Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (A) and M. Tech. (AI) (2026-2027) Batch Onwards

Sr. No.	Subject	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
	First Semester [1st year of B. Tech. (A) and M. Tech. (AI)]				
1	Fundamentals of Computer and Programming	IA101	3-0-2	4	85
2	Fundamentals of Engineering Mathematics	MA105	3-1-0	4	70
3	Linear Algebra and Statistics	MA129	3-1-0	4	70
4	English and Professional Communication	HS110	3-1-0	4	70
5	Basic Electrical and Electronic Engineering	IA105	3-0-2	4	85
			Total	**20**	**380**
6	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	IAV01 / IAP01	0-0-10	5	200 (20 x 10)
	Second Semester [1st year of B. Tech. (A) and M. Tech. (AI)]				
1	Data Structures	IA102	3-1-2	4	100
2	Object Oriented Programming	IA108	3-0-2	4	85
3	Energy and Environmental Engineering	EG110	3-0-2	4	85
4	Discrete Mathematics	MA126	3-1-0	4	70
5	Digital Electronics and Logic Design	EC106	3-0-2	4	85
6	Indian Value System and Social Consciousness	HS120	2-0-0	2	35
			Total	**22**	**460**
7	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	IAV02 / IAP02	0-0-10	5	200 (20 x 10)
	Third Semester [2nd year of B. Tech. (A) and M. Tech. (AI)]				
1	Computer Organization	IA201	3-0-0	3	70
2	Database Management Systems	IA203	3-0-2	4	85
3	Design and Analysis of Algorithms	IA205	3-0-2	4	70
4	Signals and Systems	EC203	3-1-0	4	70
5	Automata and Formal Languages	IA211	3-1-0	4	70
			Total	**23**	**365**
	Fourth Semester [2nd year of B. Tech. (A) and M. Tech. (AI)]				
1	Artificial Intelligence	IA202	3-1-0	4	85
2	Operating Systems	IA204	3-0-2	4	85
3	Machine Learning	IA206	3-0-2	4	85
4	Computer Networks	IA208	3-0-2	4	85
5	Data Science	IA212	3-0-0	3	70
			Total	**19**	**410**
7	Minor / Honor (M/H#1)	IA2AA	3-X-X	3/4	55/70/85
8	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	IAV04 / IAP04	0-0-10	5	200 (20 x 10)

Subject Code:##nXX; ##: Department Identity, n: Year, XX: Subject Sequence number XX: last digit 0 (subject offered in both ODD and EVEN semesters, XX: 01 to 30 – last digit ODD and EVEN for ODD and EVEN semesters (Mandatory Core), XX: 31 to 50 (Optional Core), XX: 51 to 99 (Elective), Subjects list for Minor and Honor (M/H#1-4), Subjects list for Specialization track (#1-4)EG: Engineering Subject, SC: Science Subject (offered combinedly by departments) (SVNIT Surat)

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	Fifth Semester [3rd year of B. Tech. (A) and M. Tech. (AI)]				
1	Deep Learning	IA301	3-0-2	4	85
2	Cloud Computing	IA303	3-0-2	4	85
3	Information Security and Cryptography	IA309	3-1-0	4	70
4	Elective	IA3AA	3-X-X	3	55/70/85
5	Elective (Specialization#1)	IA3BB	3-X-X	3	55/70/85
6	Linear and Nonlinear Optimization	IA307	3-1-0	4	70
			Total	**22**	**420-480**
7	Minor / Honor (M/H#2)	IA3CC	3-X-X	4	70/85
	Sixth Semester [3rd year of B. Tech. (A) and M. Tech. (AI)]				
1	High Performance Computing	IA302	3-0-2	4	85
2	Cyber Physical System	IA304	3-0-2	4	85
3	Big Data Analytics and Visualization	IA306	3-0-2	4	85
4	Elective	IA3DD	3-X-X	3	55/70/85
5	Elective (Specialization#2)	IA3EE	3-X-X	3	55/70/85
6	Image Processing and Computer Vision	IA308	3-0-2	4	85
			Total	**22**	**450-510**
7	Minor / Honor (M/H#3)	IA3FF	3-X-X	3/4	70/85
8	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	IAV06 / IAP06	0-0-10	5	200 (20 x 10)
	Seventh Semester [4th year of B. Tech. (A) and M. Tech. (AI)]				
1	Research Methodology	IA403	1-1-0	2	35
2	Robotics and Applications	IA405	3-0-2	4	85
3	Elective	IA4BB	3-X-X	3	55/70/85
4	Elective (Specialization#3)	IA4CC	3-X-X	3	55/70/85
5	Elective (Specialization#4)	IA4DD	3-X-X	3	55/70/85
6	Minor Project-I	IA407	0-0-10	5	150
			Total	**20**	**435-525**
8	Minor / Honor (M/H#4)	IA4EE	3-X-X	3/4	55/70/85
	Eighth Semester [4th year of B. Tech. (A) and M. Tech. (AI)]				
1	Intelligent Multiagent and Expert Systems	IA402	3-0-2	4	85
2	Professional Ethics, Business and Entrepreneurship	HUXXX	3-0-0	3	70
3	Human Computer Interaction	IA404	3-1-0	3	70
4	Elective	IA406	3-X-X	3	55/70/85
5	Elective	IA408	3-X-X	3	55/70/85
7	Minor Project-II	IA412	0-0-10	5	150
			Total	**21**	**485-545**

