Machine Learning Yearning" by Andrew NG, Deeplearning.ai	2021
2	"Python for Data Analysis" by Wes McKinney, O'Reilly Media	2022
3	"Hands-On Machine Learning with Scikit-Learn, Keras, And Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", by Aurélien Géron, 3rd Edition, O'Reilly	2022

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	Machine Learning Specialization - Stanford University https://www.coursera.org/specializations/machine-learning-introduction	Coursera
2	Data Science Specialization - Johns Hopkins University https://www.coursera.org/specializations/jhu-data-science	Coursera

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	–	–	–	–	–	1	1	–	3	1
CO2	1	1	2	1	3	–	–	–	–	–	1	1	–	3	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	–	3	2
CO4	1	2	3	1	2	–	–	–	–	–	2	3	–	3	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Software Engineering**
Course Code	**:**	**MCE110**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able –

1. To understand the fundamental principles and concepts of software engineering, including the software development lifecycle, requirements engineering, and software project management.
2. To learn and apply various software development methodologies and processes, such asAgile, Waterfall, and DevOps, in real-world software projects.
3. To gain proficiency in software design and architecture, including the creation of well-structured and maintainable software systems.
4. To explore software testing and quality assurance techniques, including unit testing,integration testing, and software verification and validation.
5. To progress skills in developing team software, and the importance of continuousimprovement and testable software.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Software Engineering:** Overview of Software Engineering, Importance of Software Engineering, Software Development Lifecycle (SDLC), Software Process Models (Waterfall, Agile, etc.), Role of Requirements Engineering, Project Management in Software Development	**8**
Unit 2	**Software Development Methodologies:** Agile Methodologies (Scrum, Kanban), DevOps and Continuous Integration/Continuous Deployment (CI/CD), Technical Debit, XP, TSP, MSS, Comparison of Software Development Methodologies, Selecting the Right Methodology for a Project, Software Teams	**8**
Unit 3	**Software Design and Architecture:** Software Design Principles, Object-Oriented Design (OOD), Design atterns Architectural Patterns, Component-Based Development, Modeling and Documentation (UML)	**8**
Unit 4	**Software Testing and Quality Assurance:** Introduction to Software Testing, Types of Software Testing (Unit Testing, Integration Testing, System Testing, etc.), Test Planning and Test Cases, Test Automation, Software Verification and Validation, Quality Assurance and Quality Control	**8**
Unit 5	**Software Maintenance and Evolution:** Software Maintenance Concepts, Challenges in Legacy Systems, Software Refactoring, Code Smells and Anti-patterns, Software Evolution and Continuous Improvement, Software Updates andVersion Control	**5**
Unit 6	**Software Standards and Metrics:** IEEE/ISO	**5**

	standards, Metrics for SRS, design, coding and testing Modern trends in software engineering	

List of Experiments:		**Number of Turns**
1	Requirements Elicitation and Analysis: To practice gathering and analyzing software requirements for a sample project using various techniques, such as interviews, surveys, and use cases.	**2**
2	Agile Software Development with Scrum: To simulate an Agile development environment using Scrum methodology, including sprint planning, daily stand-ups, and sprint reviews.	**2**
3	Software Design and UML Modeling: To design a small software system using UML diagrams, including class diagrams, sequence diagrams, and state diagrams etc, and to document the design.	**2**
4	Unit Testing and Test Automation: To write unit tests for a software module and automate the testing process using a testing framework (e.g., JUnit, pytest).	**2**
5	Software Version Control with Git: To learn version control concepts and use Git to manage a software project, including creating branches, merging changes, and resolving conflicts.	**2**
6	Software Maintenance and Bug Fixing: To work on a sample legacy codebase, fix bugs, and make enhancements, understanding the challenges and importance of maintenance.	**2**
7	Team software project Development	**2**

Course Outcomes:	
1	Students will demonstrate knowledge of fundamental software engineering concepts, methodologies, and principles, as well as comprehension of the different software development lifecycle models, testing strategies, and project management techniques.
2	Students will apply software development methodologies to real-world scenarios, analyze and design software systems using UML modeling, and apply design patterns to improve software architecture.
3	Students will evaluate software testing strategies, assess software quality through quality assurance and verification techniques.
4	Students will demonstrate problem-solving skills by identifying and fixing software bugs and issues, critically analyzing code for improvements, and making informed decisions in choosing appropriate methodologies for various project scenarios.
5	Students will apply their knowledge and skills to create a working software project, and execute experiments that involve actual software development, testing and maintenance.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Software Engineering: A Practitioner's Approach | 9th Edition by Roger Pressman and Bruce Maxim	2023
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Software Engineering, 10/e Paperback – 24 May 2017 by Ian Sommerville	2017
2	FUNDAMENTALS OF SOFTWARE ENGINEERING, 5TH ED by Rajib Mall	2018
3	Software Testing Paperback – 8 August 2012 by Yogesh Singh	2012
4	Software Engineering Body of Knowledge (SWEBOK), IEEE	Online

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	Course Name: "IBM DevOps and Software Engineering Professional Certificate" Online Platform: Coursera Course Link: https://www.coursera.org/professional-certificates/devops-and-software-engineering Details: Develop a DevOps mindset, practice Agile philosophy & Scrum methodology - essential to succeed in the era of Cloud Native Software Engineering,	Coursera
2	Course Name: Software Engineering 101: Plan and Execute Better SoftwareOnline Platform: Udemy Course Link: https://www.udemy.com/course/software-engineering-101/	Udemy

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	2	2	1	1	1	-	-	-	-	3	1
CO2	2	3	2	2	2	1	2	1	1	-	-	-	-	3	-
CO3	3	2	2	2	1	2	1	1	1	-	-	-	-	3	2
CO4	2	3	3	1	2	3	1	1	1	-	-	-	-	3	-
CO5	3	3	3	2	1	1	1	2	1	1	-	-	-	3	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Computer Networks**
Course Code	**:**	**MCE111**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able -

- To understand the basic concepts of computer networks
- To explore various applications and their protocols
- To design and implement various transport layer protocols and algorithms
- To analyze and develop various network layer protocols and algorithms
- To evaluate the performance of various data link control protocols and algorithms

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**COMPUTER NETWORKS AND THE INTERNET** What is the Internet; network edge; network core; Delay, Loss and throughput in Packet-Switched Networks; Protocol Layers and their Service Models.	**6**
Unit 2	**APPLICATION LAYER** Principles of Network Applications; The Web and HTTP; File Transfer: FTP; Electronic Mail in the Internet; DNS - The Internet's Directory Service	**8**
Unit 3	**TRANSPORT LAYER** Introduction and Transport-Layer Services; Multiplexing and Demultiplexing; Connectionless Transport: UDP; Connection-Oriented Transport: TCP; TCP Congestion Control.	**10**
Unit 4	**NETWORK LAYER** Introduction; Virtual circuit and datagram networks; What is inside a router; Internet Protocol (IP): Forwarding and Addressing in the Internet; Routing Algorithms; Routing in the Internet	**10**
Unit 5	**DATA LINK LAYER** Introduction to the link layer; Error Detection and Correction Techniques; Multiple Access links and Protocols; Switched local area networks.	**8**

List of Experiments:		**Numberof Turns**
1	Understanding and using of commands like ping, ipconfig, hostname, getmac, arp, nslookup, netstat, tracert, route,pathping	**2**
2	Socket Programming – Installing and learning Linux operating system, Understanding the syntax, purpose and use of various functions used in sockets programming – connect(), send(), recv(), bind(), listen(),accept(), sendto(), recvfrom() etc. functions, TCP/IP based echo client	**3**

	server and UDP/IP based echo client server	
3	Practicals based on Wireshark – getting started, HTTP, DNS, TCP, IP, ICMP, Ethernet & ARP, DHCP etc.	**9**

Course Outcomes: At the end of the course, students will be able to:	
1	Understand and explain various components of computer networks
2	Illustrate the various applications and protocols
3	Analyze and develop various transport layer protocols and algorithms
4	Explore and apply network layer protocols and algorithms to design and analyze the networks
5	To evaluate and compare various data link control protocols and algorithms

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	James F. Kurose and Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, 6th edition.	2017
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	A.S. Tanenbaum, "Computer Networks", 5th Edition, PHI	2010
2	G. Keiser, "Local Area Networks", 2nd Edition, TMH	2002
3	D. Bertesekas and R. Gallager, "Data Networks", 2nd Edition, PHI	2010
4	William Stallings, "Data & Computer Communication", PHI, 6th Edition	2002
5	B.A. Forouzan, "Data communications and networking", TMH, 1st ed	2000
6	B.A. Forouzan, "Local Area Networks", TMH.	2001
7	B.A. Forouzan, "TCP/IP Protocol Suite", TMH	2005

Equivalent MOOCs courses:

Sr. No.	**Course Links**	**Offered by**
1	Computer Networks, https://onlinecourses.swayam2.ac.in/cec19_cs07/preview	Swayam
2	Computer Networks and Internet Protocol, https://onlinecourses.nptel.ac.in/noc20_cs23/preview	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	2	1	1	1	1	2	3	-	3	1
CO2	2	2	1	2	3	3	2	1	1	2	-	3	-	3	-
CO3	2	3	3	3	3	2	2	1	1	2	1	3	-	2	-
CO4	3	3	3	3	3	2	2	1	2	2	1	3	-	2	2
CO5	3	3	2	2	3	2	1	1	2	2	1	3	-	3	-

1-Low, 2-Medium, 3-High

Course Name	**:**	**Computer Graphics**
Course Code	**:**	**MCE112**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able –

- To Understand graphics hardware, software, Graphics Primitives along with line andcircle drawing algorithms
- To Design Geometric transformations on 2D objects and polygon filling
- To Design Geometric transformations on 3D objects, 2D clipping and color modelsTo Illustrate interactive computer graphic, Bezier Spline Curves using the
- To Demonstrate visible surface detection methods and different types of projections

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**Introductory concepts:** Introduction of Coordinate representation and Pixel Graphics output devices: CRT, Raster Scan & Random Scan systems; Color CRT monitors, DVST, flat-panel displays, video controller and raster scan display processor. Graphics Input Devices: Keyboard, Mouse, Track-ball, space ball, Joysticks, data Glove, Light Pen, Digitizer, Image scanners, touch panels, voice systems; Graphics software	**6**
2	**Graphics Output Primitives:** Point and Lines, Line Drawing Algorithms: Simple, DDA, Bresenham's Line Drawing algorithm, Circle and Ellipse drawing algorithm, Polygon drawing: Representation of polygon; Conventional methods for drawing polygons; Real time Scan Conversion and Run length encoding; Filled area primitives, character generation, Antialiasing	**10**
3	**2D Viewing:** Viewing pipeline, Window-to-viewport transformation, 2-D Clipping, Chen-Sutherland Line Clipping, Mid-point subdivision algorithm, Liang-Barsky clipping, Cyrus-Beck line clipping; Polygon Clipping: Sutherland-Hodgeman and Weiler-Atherton polygon clipping; Character Clipping	**09**
4	**2D-3D Transformations:** Scaling, Rotation, Translation, Shearing, Reflection; Homogeneous coordinates, Composite Transformations, Affine transformation; 3-D concepts and representation, Solid Body transformations, Projections: Perspective, Orthographic, Axonometric, Oblique projections	**09**

5	**Advanced Topics:** Curves and surfaces: Spline representations, Bezier curves and surfaces, B-spline curves and surfaces Visible surface detection methods: Back-face detection,depth-buffer, A-buffer, Z- buffer, scan-line Illumination models and surface rendering: Basic illumination models, Half-toning and dithering techniques, Polygon Rendering, Color models	**08**

List of Experiments:		**Number of Turns**
1	Implement various computer Graphics Functions	1
2	Implement DDA line algorithm	1
3	Implement Bresenham Line algorithm	1
4	Implement Bresenham Circle Algorithm	1
5	Implement Mid-point Ellipse algorithm	1
6	Implement Polygon Filling using Scan Fill, Flood Fill and Boundary Fill Algorithm	1
7	Implement algorithm of 2D Transformation of an Object	2
8	Implement Line Clipping using Cohen- Sutherland Algorithm	2
9	Implement Line Clipping using Liang-Barky algorithm	1
10	Implement Polygon Clipping using Sutherland-Hodgeman Algorithm	1
11	Implement Bezier Curve with C0, C1 continuity in OpenGL	2

Course Outcomes:	
1	Understand graphics hardware, software, Graphics Primitives along with line and circle drawing algorithms
2	Design Geometric transformations on 2D objects and polygon filling
3	Design Geometric transformations on 3D objects, 2D clipping and color models
4	Illustrate, remember, contrast various interactive computer graphic, Bezier Spline Curves
5	Demonstrate visible surface detection methods and different types of projections

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Donald Hearn and M Pauline Baker, “Computer Graphics C Version”,Pearson Education	2004
Reference Books:		

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Foley, Vandam, Feiner, Hughes Computer Graphics: Principles & Practice in C, 2e	2006
2	F. S. Hill Jr., Computer Graphics using OpenGL, Pearson Education,	2003
3	W. M. Newman, R. F. Sproull – "Principles of Interactive computer Graphics" – McGraw Hill.	2001
4	Amrendra N Sinha and Arun D Udai," Computer Graphics", McGrawHill.	2007
5	Donald Hearn and M Pauline Baker, "Computer Graphics with Open GL", Pearson education	2003
6	Open GL: A Primer by Edward Angel Paperback –	2007

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1	Computer Graphics https://archive.nptel.ac.in/courses/106/106/106106090/	NPTEL
2	Computer graphics https://archive.nptel.ac.in/courses/106/103/106103224/	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	-	-	-	-	1	1	1	1	1	-	3	-
CO2	1	1	1	-	1	1	-	1	1	-	1	1	-	2	1
CO3	1	1	1	-	1	1	-	1	1	-	1	1	-	3	-
CO4	1	1	1	-	1	1	1	1	1	1	1	1	-	3	2
CO5	1	1	1	-	1	1	1	1	1	1	1	1	-	3	1

1-Low, 2-Medium, 3-High

Semester-VIII

	Course Name	L	T	P	Credits
	Humanities, Social Sciences and Mgmt. -IV/ Humanities, Social Sciences and Mgmt. -III				3
	Department Elective Course-III	3	1	0	4
	Department Elective Course-IV	3	0	2	4
	Open Elective-III	3	0	2	4
	Proficiency	0	0	4	2
MCP801	Major Project-II	0	0	8	4
	Total				**21**

Department Elective Course-III

Course ID	Course Name	L	T	P	Credits
MCE113	Complex analysis	3	1	0	4
MCE114	Game Theory	3	1	0	4
MCE115	Operations Research	3	1	0	4
MCE116	Linear Algebra and Applications	3	1	0	4

Department Elective Course-IV

Course ID	Course Name	L	T	P	Credits
MCE117	Generative Artificial Intelligence	3	0	2	4
MCE118	Soft Computing	3	0	2	4
MCE119	Mobile Computing and Sensor Networks	3	0	2	4
MCE120	Image Processing	3	0	2	4

Course Name	COMPLEX ANALYSIS
Course Code	MCE113
Credits	4
L T P	3-1-0

Total No. of Lectures – 42

Course Objectives:

Students should be able

- To analyze the basic theory of functions of a complex variable
- To develop the deep understanding of differentiability of complex-valued functions
- To analyze the concepts of singularity, residue and power series in complex functions
- To apply the techniques of complex analysis in solving integration problems

Lecture wise breakup		No. of Lectures
Unit 1	**Functions of a Complex Variable and their Properties**: Complex numbers and their geometric representation, Regions in the Complex Plane, Functions of a complex variable and mappings, Limits, Theorems on limits, Limits involving the point at infinity, Continuity and differentiation, Cauchy-Riemann equations and examples, Sufficient conditions for differentiability, Analytic functions and their examples, Exponential, logarithmic, and trigonometric functions	15
Unit 2	**Complex Integration**: Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and examples, Upper bounds for moduli of contour integrals, Antiderivatives, Cauchy-Goursat theorem, Cauchy integral formula and its extension with consequences, ,Liouville's theorem and the fundamental theorem of algebra	13
Unit 3	**Residue and Integration**: Taylor and Laurent series with examples, Integration, differentiation and uniqueness of power series, Isolated singular points, Residues, Cauchy's residue theorem, Residue at infinity, Types of isolated singular points, Residues at poles and its examples, An application to evaluate definite integrals involving sines and cosines	14

Course Outcomes:	
1	Discuss the fundamental concepts of complex analysis
2	Illustrate the basic techniques involved in calculus of functions of complex variables
3	Analyze power series and singularities in complex functions
4	Calculate line integration and real integrals via residue calculus

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Complex Variables and Applications, Brown, James Ward and Churchill, Ruel V., 9th edition, McGraw-Hill Education. Indian Reprint	2014
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Complex Analysis, Undergraduate Texts in Mathematics, Bak, Joseph & Newman, Donald J., 3rd edition, Springer	2010
2	Functions of One Complex Variable, J. B. Conway, 2nd Edition, Narosa, New Delhi	2002
3	Foundations of Complex Analysis, S. Ponnusamy, 2nd Edition, Narosa, New Delhi	2005

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Complex analysis, https://archive.nptel.ac.in/courses/111/103/111103070/	NPTEL
2	Complex analysis, https://archive.nptel.ac.in/courses/111/106/111106141/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**GAME THEORY**
Course Code	**MCE114**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

Students should be able

- To analyze the fundamental concepts of game theory.
- To study solution methods for matrix games.
- To formulate and solve games by using simplex method.
- To apply the knowledge of game theory concepts to articulate real-world decision situations.
- To understand and apply cooperative game theory principles.