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	Nineth Semester [5th year of B. Tech. (A) and M. Tech. (AI)]				
1	MOOC-I	IA501	2-0-0	2	35
2	M. Tech. Thesis Part-I	IA505	0-0-36	18	540
			Total	**20**	**575**
	Tenth Semester [5th year of B. Tech. (A) and M. Tech. (AI)]				
1	M. Tech. Thesis Part-II	IA502	0-0-40	20	600
			Total	**20**	**600**

Credit Table

Sr.	**Domain**	**Credit**	**Percentage**
1	Basic Sciences	12	5.28 /5.06 %
2	Humanities	6	2.64 / 2.53 %
3	Management	4	1.76/ 1.68 %
4	Engineering other branches	18	7.92 / 7.59 %
5	Core subjects	105	46.25 / 44.30 %
6	Electives	34/44	14.97 / 18.56 %
7	Project	48	21.14/20.25
Total		**227/237**	**100 %**

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Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – I FUNDAMENTAL OF COMPUTER AND PROGRAMMING IA101	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	Understand the basic concepts of computers and programming.
CO2	Apply the knowledge of C Programming to solve computational problems.
CO3	Debug, test, and analyse C Programs to find and correct errors and improve the solutions.
CO4	Learn various programming techniques such as iteration and recursion, and apply them to solve computational problems.
CO5	Learn and apply the advanced programming concepts such as modularization, memory management, and file handling to improve the efficiency of computational problems.

2.	Syllabus	
	INTRODUCTION TO COMPUTER ARCHITECTURE AND OPERATING SYSTEM	**(05 Hours)**
	Computer Architecture, Input unit, Output unit, Storage Unit, Central Processing Unit, Introduction of Operating System, Function OS, Unix Commands.	
	OVERVIEW OF C PROGRAMMING LANGUAGE	**(04 Hours)**
	Concepts Of High-Level, Assembly And Low-Level Languages, History of C, Importance of C, Representing Algorithms through Pseudocode and Flowchart, Basic Structure of a C Program, How to Compile a C Program, How to Run a C Program, Sample Programs.	
	CONSTANTS, VARIABLES, AND DATA TYPES	**(02 Hours)**
	Character Set in C, Keywords, Identifiers, Constants, Strings, Operators, Special Symbols, Variables, Data Types: Primary Data Types and User Defined Data Types, Declaration of Variables, Assigning Values to Variables, Initialization of Variables, Defining Symbolic Constants, Declaring Variables as Constants.	
	OPERATORS, EXPRESSIONS AND LIBRARY FUNCTIONS	**(04 Hours)**
	Operators: Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitwise, Comma Operator, sizeof Operator, Operators used in Pointers and Structures, Arithmetic Expressions, How C programming Evaluates Arithmetic Expressions, Precedence of Arithmetic Operators and Associativity Rule, Type Conversion: Implicit and	