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Game Theory**: Basic definitions, the von Neumann Minimax Theorem, Two person zero sum games with mixed strategies, Dominated Strategies, Graphical Solutions of 2 x m and n x 2 games.	**10**
Unit 2	**Matrix Games:** Solution Methods for Matrix Games, Invertible Matrix Games, Symmetric Games, Matrix Games and Linear Programming, Simplex Algorithm.	**14**
Unit 3	**Two Person Non-Zero Sum Games,** 2×2 Bimatrix Games, Interior Mixed Nash Points, Nonlinear Programming Method for Nonzero Sum Two-Person Games, Choosing Among Several Nash Equilibria.	**08**
Unit 4	**Cooperative Games:** Coalitions and Characteristic Functions, Imputations and their Dominance, The Core of a Game and Strategic Equivalence, Stable Sets of Imputations and Shapley Values	**10**

Course Outcomes:

Students are able to

1	Solve two person zero sum games with mixed strategies.
2	Apply simplex method to solve games.
3	Understand Bimatrix games and two person non-zero sum games.
4	Formulate cooperative games.

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Barron, Emmanual N., Game theory: an introduction. 1st Edition, John Wiley & Sons.	2008
2	Tadelis, Steven. Game theory: an introduction. Princeton university press.	2013

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Kanti Swarup, P.K. Gupta & Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi 9th Edition.	2001
2	N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, Madras.	1984

Equivalent MOOCs courses

Sr. No.	Course Links	Offered by
1	An Introduction to Game Theory https://archive.nptel.ac.in/courses/110/104/110104063/	NPTEL
2	Game theory & Economics https://archive.nptel.ac.in/courses/109/103/109103021/	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MCE115**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able • To explore he characteristics and scope of operations research • To analyze different linear models of optimization problems • To develop, formulate, and solve problems of transportation and assignment model • To apply the theory of queuing models to address issues in real world problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Operations Research:** Definition of operations research, Characteristics of operations research, Scope of operations research.	**3**
Unit 2	**Linear Programming:** Formulation of linear programming problem, Graphical solution, Simplex method, Unrestricted variables, Artificial variables, M-Method, Two phase method, Duality.	**17**
Unit 3	**Transportation Models:** Introduction to the transportation model, Assumption in the transportation model, Definition of the transportation model, Matrix terminology, Formulation and solution of transportation model, Assignment model.	**10**
Unit 4	**Queueing Theory:** Random variable, Poisson and exponential distribution, Queuing model: Introduction, Application of queuing model, Elements of queuing system, Operating characteristics of queuing system, Waiting time and idle time costs.	**12**

Course Outcomes:	
1	Describe the characteristics of operations research and identify its scope in real-world problems
2	Formulate and solve linear models of optimization problems using graphical and simplex method
3	Understand the transportation and assignment models and evaluate their solutions
4	Analyze the performance of queuing systems using different metrics

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Taha, H.A, 10th edition, Pearson.	2017
2	Operations Research, Ravindran, Phillips, and Solberg, 2nd	2000

	edition, John Wiley & sons.	
3	Engineering Optimization, S S Rao, 4nd edition, New Age.	2009
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007
2	Operations Research, Sharma S.D., Kedarnath, Ramnath & Company.	1994
3	Operations Research, Bronson R, Shaum's Outline Series.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL
3	Advanced Operations Research https://nptel.ac.in/courses/112106131	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	1
CO2	3	2	1	1	1	–	–	–	–	–	2	1	3	–	3
CO3	1	2	1	1	2	–	–	–	–	–	1	2	3	–	3
CO4	2	3	1	2	1	–	–	–	–	–	2	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**LINEAR ALGEBRA AND APPLICATIONS**
Course Code	**:**	**MCE116**
Credits	**:**	**4**
L T P		**3-1-0**

Course Objectives:

Students should be able

1. To explore basic properties of vector spaces over fields.
2. To apply various canonical forms for matrices.
3. To explore fundamentals of inner product spaces and orthogonality.
4. To develop knowledge of bilinear forms and its properties.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit I	**VECTOR SPACES** Fields: Fields of numbers, finite fields, vector spaces over fields, Linear dependence, basis, dimension, co-ordinates with respect to basis, change of basis, subspace, linear transformation, range space and rank, null space and nullity, rank-nullity theorem, matrix representation of a linear transformation.	8
Unit II	**CANONICAL FORMS** Review of eigenvalues and eigenvectors, the minimal polynomial, algebraic and geometric multiplicities, triangularization, diagonalization, invariant subspaces, invariant direct sums, primary decomposition theorem, Jordan Canonical form.	14
Unit III	**INNER PRODUCT SPACES** Definition of inner product, orthogonality, Gram-Schmidt orthogonalization process, orthogonal projections, positive definite, adjoint, self-adjoint, unitary and normal operators, spectral theorem for self-adjoint and normal vectors on finite dimensional vector spaces, bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia.	20

Course Outcomes: By the end of the course, the students will be able to

1. Discuss vector spaces over fields, subspaces and inner product spaces and state its properties.
2. Apply the significance of canonical forms of matrices in solving problems.
3. Explain the linear algebra techniques to solve linear system of equations
4. Analyze the properties of inner product spaces to determine orthogonality and projections of vectors.
5. Interpret the mathematical models using linear algebra concepts to represent real world problems.

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Stephen H. Friedberg, A. Insel, L. Spence, Linear Algebra,	2003

	Pearson.	

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Prentice Hall of India.	2015
2	S. Axler, Linear Algebra Done Right, 3rd edition. Undergraduate Texts in Mathematics. Springer.	2015
3	P. Halmos, Finite Dimensional Vector Spaces, Springer.	1974
4	S. Lang, Linear Algebra, Undergraduate Texts in Mathematics. Springer-Verlag, New York.	2004

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1	NPTEL :: Mathematics - NOC:Linear Algebra https://archive.nptel.ac.in/courses/111/104/111104137	NPTEL
2	NPTEL :: Mathematics - NOC:Linear Algebra https://archive.nptel.ac.in/courses/111/106/111106135	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	–	–	–	–	–	1	1	3	–	1
CO2	1	1	2	1	2	–	–	–	–	–	1	1	3	–	2
CO3	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	2	3	1	2	–	–	–	–	–	2	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Generative Artificial Intelligence**
Course Code	**:**	**MCE117**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able -

- To understand the fundamental concepts and techniques of Generative AI.
- To analyze and compare various generative AI models.
- To apply generative AI tools and techniques to real-world applications.
- To critically evaluate the ethical and societal implications of Generative AI.
- To develop practical skills in implementing and working with generative AI modelsusing popular libraries and frameworks.

Total No. of Lectures – 42

Lecture wise breakup		**No.of Lectures**
Unit 1	**Foundations of Generative AI** Introduction to AI, Machine Learning, and Deep Learning; Overview of Generative AI: Concepts, applications, and challenges; Probability and Statistics for Generative AI; Backpropagation and Optimization Techniques for Generative Models	**8**
Unit 2	**Generative Modeling Techniques** Generative Adversarial Networks (GANs): Theory, architectures, and training strategies; Variational Autoencoders (VAEs): Latent space exploration, loss functions, and applications; Autoregressive Models: Recurrent Neural Networks (RNNs), Transformers, and their applications in text generation; Other Generative Models: PixelCNN, StyleGAN, VQ-VAE, and their unique capabilities	**10**
Unit 3	**Applications of Generative AI** Image generation and editing: Deepfakes, photorealistic images, and artistic style transfer; Text generation and manipulation: Machine translation, creative writing, and dialogue systems; Music generationand composition: Neural networks for creating new musical pieces and styles; Other Applications: Drug discovery, materials science, and personalized learning	**10**
Unit 4	**Ethical and Societal Implications** Bias and fairness in Generative Models; Deepfakes and misinformation; Explainability and transparency of Generative Models; Intellectual property and ownership of AI-generated content	**8**
Unit 5	**Projects on Generative AI** Introduction to popular libraries and frameworks (TensorFlow, PyTorch); Implementing a simple GAN for image generation; Text generation with LSTMs and Transformers; Project presentations anddiscussion	**6**

List of Experiments:		Number of Turns
1	Explore python libraries and frameworks for implementing generative AI models.	**2**
2	Visualize how a linear regression model makes decisions by exploring its decision boundary.	**1**
3	Generate and analyze realistic MNIST digits using a basic Generative Adversarial Network (GAN).	**2**
4	Train a Variational Autoencoder (VAE) on MNIST images and explore its latent space. Manipulate the latent space to generate new and excitingvariations of MNIST digits.	**2**
5	Fill in the gaps of a partially occluded image using AI magic (image inpainting).	**2**
6	Transform a photograph into a painting with AI-powered style transfer.	**1**
7	Analyze the bias of a pre-trained image classification model using fairness metrics.	**2**
8	Use a pre-trained language model like GPT-3 to generate poems, code, or scripts based on your prompts.	**2**

Course Outcomes: After completion of course, students would be able to:	
1	Apply fundamental concepts of Generative AI to analyze and compare different generative models.
2	Design and implement generative models for specific applications like image generation and text synthesis.
3	Evaluate the ethical and societal implications of Generative AI and propose mitigation strategies.
4	Independently explore and learn new advancements in the field of Generative AI.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication /Reprint**
1	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning" (Adaptive Computation and Machine Learning series). MIT Press.	2016
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	David Foster, "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play". O'Reilly Media.	2023
2	Kim-Hui Yap, "Deep Learning with Generative Adversarial Networks", Apress.	2019
3	Carl Berg-Lund and Thomas Lee, "Deep Learning for Computational Physics", CRC Press.	2023

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1	"Generative AI Fundamentals Specialization" https://www.coursera.org/specializations/generative-ai-for-everyone	Coursera (IBM)
2	"Generative AI for Everyone" https://www.coursera.org/learn/generative-ai-for-everyone	Coursera (Google Cloud & DeepMind)
3	"Generative AI with LLMs" https://www.deeplearning.ai/courses/generative-ai-with-llms/	DeepLearning.AI
4	"Generative AI Fundamentals with Google Cloud", https://www.udacity.com/course/generative-ai-fundamentals-for-google-cloud--cd13291	Udacity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	2	-	-	-	-	1	-	1	1	2	1
CO2	2	-	3	-	2	-	-	-	-	1	-	1	1	2	-
CO3	1	-	1	-	-	2	-	3	-	1	-	1	-	1	2
CO4	1	-	1	-	1	1	-	2	-	1	1	2	-	2	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Soft Computing**
Course Code	**:**	**MCE118**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able

- To understand and analyze various soft computing techniques.
- To explore and analyze how to design, train, and fine-tune different soft computingtechniques using practical programming languages and tools.
- To annotate the synergy of combining different soft computing paradigms and learn howto create hybrid models to solve multidisciplinary challenges.
- To evaluate the performance of different soft computing techniques.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION TO SOFT COMPUTING** Evolution of Soft computing, Soft and Hard Computing, Characteristics and Application of Soft Computing, Soft Computing Constituents	**5**
2	**NEURAL NETWORKS** Structure and working of Biological Neural Network, Fundamentals of Artificial Neural Networks & Applications, Characteristics of Artificial Neural Networks, History of Neural Network research, Learning Methods, Perceptron, Multilayer Neural Networks, Recurrent and Non-Recurrent Neural Networks, Advances in Neural Networks, Applications of ANN in Solving Engineering Problems	**8**
3	**INTRODUCTION TO FUZZY LOGIC** Fuzzy Logic, Fuzzy Sets, Operations on Fuzzy Sets, Membership Functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Defuzzification, Fuzzy Decision Making, Fuzzy Logic Controller Design and Applications	**8**
4	**GENETIC ALGORITHMS (GA)** Introduction to GA, GA Operators: Encoding, Crossover, Selection, Mutation, Phases of GA, Solving of Single Objective Problems, Solving of Multi Objective Optimization Problems, Applications of GA	**8**
5	**HYBRID SYSTEMS** Introduction, Architecture of a Hybrid system and its applications	**7**

6	**MACHINE LEARNING** Introduction to Machine Learning, Types of Machine Learning, Machine Learning Techniques: Supervised, Unsupervised and Reinforcement learning	**6**

List of Experiments:		**Number of Turns**
1	Implement OR, AND using Perceptron	**3**
2	Implement X-OR function using back propagation algorithm	**3**
3	Solve a given problem-1 (Operations) using Fuzzy Logic	**2**
4	Solve a given problem-1 (Max-Min Composition) using Fuzzy Logic	**2**
5	To find the solution of the function Maximize, given the constraintsusing GA approach.	**2**
6	Design a hybrid system for any real-world problem	**2**

Course Outcomes:	
1	Identify and describe soft computing techniques and their roles in building intelligent machines
2	Recognize the feasibility of applying a soft computing methodology for a particular problem
3	Effectively use existing software tools to solve real problems using a soft computing approach
4	Evaluate and compare solutions by various soft computing approaches for a given problem.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Neuro fuzzy and soft computing by Jang, Pearson Education	1996
Reference Books:		

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Learning and Soft Computing by Kecman, Pearson Education	2001
2	With Case Studies and Applications from the Industry, Apress	2020
3	Neural Network in computer Intelligence by Fu, TMH	2003
4	Bio-Inspired Artificial Intelligence – Dario Floreano, PHI	2008

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1	NOC:Evolutionary Computation for Single and Multi-ObjectiveOptimization, IIT Guwahati https://nptel.ac.in/courses/112103301	Swayam
2	Neural Networks and Applications, IIT Kharagpur, Prof. Somnath Sengupta	Swayam

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	3	1	3	1	1	1	1	1	3	1	3	-	3	2
CO2	3	3	2	2	3	1	1	1	2	2	2	3	-	3	2
CO3	3	3	3	3	3	2	3	2	3	3	3	3	-	3	2
CO4	1	3	1	3	1	3	3	3	1	1	1	1	-	3	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Mobile Computing and Sensor Networks**
Course Code	**:**	**MCE119**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able

- To Identify the key components and technologies involved in mobile computing andsensor networks.
- To Explain the principles behind wireless LAN, PAN and WAN technologies
- To Analyze and Apply mobile network and transport layer protocols
- To Evaluate the trade-offs between different sensor network architectures andprotocols.
- To Assess the security measures in mobile and sensor network applications.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Wireless and Mobile Computing Fundamentals** Wireless transmission and networking, Multiple Access Technologies- CDMA, FDMA, TDMA, Cellular architecture, Frequency reuse, Channel assignment strategies, Spread spectrum Technologies	**8**
Unit 2	**Wireless LAN, PAN, WAN** Wireless LANs - IEEE 802.11 standards, Architecture & protocols,Infrastructure vs. Adhoc Modes, Hidden Node Problems, Wireless PANs - Bluetooth and Zigbee, Introduction to WirelessSensors, Introduction to Vehicular Adhoc Networks Wireless WANs – 2G, 3G, 4G, 5G, 6G, Protocols for digital cellularsystems such as GSM, EDGE, GPRS, UMTS	**10**
Unit 3	**Mobile Network and Transport Layer** Mobile IP, DHCP, traditional TCP, classical TCP improvements,support for mobility	**8**
Unit 4	**Ad hoc & Sensor Networks** Adhoc network routing protocols - Destination sequenced distance vector algorithm, Cluster based gateway switch routing, Ad hoc on- demand routing, Location aided routing, Zonal routing algorithm. Sensor networks - fundamentals, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS	**10**
Unit 5	**Security in Wireless and Mobile Networks** Vulnerabilities, Security techniques, Wi-Fi Security, IEEE 802.11x andIEEE 802.11i standards, DoS in wireless communication	**6**