	Explicit. Reading Character from Keyboard, Printing Character on Screen, Reading String from Keyboard, Printing String on Screen, Formatting input and Output, Math Functions.	
	DECISION MAKING, BRANCHING, AND LOOPING	**(06 Hours)**
	Decision Making in C Programming, If Statement, Nested If Statement, Else If Ladder, Switch Statement, Conditional Operator Statement, Goto Statement, Decision Making with Logical Operators, Sample Programs. Introduction to Loops, While Loop, Do While Loop, For Loop, Break Statement, Goto Statement, Continue Statement, Sample Programs.	
	ARRAYS AND CHARACTER ARRAYS	**(05 Hours)**
	Introduction to Arrays, One Dimensional Array, Declaration and Initialization of One Dimensional Array, Two Dimensional Array, Declaration and Initialization of Two Dimensional Array, Multi-Dimensional Array, Sample Programs, Declaration and Initialization of Strings, Arithmetic Operations on Characters, String Functions: Strlen(), Strcat(), Strcpy(), Strstr(), Strcmp(), etc.	
	FUNCTIONS	**(05 Hours)**
	Function Declaration, Function Definition, Function Calls, Functions with No Arguments and No Return Values, Functions with Arguments and No Return Values, Functions with No Arguments and Return Values, Functions with Arguments and Return Values, Recursive Functions, Passing Arrays to Functions, Call by Value, Call by Reference, Scope and Lifetime of Functions: Local, Global, Static, and Register Declaration.	
	STRUCTURES AND UNIONS	**(04 Hours)**
	Structure Template, Structure Variable Declaration and Initialization, Structure Variable Assignment, Accessing Structure Variables, Arrays as Structure, Arrays with Structures, Passing Structure Members to Functions, Unions, Difference Between Structures and Unions, Bit Fields.	
	POINTERS AND MEMORY MANAGEMENT	**(05 Hours)**
	Declaration and Initialization of Pointers, Accessing Memory through Pointers, Pointer to Pointer, Pointer Arithmetic, Dynamic Memory Allocation, Memory Management Functions: Malloc, Calloc, and Free, Using Pointers to Access Dynamically Allocated Memory Locations, Pointers with Arrays, Function and Structure, Use of Pointers to Return Multiple Values From Functions.	
	FILE MANAGEMENT AND PREPROCESSOR	**(05 Hours)**
	Opening and Closing a File, Modes in File Opening: Read, Write and Append, Input and Output, Operations on Files, File Handling Functions such as fseek(), ftell(), rewind(). Pre-processor	

	directives, Macro Substitution, Importing a File, Compiler Control Directives, Command Line arguments	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practical**
1	C Programming – How to write a program, compile a program, and execute a program
2	Read the input from a keyboard and write the output to computer screen
3	Variable declaration, initialization, and assignment, Constant declaration, Experiments with different data types
4	Experiments with different C Operators, Analysing the impact of precedence and associativity rules while evaluating expressions in C
5	Experiments with standard library functions related to math library, time library, standard input and output library etc.
6	Experiments with If, Else If, Switch, Goto statements
7	Experiments with While, Do…While, For Loops, and analysing the impact of Break, Goto and Continue statements on C Loops
8	Experiments with Arrays and Character Arrays
9	Experiments with Different Functions having Arguments/No Arguments and Return Values/No Return Values, Scope and Lifetime of Functions, and Understanding Local, Global, Static, and Register Declaration
10	Experiments with Structures and Unions, Analysing the difference between the structure and union with respect to memory
11	Experiments with Pointers with respect to Accessing Memory from the Stack and Heap Section of the RAM (i.e., Experiments with Static and Dynamic Memory Management)
12	Opening, Closing the Files using a C program, and accessing the files to get the input from the file and store the output to the file.
13	Experiments with pre-processor directives.

4.	**Books Recommended**
1.	Introduction to Computer Science", Fourth Impression, Pearson Education, ITL Education Solutions Limited, 2009.
2.	Nell Dale and John Lewis, "Computer Science Illuminated", Jones and Bartlett Publishers.
3.	E. Balagurusamy, "Programming in ANSI C", Mc-Graw Hill.
4.	Brian W. Kernighan / Dennis Ritchie,"The C Programming Language", Pearson.

5.	Yashavant Kanetkar, “Let us C”, BPB Publications.
6.	Harbison and Steele, “C: A Reference Manual”

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Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – I FUNDAMENTALS OF ENGINEERING MATHEMATICS MA105	Scheme	L	T	P	Credit
		3	1	0	04

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Accept the challenge to solve the problem with Mathematics.
CO2	Apply the knowledge of curve tracing to solve problem of engineering.
CO3	Identify, formulate and analyze complex engineering and affiliated field problems, specifically the differential equation concept in different engineering field.
CO4	Apply the knowledge of mathematics for model and analyze computational processes using analytic and combinatorial methods
CO5	Design solutions engineering industrial problems with effective mathematical skill.