List of Experiments:		Number of Turns
1	netsh WLAN Commands for Windows 10	**3**
2	Wireshark Lab: Getting Started, Investigating the 802.11 wireless network protocol, Examining and investigating the DHCP packets,analyzing a trace of the TCP segments	**4**
3	Downloading, Installing and learning Linux operating system	**1**
4	Downloading, Installing and Learning ns3.36.1	**1**
5	Study and Run networking scripts in ns3.36.1	**5**

Course Outcomes: At the end of the course, students will be able to:	
1	Recall and Describe the core concepts and terminologies related to mobile computing and sensor networks
2	Explain the principles and components of wireless LAN, PAN and WAN technologies
3	Demonstrate and examine the ability of mobile network and transport layer protocols
4	Evaluate and compare various sensor network architectures and protocols
5	Assess the security measures in mobile and sensor network applications.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication /Reprint**
1	Jochen Schiller "Mobile Communications", Addison Wesley, Pearson Education, 2nd edition.	2003
2	Behrouz A. Forouzan, "Data Communication and Networking", McGraw Hill, 5th edition	2013
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication /Reprint**
1	Theodore S. Rappaport, "Wireless communications – principles and practice" PHI, 2nd	2010
2	Willian Stallings, "Wireless communications and networks", pearson, 2nd ed	2009
3	R. Price, "Fundamentals of Wireless networking", TMH	2012
4	T.L. Singal, "Wireless communications", MGH	2013
5	CK. Toh, "Adhoc mobile wireless networks-protocols and systems", Pearson	2015
6	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc	2014

Equivalent MOOCs courses:

Sr. No.	Course Links	Offered by
1	Wireless Adhoc and Sensor Networks https://archive.nptel.ac.in/courses/106/105/106105160/	NPTEL
2	Sensor Networks https://www.coursera.org/lecture/internet-of-things-history/sensor- networks-n-to-1	Coursera

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	1	1	1	2	2	1	3	-	3	2
CO2	3	1	1	1	3	1	1	1	2	2	1	3	-	3	2
CO3	3	3	3	3	3	1	1	1	2	2	1	3	-	3	1
CO4	3	3	3	3	3	1	1	1	2	2	1	3	-	3	2
CO5	3	2	2	2	3	1	1	1	2	2	1	3	-	3	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Image Processing**
Course Code	**:**	**MCE120**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

Students should be able -

- To analyze the basic theory and the methods that are widely used in digital image processing
- To explore various methods to enhance the image in different domains using imageprocessing
- To apply the techniques of noise removal, edges detection etc
- To develop hands on experience to process images in many domains.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**INTRODUCTION AND FUNDAMENTAL TO DIGITAL IMAGE PROCESSING** Origin of Digital Image Processing, Fundamental steps in Digital Image Processing, Components of Digital Image Processing System, Image sensing and acquisition, Image sampling, quantization and representation, Basic relationship between pixels.	**7**
Unit 2	**IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN & FREQUENCY DOMAIN** Basic grey level transformation, Histogram processing, Basics of Spatial filtering, Smoothing and Sharpening spatial filters, Introduction to Fourier Transform and the Frequency Domain, Discrete Fourier Transform, Smoothing and Sharpening Frequency – Domain filters.	**8**
Unit 3	**IMAGE RESTORATION** Image Degradation/Restoration Process, Noise models, restoration in presence of noise, Inverse filtering, Minimum Mean Square Filtering, Geometric menu filter, Geometrictransformations.	**5**
Unit 4	**COLOR IMAGE PROCESSING** Color Fundamentals, Color models, Basis of full color imageprocessing, Colortransformations.	**3**
Unit 5	**IMAGE COMPRESSION** Fundamentals, Image compression models, Error freecompression, Lossy compression.	**5**
Unit 6	**MORPHOLOGICAL IMAGE PROCESSING and IMAGE SEGMENTATION** Edge detection, Edge linking via Hough transform Thresholding – Region based segmentation – Region growing – Region splitting and merging	**5**

	Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.	
Unit 7	**REPRESENTATION, DESCRIPTION AND RECOGNITION** Representation-chain codes, polygonal approximation andskeletons, Boundary descriptors-simple descriptors, shape numbers, Regional descriptors, topological descriptors.	**3**
Unit 8	**PATTERN RECOGNITION** Pattern and pattern classes, Recognition Based on Decision-Theoretic Methods, Structural methods	**6**

List of Experiments:		**Number of Turns**
1	Implement the basic commands/ functions of an image processing tool.	1
2	Take an input image and plot its histogram with various ways asimhist, bar, stem, plot and histogram processing can be used for imageenhancement.	1
3	Various operations like scaling, Arithmatic operators etc on image.Filtering using MATLAB package	1
4	Filtering for Blurring and Sharpening the image in spatial and frequency domain	2
5	Implement various Nonlinear Spatial Filters.	2
6	Implement various types of filters to remove the noise in an image.	2
7	Implement image compression algorithms.	2
8	Design problems related to image segmentation	1
9	Design problems related to image recognition, pattern recognition	2

Course Outcomes:	
1	Understand the concepts of Digital image processing
2	Apply the concept of spatial and domain filtering in image processing
3	Identify the cause of image degradation and Apply restoration methods
4	Evaluate and calculate the image compression techniques, image segmentation

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Digital Image processing By Rafael C. Gonzalez and Richard E. Woods- Pearson Education	2006

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Digital Image Processing by A.K. Jain, PHI	1995
2	Digital Image processing (An algorithmic approach) By Madhuri A. Joshi - PHI	2006
3	Digital Image Processing And Pattern Recognition, malaya k pakhira, PHI	2011

Equivalent MOOCs courses:

Sr. No..	**Course Links**	**Offered by**
1	https://onlinecourses.nptel.ac.in/noc22_ee116/preview IIT- Khargpur (Prof. Prabir Kumar Biswas, Department Of EECE IIT Kharagpur)	NPTEL
2	https://onlinecourses.nptel.ac.in/noc21_ee23/preview Prof MK Bhuyan, IIT Guwahati	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	1	1	1	-	1	1	1	1	1	1	2	-	3	1
CO2	-	1	1	-	1	1	1	1	1	-	1	1	-	3	-
CO3	-	1	1	-	1	1	1	1	1	-	1	1	-	3	2
CO4	-	1	1	1	1	1	1	1	1	1	1	1	-	3	3

1-Low, 2-Medium, 3-High

OPEN ELECTIVE COURSES

S. No.	Course Code	Course Name	L	T	P	Credits
1.	MCO101	Optimization Techniques	3	1	0	4
2.	MCO102	Algebra	3	1	0	4
3.	MCO103	Number Theory	3	1	0	4
4.	MCO104	Fourier Series and Integral Transforms	3	1	0	4
5.	MCO105	Algebraic Coding Theory	3	1	0	4
6.	MCO106	Topology	3	1	0	4
7.	MCO107	Numerical Analysis	3	1	0	4
8.	MCO108	Partial Differential Equations and Special Functions	3	1	0	4

Course Name	**:**	**OPTIMIZATION TECHNIQUES**
Course Code	**:**	**MCO101**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able - • To develop mathematical model of optimization problems and explore different techniques to solve linear models of optimization • To analyze the extreme values of unconstrained and constrained problems • To apply classical methods to solve non-linear models for optimization problems • To analyze conditions for the optimality of multivariable optimization problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Linear Programming:** Formulation, Graphical solution, Simplex method, Relation between graphical and simplex method, Unrestricted variables, Artificial variables, M-method and Dual phase method.	**16**
Unit 2	**Optimization Techniques:** **Unconstrained Problems -** (single and multivariable optimization) necessary and sufficient conditions for extreme points. **Constrained Problems** - (multivariable optimization) Equality constraints - Jacobian and Lagrangian methods, Application of Jacobian method to linear problems. Inequality constraints – extension of Lagrangian method, Karush Kuhn Tucker conditions.	**12**
Unit 3	**Non - Linear Programming:** **Unconstrained Algorithms –** Direct search methods - Dichotomous and Golden search, Univariate and Hooke and Jeeves search methods. Gradient methods - Cauchy's steepest ascent method and Newton's method.	**14**