2.	**Syllabus**	
	DIFFERENTIAL CALCULUS	**(09 Hours)**
	Differentiation of Hyperbolic and Inverse Hyperbolic functions. Successive Differentiation, standard forms, Leibnitz's theorem and applications, Power series, Expansion of functions, Taylor's and Maclaurin's series. Curvature, Radius of curvature for Cartesian curve with application.	
	PARTIAL DIFFERENTIAL CALCULUS	**(09 Hours)**
	Partial differentiation, Euler's theorem for homogeneous function, Modified Euler's theorem, Taylor's and Maclaurin's series for two variables. Tangent plane and Normal line, Error and Approximation, Jacobians with properties, Extreme values of function of two variables, Lagrange's methods of undetermined multipliers.	
	CURVE TRACING	**(06 Hours)**
	Cartesian, polar and parametric form of standard curves.	
	ORDINARY DIFFERENTIAL EQUATION	**(09 Hours)**
	Reorientation of differential equation first order first degree, exact differential equation and Integrating factors, first order higher degree odes, solvable for p, y and x, Solution of homogenous equations higher order, complementary functions, Particular Integrals, Linear differential equation with variable coefficient, Cauchy's Euler and Legendre's equation with variable coefficient, Method of variation of parameters.	
	APPLICATION OF DIFFERENTIAL EQUATION (MATHEMATICAL MODELLING)	**(06 Hours)**

	Modelling of Realworld problems particularly Engineering System, Electrical network models (LCR), spread of epidemic (SI, SIS, SIR), Newton's Law of cooling, Compartment modelling, Bending of beam models.	
	SERIES SOLUTION AND SPECIAL FUNCTIONS	**(06 Hours)**
	Regular point, Singular point, series solution of ODE of 2nd order with variable coefficient with special emphasis to differential equation of Legendre's and Bessel's for different cases of roots of indicial equations.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials**
1	Problems on Array
2	Problems on Stack and Queue
3	Problems on Linked List
4	Problems on Trees
5	Problems on Graph

4.	**Books Recommended**
1	James Stewart, "Calculus", Thomson Asia, Singapore, 2003.
2	Kreyszing E., "Advanced Engineering Mathematics", John Wiley & Sons, Singapore, Int. Student Ed. 2015.
3	Wiley C. R., "Advanced Engineering Mathematics", McGraw Hill Inc., New York Ed. 1993.
4	F. B. Hilderband, "Methods of Applied mathematics", PHI, New Delhi, 1968
5	Ramana D. V., "Higher Engg. Mathematics", The McGraw-Hill Inc., New Delhi, 2007.

ADDITIONAL REFERENCE BOOKS	
1	Srimanta Pal, Subodh C. Bhunia, "Engineering Mathematics", Oxford University Press, New Delhi, 2015.
2	Bali and Iyengar, "Engineering Mathematics", Laxmi Publications, New Delhi, 2004.
3	Mary L. Boas, "Mathematical Methods in the Physical Sciences", John Wiley & Sons, Ed.2005

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Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – I LINEAR ALGEBRA AND STATISTICS MA129	Scheme	L	T	P	Credit
		3	1	0	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	accept the challenge to solve the problem with statistics
CO2	apply the knowledge of Linear Algebra to solve problem of engineering.
CO3	identify, formulate and analyze complex engineering and affiliated field problems, specifically the Partial differential equation concept in different engineering field
CO4	apply the knowledge of vector calculus and analyze computational processes
CO5	design solutions to work on engineering industrial problems with effective mathematical skill.

2.	Syllabus	
	PROBABILITY THEORY AND RANDM PROCESS	**(09 Hours)**
	Fundamentals of Probability Theory: - views of probability, Random variables and Joint distributions, Marginal distribution, Conditional probability, Conditional independence, Expectation and variance, Probability distributions Central limit theorem, Functions of random variable, Sum of independent random variable, Correlation and regression, Random process, Stationary random process, Autocorrelation and cross correlation, Ergodic process, Markov process, Birth and death process, Poisson process, Markov chain, Chapman Kolmogorov theory, Spectral analysis of random processes, power spectral density.	
	ESTIMATION AND STATISTICS	**(08 Hours)**
	Sampling theory, Population and sample, Statistical interference, Sampling distribution, Sample mean, Bias estimation, Unbiased estimator, Confidence interval, Point estimation and interval estimates, Statistical decision, Hypothesis testing, Statistical hypotheses, Null hypotheses, Significance test, Type I and types II errors, Level of significance, One tail and two tailed test, Chi square test, Maximum likelihood estimate, Least square estimate, MAP estimate, Minimum mean square estimate.	
	INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATION	**(09 Hours)**
	Introduction to Partial differential equation, Formation of partial differential Equation, Partial differential Equation of first order, Linear partial differential equation of first order (Pp + Qq =R) and method of obtaining its general solution, Non-linear partial differential equation of first order f(p, q)=0, f(z, p, q)=0, f(x, p)= g(y, q), z= px + qy + f(p,q).	
	BASIC CONCEPTS OF VECTOR CALCULUS	**(08 Hours)**