Course Outcomes:	
1	Analyze the performance of linear and non-linear programming algorithms
2	Explain and implement the graphical solution and simplex method for linear programming problems
3	Apply and compare the Jacobian and Lagrangian methods to solve non-linear programming problems
4	Identify and classify the critical points of the non-linear functions

5	Describe the necessary and sufficient conditions for optimality in non-linear programming

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Hamady Taha, 10th edition, Pearson	2017
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Ravindran, Phillips, and Solberg, John Wiley & sons.	2000
2	Engineering Optimization, S S Rao, New Age	2000
3	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization Methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	1	–	–	–	–	–	2	2	3	–	1
CO2	2	3	1	1	1	–	–	–	–	–	1	2	3	–	2
CO3	3	1	1	1	2	–	–	–	–	–	2	2	2	–	2
CO4	1	3	1	2	1	–	–	–	–	–	1	2	3	–	2
CO5	3	1	2	1	1	–	–	–	–	–	1	2	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**ALGEBRA**
Course Code	**:**	**MCO102**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Student should be able

- To explore the basic concepts of group theory
- To apply the Lagrange's and Euler's Theorems to solve problems related to groups
- To analyze the normal subgroups, quotient groups, and homomorphisms
- To develop a deep understanding of the fundamental concepts of ring theory

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Group:** Definition of a group, Examples, Some preliminary lemmas, Subgroups, Examples, Cosets, Order of a group, Lagrange's theorem, Euler's theorem, A counting principle.	**12**
Unit 2	**Properties of Groups:** Normal subgroups and quotient groups, Homomorphism, Cauchy's theorem, Sylow's theorem for Abelian groups, Permutation groups, Conjugacy classes, Class equation.	**14**
Unit 3	**Rings :** Definition and examples of rings, Subrings, Integral domain, Fields, Characteristic of a ring, Ideals, Factor rings, Prime ideals and maximal ideals. .	**16**

Course Outcomes:	
1	Define and illustrate the concept of groups, subgroups, and cosets
2	Explain the application of Lagrange's theorem in group theory
3	Interpret the significance of normal subgroups, quotient groups, and homomorphisms
4	Analyze the concept of conjugacy classes and class equation
5	Discuss the fundamental concepts of ring theory

Text Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Topics in Algebra, Herstein, I.N., 2nd edition, Wiley Eastern Limited, New Delhi.	1981
2	Contemporary Abstract Algebra, Joseph A. Gallian, (4th Edition), Narosa Publishing House, New Delhi	1999
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	Modern Algebra, Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
2	Rings and Modules, Musili, C, Narosa Publishing House, (2nd Edition), New Delhi.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Introduction to abstract and linear algebra, https://archive.nptel.ac.in/courses/111/105/111105112/#	NPTEL
2	Introduction to abstract group theory, https://archive.nptel.ac.in/courses/111/106/111106113/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	1	1	2	1	–	–	–	–	–	1	1	3	–	1
CO3	2	3	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	2	3	1	2	1	–	–	–	–	–	2	1	3	–	2
CO5	3	1	2	1	1	–	–	–	–	–	1	1	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**NUMBER THEORY**
Course Code	**:**	**MCO103**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able

- To develop a deep understanding of number theory, including divisibility, greatest common divisor, Euclidean algorithm, primes, and fundamental theorem of arithmetic
- To analyze and solve congruences, including residue classes, reduced residue classes, Fermat's theorem, Euler's theorem, Wilson's theorem, and Chinese remainder theorem
- To explore the concepts of congruences of higher degree, prime power modulii, prime modulus, primitive roots, indices, power residues, quadratic residues, quadratic reciprocity, and Jacobi symbols
- To apply the concepts of number theory to solve Diophantine equations and other problems in mathematics and computer science

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Basic Properties of Integers:** Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, Primes, Fundamental theorem of arithmetic.	**8**
Unit 2	**Congruences of Degree One:** Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson theorem, Solution of congruences, Congruences of degree 1, Chinese remainder theorem with applications. Euler's φ-function.	**12**
Unit 3	**Congruences of Higher Degree :** Congruences of higher degree, Prime power moduli, Prime modulus, Primitive roots, Indices and their applications, power residues, Quadratic residues, Quadratic reciprocity, Legendre symbol, Euler's criterion, Gauss's lemma, Quadratic reciprocity law, Jacobi symbol.	**12**
Unit 4	**Diophantine Equations :** Greatest integer function, Arithmetic function, Mobius inversion formula, Diophantine equations.	**10**

Course Outcomes:	
1	Define and explain the key concepts of number theory, including divisibility, Euclidean algorithm, primes, fundamental theorem of arithmetic, congruences, residue classes, Fermat's theorem, Euler's theorem, Wilson's theorem, quadratic reciprocity law, etc.
2	Explain the relationship between the different concepts in number theory, such as how congruences are related to residue classes and how quadratic reciprocity is related to power residue
3	Define and apply the concepts of greatest integer function, arithmetic functions Möbius inversion formula to prove number-theoretic identities
4	Apply the Chinese remainder theorem to solve a system of linear congruences, the quadratic reciprocity law to determine the solvability of a

	quadratic congruence and Euler's theorem to solve a problem in modular arithmetic
5	Define and apply the basic concepts of number theory, including divisibility, greatest common divisor, prime numbers, and the Fundamental theorem of arithmetic

Text Book:		
Sr.No	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	An introduction to theory of numbers, Niven I., Zuckerman S. H. and Montgomary L. H. 5th edition, John Wiley and Sons.	1991
Reference Books:		
Sr.No	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Introduction to Theory of Numbers, Hardy and Wright W. H. Oxford University Press	2008
2	Higher Arithmetic, Davenport H. 8th edition, Cambridge University Press.	2008
3	Elementary Number Theory, David M. Burton, McGraw-Hill Higher Education	2010

Equivalent MOOCs courses

Sr.No	**Course Links**	**Offered by**
1	A basic course in number theory https://archive.nptel.ac.in/courses/111/101/111101137/	NPTEL
2	Number Theory https://archive.nptel.ac.in/courses/111/103/111103020/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	2	1	1	1	–	–	–	–	–	1	2	3	–	2
CO3	1	3	1	1	2	–	–	–	–	–	2	1	3	–	2
CO4	3	2	1	2	1	–	–	–	–	–	1	2	3	–	2
CO5	3	1	2	1	1	–	–	–	–	–	2	3	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**FOURIER SERIES AND INTEGRAL TRANSFORMS**
Course Code	**:**	**MCO104**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able ● To develop a comprehensive understanding of periodic functions, trigonometric series, and Fourier series ● To apply the knowledge of Fourier series and Fourier integrals in approximating functions by trigonometric polynomials ● To explore the principles and applications of Fourier transforms, including Fourier Cosine and Sine transforms, and the properties associated with them ● To analyze the Laplace transforms to solve differential and integral equations using techniques such as s-shifting, t-shifting, and the convolution theorem

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Fourier Series:** Periodic functions, Trigonometric series, Fourier series, Euler's formula, Conditions for existence of Fourier series, Functions of any period p = 2L, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis, Approximation by trigonometric polynomials.	**12**
Unit 2	**Fourier Transforms and Their Properties:** Fourier integral, Fourier Sine and Cosine integrals, Evaluation of integrals, Fourier transforms, Fourier Cosine and Sine transforms, Properties of Fourier transform, Linearity and symmetry, Change of time scale, Time shifting, Frequency shifting, Fourier transform of derivatives and integrals.	**18**
Unit 3	**Laplace Transforms, Properties and Applications:** Laplace transform, Inverse transform, Properties of Laplace transform, Transforms of derivatives and integrals, s-Shifting, t-Shifting, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Convolution theorem - Applications to differential and integral equations.	**12**

Course Outcomes:	
1	Define and recognize the concepts of periodic functions, trigonometric series, and Fourier series
2	Analyze functions of any period and apply half-range expansions and harmonic analysis
3	Synthesize knowledge of Fourier cosine and sine integrals and their evaluation techniques
4	Apply the knowledge of Laplace transform to solve differential and integral equations arising in engineering problems

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics Erwin Kreyszig, John Wiley, 10th edition	2011
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Higher Engineering Mathematics, B V Ramana, Tata McGraw -Hill	2008
2	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill.	2003
3	Integral transforms and their Applications, L. Debnath, CRC Press, New York London- Tokyo	1995