	Scalar and vector point function, differential operator, gradient, directional derivative, divergence, curl and Laplacian operator with their properties.	
	LINEAR ALGEBRA	**(11 Hours)**
	Linear systems, Elementary row and column transformation, rank of matrix, consistency of linear system of equations, Linear Independence and Dependence of vectors, Gauss Elimination method, Gauss-Jorden Method, Gauss-Jacobi Iteration Method; Vector spaces, Subspace, Field, Ring, Norm and distance, Linear Mapping, Orthogonality, Eigenvectors and Eigenvalues, Least square, Least square data fitting, Constrained least square applications.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Books Recommended**
1	Kreyszing E., “Advanced Engineering Mathematics”, John Wiley & Sons, Singapore, Int. Student Ed. 2015.
2	Wiley C. R., “Advanced Engineering Mathematics”, McGraw Hill Inc., New York Ed. 1993.
3	Gilbert Strang, “Introduction to Linear Algebra”, Wellesley Cambridge Press, 4th Ed., 2009.
4	David C. Lay, “Linear Algebra and its applications”, 3rd Ed., Pearson, 2006.
5	A. Papoulis and S. U. Pillai, “Probability, Random Variables and Stochastic Processes”, 4th Ed., Mc-Graw Hill, 2002.

ADDITIONAL REFERENCE BOOKS	
1	Ramana D. V., “Higher Engg. Mathematics”, McGraw-Hill Inc., New Delhi, 2007.
2	Srimanta Pal, Subodh C. Bhunia, “Engineering Mathematics”, Oxford University Press, New Delhi, 2015.
3	Mary L. Boas, “Mathematical Methods in the Physical Sciences”, John Wiley & Sons, Ed.2005.

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Integrated B. Tech. (AI) and M. Tech. (AI) Semester – I ENGLISH AND PROFESSIONAL COMMUNICATION HS110	Scheme	L	T	P	Credit
		3	1	0	04

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	show enhanced reception towards the use of English language.
CO2	choose and employ appropriate words for professional communication.
CO3	develop sentences and text in English coherently and formally.
CO4	demonstrate overall improvement in oral communication.
CO5	analyze and infer from written and oral messages.

2.	Syllabus	
	COMMUNICATION	(05 Hours)
	Introduction to Communication, Different forms of Communication, Barriers to Communication and some remedies, Non-Verbal Communication – Types, Non-Verbal Communication in Intercultural Context.	
	VOCABULARY AND USAGE OF WORDS	(05 Hours)
	Common Errors, Synonyms, Antonyms, Homophones, and Homonyms; One Word Substitution; Misappropriations; Indianisms; Redundant Words.	
	LANGUAGE THROUGH LITERATURE	(09 Hours)
	Selected short stories, essays, and poems to discuss nuances of English language.	
	LISTENING AND READING SKILLS	(06 Hours)
	Types of listening, Modes of Listening-Active and Passive, Listening and note taking practice, Practice and activities Reading Comprehension (unseen passage- literary /scientific/technical) Skimming and scanning, fact vs opinion, Comprehension practice	
	SPEAKING SKILLS	(10 Hours)
	Effective Speaking, JAM, Presentation Skills- types, preparation and practice. Interviews-types, preparation and mock interview; Group Discussion- types, preparation and practice	
	WRITING SKILLS	(10 Hours)

	Prerequisites of effective writing, Memo-types, Letter Writing- types, Email etiquette and Netiquette, Résumé-types, Report Writing and its types, Editing.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials**
1	Letter and Resume
2	Group Discussion
3	Presentation Skills (Individual)
4	Role Play on Nonverbal communication
5	Group Presentation
6	Debate
7	Body language and intercultural communication
8	Listening Activities
9	Editing
10	Report Writing
11	Mock interviews
12	JAM

4.	**Books Recommended**
1	Kumar, Sanjay and Pushp, Lata. *Communication Skills*, 2nd Edition, OUP, New Delhi, 2015.
2	Raman, Meenakshi & Sharma Sangeeta. *Technical Communication Principles and Practice*, 3rd Edition, OUP, New Delhi, 2015.
3	Raymond V. Lesikar and Marie E Flatley. *Basic Business Communication skills for Empowering the Internet generation.* Tata McGraw Hill publishing company limited. New Delhi 2005.
4	Courtland L. Bovee, John V. Thill, and Mukesh Chaturvedi. “Business Communication Today.” Ninth Edition. Pearson, 2009.
5	Mike Markel. “Practical Strategies for Technical Communication,” Bedford/ St. Martin's Second Edition, 2016
6	Laura J. Gurak and John M. Lannon. “Strategies for Technical Communication in the Workplace,” Pearson, 2013.