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Transform Calculus and Its Applications In Differential Equation, https://archive.nptel.ac.in/courses/111/105/111105123/	NPTEL
2	Integral Transforms and their Applications, https://archive.nptel.ac.in/courses/111/102/111102129/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PS02**	**PSO3**
CO1	2	3	1	1	1	–	–	–	–	–	2	2	3	–	1
CO2	3	2	1	1	1	–	–	–	–	–	1	2	3	–	1
CO3	1	3	1	1	2	–	–	–	–	–	1	1	3	–	2
CO4	1	3	2	2	1	–	–	–	–	–	3	3	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MCO105**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able • To explore the foundational concepts of source and channel coding • To develop the understanding of finite fields and polynomial rings • To explore the concepts of linear codes • To apply the theory of cyclic codes to solve problems related to coding theory

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Coding Theory:** Source and Channel coding, Error detecting and error correcting codes.	2
Unit 2	**Error Detection, Error Correction and Decoding:** Communication Channels, Maximum likelihood decoding, Hamming distance, Nearest neighbour / minimum distance decoding, Distance of a code.	6
Unit 3	**Finite Fields:** Fields, Polynomial rings, Structure of finite fields, Minimal polynomials.	10
Unit 4	**Linear Codes:** Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome decoding, Weight enumerator of a Code, Macwilliam's identity**.**	16
Unit 5	**Cyclic Codes:** Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes:	
1	Define and comprehend the concepts of source and channel coding
2	Execute knowledge of finite fields, polynomial rings, and the structure of finite fields to solve coding theory problems
3	Analyze linear codes and their properties, including the Hamming weight, generator matrix, parity check matrix
4	Apply the concepts of cyclic codes, including the understanding of generator polynomials

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Coding Theory, San Ling & Chaoping Xing, Cambridge University Press.	2010
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Introduction to the 'Theory of Error Correcting Codes, Vera Pless, Cambridge University Press.	2003
2	Introduction to Error Correcting Codes, Raymond Hill, Clarendon Press, Oxford.	1986
3	Theory of Error Correcting Codes Part I & II, F.J.Macwilliams & NJA Sloane.	1977

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	An Introduction to Coding Theory, https://onlinecourses.nptel.ac.in/noc20_ee94/preview	NPTEL
2	Coding theory, https://archive.nptel.ac.in/courses/117/106/117106031/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	2	1	1	1	–	–	–	–	–	1	1	3	–	2
CO3	2	3	1	1	1	–	–	–	–	–	1	1	3	–	1
CO4	3	1	1	2	2	–	–	–	–	–	2	3	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**TOPOLOGY**
Course Code	**:**	**MCO106**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able ● To develop a comprehensive understanding of topological spaces and its properties ● To explore the concept of continuous mappings on a topological space ● To analyze the notions of connectedness, path-connectedness, and local connectedness in relation to the continuity of functions ● To apply the principles of compactness and separation axioms to solve problems related to topological spaces

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Topological Concepts**: Topological spaces, Basis, Subbases, Open sets, Closed sets, Limit point, Closure of a set and its properties, Neighborhood of a point, Neighborhood axioms, Boundary of a set, Creating new topology, The subspace topology, Quotient topology, Product topology.	12
Unit 2	**Continuous Maps and Their Properties:** Alternative method of defining topology in terms of Kuratowski closure operator, First and second countable spaces, Separable spaces, Continuous maps, Closed maps and their characterizations, Homeomorphisms.	12
Unit 3	**Topological Properties:** Connectedness, Connected components, Path connectedness, Local connectedness, Continuity and connectedness. Compactness, Basic properties of compactness, One point compactification, Finite intersection property, B-W compactness. Countable compactness, Lindelof spaces.	12
Unit 4	**Separation Axioms:** T_0,T_1,T_2,T_3,T_4, Regular, Normal, Completely regular and their properties.	6

Course Outcomes:	
1	Define and illustrate the concepts of topological spaces, and their basic elements
2	Explain the properties of closed sets, limit points, and neighborhoods in the context of topological spaces
3	Analyze the role of continuous maps, closed maps, and homeomorphisms in the context of topological spaces
4	Interpret the principles of compactness, separation axioms, and their properties

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	General Topology, S.Willard, Dover publications.	2012
2	Foundations of General Topology, William J. Pervin and Ralph P. Boas (Auth.), Elsevier Inc	1964
3	Topology, J.R. Munkres, 2nd edition, Pearson education	2003
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	General Topology, J.L.Kelly, Springer.	1975
2	Counter Examples in Topology, L.A.Steen & J.A. Seebach, (2nd ed.) Dover Publications.	1995
3	Topology For Analysis,A.Wilansky:Toronto:Xerox College Publishing.	1970

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Topology https://nptel.ac.in/courses/111106054	NPTEL
2	An invitation to topology https://nptel.ac.in/courses/111106159	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	2	1	1	1	–	–	–	–	–	1	1	3	–	1
CO3	1	3	1	1	2	–	–	–	–	–	2	1	3	–	1
CO4	2	3	1	2	1	–	–	–	–	–	1	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**NUMERICAL ANALYSIS**
Course Code	**:**	**MCO107**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able –

- To develop a deep understanding of the theoretical foundations of numerical methods, including the concepts of convergence, stability, and accuracy
- To analyze the different types of errors in numerical calculations and their effects on the accuracy of results
- To explore methods and algorithms for reducing and controlling errors in numerical calculations
- To analyze the accuracy of different interpolation and numerical differentiation and integration methods, and identify the most appropriate method to use for a given problem
- To apply different numerical methods to solve algebraic and transcendental equations

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Errors:** Errors in numerical calculations, Absolute, Relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.	5
Unit 2	**Root Finding Methods:** Bisection method, Regula-Falsi , Fixed point iteration and its convergence, Newton-Raphson, Acceleration of convergence using Aitken's method; Generalized Newton's	7
Unit 3	**Solution of Linear System of Equations:** Direct methods - Gauss elimination, Partial pivoting, Complete pivoting, Gauss-Jordan and factorization methods, Iterative methods-Gauss Seidal and Jacobi's methods.	6
Unit 4	**Interpolation:** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Errors.	10
Unit 5	**Numerical Differentiation and Integration:** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature.	8
Unit 6	**Numerical Methods for Differential Equations:** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods (Adam's and Milne's method).	6

Course Outcomes:	
1	Define and explain the key concepts of numerical methods, including errors, convergence, stability, and accuracy

2	Describe the different numerical methods for solving non-linear equations, interpolation, numerical differentiation and integration, and differential equations
3	Explain how to compute the absolute, relative, and percentage errors of a numerical calculation
4	Compare and contrast different numerical methods for solving a given problem
5	Identify the most appropriate numerical method to use for a given problem, taking into account the desired accuracy, computational cost, and other factors

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Numerical Methods for Mathematics, Science and Engineering, John H. Mathews, Prentice Hall.	1992
2	Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, McGraw-Hill.	2014
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
2	An Introduction to Numerical Analysis, Atkinson, John Wiley.	2012
3	Numerical Methods, Jain, S R K Lyengar R K, New Age international Publishers.	2009

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Numerical Analysis https://archive.nptel.ac.in/courses/111/107/111107062	NPTEL
2	Numerical Analysis https://archive.nptel.ac.in/courses/111/101/111101165/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	3
CO2	3	2	1	1	1	–	–	–	–	–	1	1	3	–	2
CO3	2	3	1	1	1	–	–	–	–	–	2	3	3	–	2
CO4	3	1	1	2	2	–	–	–	–	–	1	1	3	–	3
CO5	3	2	1	1	1	–	–	–	–	–	2	2	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**PARTIAL DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS**
Course Code	**:**	**MCO108**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able –

- To develop a deep understanding of the theoretical foundations of partial differential equations and special functions
- To analyze the different types of partial differential equations and their properties
- To explore methods for solving partial differential equations and series solutions to differential equations
- To analyze the behavior of special functions, such as Legendre polynomials and Bessel functions
- To explore the applications of partial differential equations and special functions in science and engineering

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Partial Differential Equations:** Introduction and formation of first order partial differential equations, Method of characteristic and general solution of first order PDE, Method of separation of variables for first order PDE, Classification of quasilinear second order PDE, Linear equations of second order with constant coefficients, Applications to engineering problems.	**17**
Unit 2	**Special Functions:** Singular points, Series solution of differential equations, Power series methods, Series solution of Legendre's differential equation, Generating functions, Legendre's polynomial, Recurrence relations, Frobenius method, Series solution of Bessel's differential equation, Bessel's functions, Modified Bessel's functions, Recurrence relations, Equations reducible to Bessel's equation.	**25**