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Department of Artificial Intelligence

Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – I BASIC OF ELECTRICAL AND ELECTRONIC ENGINEERING IA105	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	Understand Basic Electrical Concepts – Explain circuit components, Ohm's law, Kirchhoff's laws, and AC/DC circuit behavior.
CO2	Analyze Circuits Using Network Theorems – Apply Thevenin's, Norton's, Superposition, and other theorems for circuit analysis.
CO3	Analyze single-phase AC circuits and compute electrical quantities using RMS, average values, and power factor concepts.
CO4	Explain the working principles and characteristics of semiconductor devices and integrated circuits, and apply them in designing basic analog electronic circuits including amplifiers, oscillators, multivibrators, and timer-based applications.
CO5	Use Electrical Measurement Instruments – Operate multimeters, oscilloscopes, and transducers for measuring electrical parameters.

2.	**Syllabus**	
	Basic Electrical Engineering Concepts, Laws and Principles	**(07 Hours)**
	Introduction to Electrical Engineering, Current and Voltage sources, Resistance, Inductance, and Capacitance. Ohm's law, Kirchhoff's law, Work, Energy and Power, Electric Current, Resistance, Potential, and Potential Difference, Electromagnetism and Electromagnetic Induction, Faraday's Laws of Electromagnetic Induction, Magnetic Circuits, Self and Mutual Inductance, Series and parallel combination of R, L, C components. Voltage Divider and Current Divider Rules. Energy Stored in a Capacitor, Capacitor in Parallel and in Series, Sinusoidal voltage and current, Introduction to 3-phase systems, Electric Grids.	
	DC Networks, Network Theorems and Circuit Analysis	**(08 Hours)**
	DC Network Terminologies, Voltage, and Current Sources, Series–Parallel Circuits, Kirchhoff's Current Law Kirchhoff's Voltage Law, Solution of Simultaneous Equations Using Cramer's Rule, Maxwell's Mesh Current Method, Nodal Voltage Method (Nodal Analysis), Network Theorems, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Millman's Theorem, Maximum Power Transfer Theorem, Star–Delta Transformation, DC Transients- Transient in R–L Circuit, Transient in R–C Circuit.	
	AC Fundamentals and Single-phase Circuits	**(08 Hours)**
	Introduction, Generation of Alternating Voltage in an Elementary, Generator , Concept of Frequency, Cycle, Time Period, Instantaneous, Value, Average Value, and Maximum Value, Sinusoidal and Non-sinusoidal Wave Forms, Concept of Average Value and Root Mean Square (RMS) Value of an Alternating Quantity Analytical Method of Calculation of RMS Value, Average Value, and Form Factor, RMS and Average Values of Half-wave-rectified Alternating Quantity, Concept of Phase and Phase Difference, Single-phase AC Circuits, Behaviour of R, L, and C in AC Circuits, L–R Series Circuit , Apparent Power, Real Power, and Reactive Power, Power in an AC	

	Circuit, R–C Series Circuit, R–L–C Series Circuit, AC Parallel Circuits, AC Series—Parallel Circuits, Resonance in AC Circuits.	
	Semiconductor Devices	**(09 Hours)**
	Intrinsic and extrinsic semiconductors-, n-Type Semiconductor Material, P-Type Semiconductor Material, The p–n Junction, Biasing of p–n Junction, Semiconductor Diodes- Volt-ampere Characteristic of a Diode, An Ideal Diode, Diode Parameters and Diode Ratings, Zener Diode, Zener Diode as Voltage Regulator and Reference Voltage, Diode and Triode for Alternating Current (DIAC and TRIAC), Oscillators, Barkhausen criterion, sinusoidal and non-sinusoidal oscillators, Multivibrators: Astable, Monostable and Bistable Multivibrator, Transistors, Bipolar Junction Transistors, Working of a n–p–n and p–n–p Transistor, Transistor Configurations, Transistor as an Amplifier, Transistor As a Switch, Field Effect Transistors, Junction Field Effect Transistors (JEFT), Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET).	
	Integrated Circuits	**(07 Hours)**
	Introduction to Monolithic and Hybrid ICs, Linear and Digital ICs, Amplifiers, Operational Amplifiers, Ideal OP-AMP, Application of OP-AMP as a Summing, Differential Amplifier, The 555 Timer Integrated Circuit, Three Operating Modes of IC 555, Pin configuration, Functional Block Diagram, Astable and Monostable application of IC 555, IC Voltage Regulators or Regulator ICs.	
	Principles of Electronic Measurements and Sensors	**(06 Hours)**
	Analog and Digital Instruments, Passive and Active Instruments, Static Characteristics of Instruments- Accuracy, Precision, Sensitivity and Resolution, Error, Threshold, and Loading Effect, Indicating-type Instruments- CRO (Cathode Ray Oscilloscope), Measurement of Power in DC and AC Circuits, Measurement of Energy, Sensor fundamentals and characteristics, Classification of Sensors- Resistive sensors, Capacitive sensors, Inductive sensors, Eddy current sensors, Linear variable differential transformers (LVDT).	

3.	**Practical**
1	Measure and confirm Ohm's Law, by measuring measuring voltage and current across a resistor while varying the DC supply voltage in steps, keeping the resistance constant, and plotting the V–I graph to observe the linear relationship.
2	Demonstrate Kirchhoff's Current Law (KCL) at a circuit junction and Kirchhoff's Voltage Law (KVL) in a closed loop by measuring currents and voltages in a resistive network and comparing them with theoretical values.
3	Set up electrical circuits with resistors, inductors, and capacitors in series and parallel combinations, and to measure and verify their equivalent resistance, inductance, and capacitance using appropriate instruments, confirming the theoretical values through practical experimentation.
4	To measure and analyze the power consumption in DC and AC circuits by experimentally determining voltage, current, and power factor, and verifying the results using theoretical calculations.
5	To observe the time-domain transient behavior of RL and RC circuits during charging and discharging phases.

6	Construct a linear electrical network and determine its Thevenin and Norton equivalent circuits by measuring open-circuit voltage and short-circuit current, and then validate the equivalence experimentally through practical observation and comparison with the original network behavior.
7	Investigate the load regulation behavior of a Zener diode by varying the load resistance at a constant input voltage, and measuring the output voltage, load current, and Zener current to determine the diode’s voltage regulation capability.
8	Examine the operation of a inverting and non-inverting amplifier configuration using an OP-AMP by changing input voltage and resistance values, and plotting the output response to validate the voltage gain relationship.
9	Analyze the output characteristics of a BJT in common emitter mode by varying the collector-emitter voltage (VCE) for fixed base current (IB) values and plotting the collector current (IC) versus VCE.
10	Analyze the output characteristics of a BJT in common emitter mode by varying the collector-emitter voltage (VCE) for fixed base current (IB) values and plotting the collector current (IC) versus VCE.

4.	**Books Recommended**
1	Milman, Halkias and Jit, Electronics Devices and Circuits, Tata McGraw-Hill, 2nd Edition Sedra and Smith, Microelectronics Circuits, 6th edition, Oxford University Press.
2	Boylestad, Robert L., & Nashelsky, Louis Electronic Devices and Circuit Theory 11th Edition, Pearson Education, 2015. ISBN: 9781292060546
3	Kothari, D. P., & Nagrath, I. J. Basic Electrical Engineering 4th Edition, McGraw-Hill Education, 2019. ISBN: 9789353162344
4	Bhattacharya, S. K., & Chatterjee, S. Basic Electrical and Electronics Engineering, Pearson Education, 1st Edition, 2012. ISBN: 9788131733324

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II DATA STRUCTURES IA102	Scheme	L	T	P	Credit
		3	1	2	05

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	recognize the need of different data structures and understand its characteristics.
CO2	apply different data structures for given problems.
CO3	design and analyse different data structures, sorting and searching techniques.
CO4	evaluate data structure operations theoretically and experimentally.
CO5	give solution for complex engineering problems.

2.	Syllabus	
	INTRODUCTION TO DATA STRUCTURES	**(03 Hours)**
	Review of Concepts: Information and Meaning, Abstract Data Types, Internal Representation of Primitive Data Structures, Arrays, Strings, Structures, Pointers.	
	LINEAR LISTS	**(06 Hours)**
	Sequential and Linked Representations of Linear Lists, Comparison of Insertion, Deletion and Search Operations for Sequential and Linked Lists, Doubly Linked Lists, Circular Lists, Lists in Standard Template Library (STL), Applications of Lists.	
	STACKS	**(06Hours)**
	Sequential and Linked Implementations, Representative Applications such as Recursion, Expression Evaluation Viz., Infix, Prefix and Postfix, Parenthesis Matching, Towers of Hanoi, Wire Routing in a Circuit, Finding Path in a Maze.	
	QUEUES	**(06 Hours)**
	Operations of Queues, Circular Queue, Priority Queue, Dequeue, Applications of Queues, Simulation of Time Sharing Operating Systems, Continuous Network Monitoring System Etc.	
	SORTING AND SEARCHING	**(04 Hours)**
	Sorting Methods, Bubble Sort, Selection Sort, Quick Sort, Radix Sort, Bucket Sort, Dictionaries, Hashing, Analysis of Collision Resolution Techniques, Searching Methods, Linear Search, Binary Search, Character Strings and Different String Operations.	