Course Outcomes:	
1	Define and explain the key concepts of partial differential equations and special functions, such as first-order PDEs, linear PDEs with constant coefficients, Legendre polynomials, and Bessel functions
2	Explain how to form and solve first-order partial differential equations
3	Describe the properties of Legendre polynomials and Bessel functions, such as their orthogonality and asymptotic behaviour
4	Identify the different types of partial differential equations and describe the series solution method for solving differential equations

5	Analyse the convergence of series solutions to differential equations and behavior of Legendre polynomials and Bessel functions under different conditions

Text Book:		
Sr.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
Reference Books:		
Sr.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Elements of Partial differential equations, Sneddon, McGraw Hill.	2006
2	Higher Engineering Mathematics, B. V. Ramana, McGraw Hill.	2008
3	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill.	2003

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Partial Differential Equations https://archive.nptel.ac.in/courses/111/101/111101153/	NPTEL
2	Ordinary and Partial Differential Equations and Applications https://archive.nptel.ac.in/courses/111/107/111107111/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	2	1	2	1	–	–	–	–	–	1	1	3	–	3
CO3	3	2	1	1	1	–	–	–	–	–	1	1	3	–	2
CO4	1	3	1	1	2	–	–	–	–	–	1	1	3	–	1
CO5	3	2	1	1	1	–	–	–	–	–	1	2	3	–	2

1-Low, 2-Medium, 3-High

MINOR SPECIALIZATION IN MATHEMATICS

S.No.	Course Code	Course Name	L	T	P	Credits
1.	MCM101	Operations Research	3	1	0	4
2.	MCM102	Complex Analysis	3	1	0	4
3.	MCM103	Probability And Statistics	3	1	0	4
4.	MCM104	Minor Specialization Project-I*	-	-	-	3
5.	MCM105	Minor Specialization Project-II*	-	-	-	3

*The students will be guided for interdisciplinary project.

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MCM101**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able • To analyze the characteristics and scope of operations research • To explore different linear models of optimization problems • To develop, formulate, and solve problems of transportation and assignment model • To apply the theory of queuing models to address issues in real world problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Operations Research:** Definition of operations research, Characteristics of operations research, Scope of operations research.	**3**
Unit 2	**Linear Programming:** Formulation of linear programming problem, Graphical solution, Simplex method, Unrestricted variables, Artificial variables, M-Method, Two phase method, Duality.	**17**
Unit 3	**Transportation Models:** Introduction to the transportation model, Assumption in the transportation model, Definition of the transportation model, Matrix terminology, Formulation and solution of transportation model, Assignment model.	**10**
Unit 4	**Queueing Theory:** Random variable, Poisson and exponential distribution, Queuing model: Introduction, Application of queuing model, Elements of queuing system, Operating characteristics of queuing system, Waiting time and idle time costs.	**12**

Course Outcomes:	
1	Describe the characteristics of operations research and identify its scope in real-world problems
2	Formulate and solve linear models of optimization problems using graphical and simplex method
3	Understand the transportation and assignment models and evaluate their solutions
4	Analyze the performance of queuing systems using different metrics

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operations Research, Taha, H.A, 10th edition, Pearson.	2017
2	Operations Research, Ravindran, Phillips, and Solberg, 2nd edition, John Wiley & sons.	2000
3	Engineering Optimization, S S Rao, 4nd edition, New Age.	2009
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007
2	Operations Research, Sharma S.D., Kedarnath, Ramnath & Company.	1994
3	Operations Research, Bronson R, Shaum's Outline Series.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL
3	Advanced Operations Research https://nptel.ac.in/courses/112106131	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	3	–	1
CO2	3	2	1	1	1	–	–	–	–	–	2	2	3	–	2
CO3	1	3	1	1	2	–	–	–	–	–	1	2	3	–	1
CO4	2	3	1	2	1	–	–	–	–	–	2	1	3	–	2
CO5	3	1	2	1	1	–	–	–	–	–	2	2	3	–	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Complex Analysis**
Course Code	**:**	**MCM102**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Student should be able: • To explore the basic ideas of complex analysis • To analyze the basic theory of functions of a complex variable • To apply the techniques of complex analysis in solving integration problems • To apply the concept of conformal mappings to solve specific formulated engineering problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Complex Analysis:** Introduction to complex numbers, Functions of complex variables, Exponential function, Trigonometric and hyperbolic functions, Euler's formula, Logarithm.	8
Unit 2	**Functions of Complex Variables:** Limit and continuity of complex functions, Analytic function, Cauchy–Riemann equations, Laplace's equation, Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions.	12
Unit 3	**Power Series :** Power series, Taylor and Maclaurin series, Laurent Series, Singularities and zeros, Residue integration method, Residue integration of real integrals.	10
Unit 4	**Conformal Mappings:** Conformal mapping, Linear fractional transformations (Möbius transformations), Special linear fractional transformations, Conformal mapping by other functions, Applications of complex analysis in engineering.	12

Course Outcomes:	
1	Discuss the fundamental concepts of complex analysis
2	Illustrate the basic techniques involved in calculus of functions of complex variables
3	Calculate line integration and real integrals via residue calculus
4	Analyze power series and singularities in complex functions
5	Synthesize knowledge of conformal mapping for practical engineering applications

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley, 10th edition	2011
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Complex Variables and Applications, Ruel V. Churchill and James Ward Brown, McGraw-Hill Publishing Company 8th edition	2009
2	A First Course in Complex Analysis with Applications, Dennis G. Zill and Patrick D. Shanahan, Jones and Bartlett Publishers, 2nd edition	2010
3	Complex analysis, Joseph Bak and Donald J. Newman, Springer-Verlag New York, Inc., New York, 2nd edition.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Complex analysis, https://archive.nptel.ac.in/courses/111/103/111103070/	NPTEL
2	Complex analysis, https://archive.nptel.ac.in/courses/111/106/111106141/	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	1	–	–	–	–	–	2	2	3	–	2
CO2	3	2	1	1	2	–	–	–	–	–	1	1	3	–	2
CO3	1	3	1	2	2	–	–	–	–	–	1	1	2	–	1
CO4	2	3	1	2	1	–	–	–	–	–	2	3	3	–	2
CO5	3	1	2	1	1	–	–	–	–	–	1	1	3	–	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**PROBABILITY AND STATISTICS**
Course Code	**:**	**MCM103**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives

Students should be able –

- To develop a deep understanding of the theoretical foundations of random variables and probability theory
- To analyze the different types of probability distributions and their properties.
- To explore random variables in statistics, machine learning, and other fields
- To apply statistical estimation procedures to estimate population parameters from sample data
- To apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Random Variables:** Random variables, Discrete, Continuous, Expectation, Variance, Moments, Moment generating function, Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial.	**10**
Unit 2	**Joint Probability Distributions:** Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality.	**10**
Unit 3	**Sampling Distributions:** Population, Sample, Sampling distributions, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution.	**7**
Unit 4	**Estimation:** Estimation of parameters, Point estimate, Confidence interval for mean, Difference of means and proportions.	**6**
Unit 5	**Tests of Hypotheses:** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and two samples tests for mean and proportion.	**9**

Course Outcomes:	
1	Define and explain the key concepts of random variables and probability theory, including discrete and continuous random variables, probability distributions, expectation, variance, and covariance
2	State the different types of hypothesis tests and estimation procedures, and identify the appropriate test or procedure to use for a given problem
3	Calculate the expectation, variance, and covariance of random variables
4	Apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7th edition, Pearson Education	2006
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Miller and Freund's: Probability and Statistics for Engineers, Richard A. Johnson, C.B. Gupta, Pearson Education.	2006
2	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education.	2004
3	A First Course in Probability, Sheldon Ross, 6th edition, Pearson Education Asia	2002

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Probability Theory and Applications https://nptel.ac.in/courses/111104079	NPTEL
2	Introduction to Probability Theory and Statistics https://nptel.ac.in/courses/111102160	NPTEL

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	2	–	1
CO2	3	1	1	2	1	–	–	–	–	–	3	2	3	–	3
CO3	2	3	1	1	1	–	–	–	–	–	2	1	3	–	3
CO4	3	2	1	2	2	–	–	–	–	–	3	3	3	–	2

1-Low, 2-Medium, 3-High