	TREES	**(08 Hours)**
	Binary Trees and Their Properties, Terminology, Sequential and Linked Implementations, Tree Traversal Methods and Algorithms, Complete Binary Trees, General Trees, AVL Trees, Threaded Trees, Arithmetic Expression Evaluation, Infix-Prefix-Postfix Notation Conversion, Heaps as Priority Queues, Heap Implementation, Insertion and Deletion Operations, Heapsort, Heaps in Huffman Coding, Tournament Trees, Bin Packing.	
	MULTIWAY TREES	**(05 Hours)**
	Issues in Large Dictionaries, M-Way Search Trees, BTrees, Search, Insert and Delete Operations, Height of B-Tree, 2-3 Trees, Sets and Multisets in STL.	
	GRAPHS	**(07 Hours)**
	Definition, Terminology, Directed and Undirected Graphs, Properties, Connectivity in Graphs, Applications, Adjacency Matrix and Linked Adjacency Chains, Graph Traversal, Breadth First and Depth First Traversal, Spanning Trees, Shortest Path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours + 30 Hours = 90 Hours)	

3.	**Tutorials**
1	Problems on Array
2	Problems on Stack and Queue
3	Problems on Linked List
4	Problems on Trees
5	Problems on Graph

4.	**Practical**
1	Implementation of Array and its applications
2	Implementation of Stack and its applications
3	Implementation of Queue and its applications
4	Implementation of Link List and its applications

5	Implementation of Trees and its applications
6	Implementation of Graph and its applications
7	Implementation of Hashing functions and collision resolution techniques
8	Mini Project (Implementation using above Data Structure)

5.	**Books Recommended**
1	Trembley & Sorenson: "An Introduction to Data Structures with Applications", 2/E, TMH, 1991.
2	Tanenbaum & Augenstein: "Data Structures using C and C++", 2/E, Pearson, 2007.
3	Horowitz and Sahani: "Fundamentals of Data Structures in C", 2/E, Silicon Press, 2007.
4	T. H. Cormen, C. E. Leiserson, R. L. Rivest: "Introduction to Algorithms",3/E, MIT Press, 2009.
5	Robert L. Kruse, C. L. Tondo and Brence Leung: "Data Structures and Program Design in C", 2/E, Pearson Education, 2001.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (Artificial Intelligence) and M. Tech. (Artificial Intelligence)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II OBJECT ORIENTED PROGRAMMING IA108	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Explain the core principles of object-oriented programming using Java and Python: objects, classes, inheritance, polymorphism, and encapsulation.
CO2	Analyse the advantages and limitations of using object-oriented programming compared to procedural programming.
CO3	Design and implement classes in Java to represent real-world entities and their functionalities.
CO4	Apply the concepts of Multithreading and Exception handling to develop efficient and error-free codes.
CO5	Design event-driven GUI and web-related applications that mimic real-world scenarios.

2.	**Syllabus**	
	Elementary Programming	**(06 Hours)**
	Introduction Java and Python, Hello World Program, Concepts of object-oriented programming language, Difference between OOP and other conventional programming – advantages and disadvantages, Class, Object, Identifiers, Variables, Operators, Data Types, Selections, Loops, Methods, Arrays.	
	Object Oriented Principles and Concepts	**(08 Hours)**
	Basic concepts of Java and Python programming – advantages of Java and python, byte-code & JVM, PVM working and Architecture, garbage collection, Memory Management – Heap/Stack, creation of class, object, constructor, finalize and, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, Superclass & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, IIB, SIB, dynamic method dispatch, use of abstract classes & methods, interfaces. Create packages, import packages, and provide member access for packages. Auto Widening, Explicit narrowing, Auto up casting, Explicit down casting, Wrapper Classes, AutoBoxing, nested & inner classes.	
	String, Exception, and Text I/O	**(07Hours)**
	Basic string handling concepts in Java and Python- String, concept of mutable and immutable string, StringBuffer, StringBuilder, StringTokenizer, command line arguments, Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user-defined exception classes. Basics of I/O operations – keyboard input	

	using Buffered Reader & Scanner classes, Serialization, Externalization	
	Multithreading	**(07 Hours)**
	Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter-thread communication, deadlocks for threads, suspending & resuming threads.	
	Collections Framework, and Design Patterns	**(08 Hours)**
	List, set, map, tuple, Lambda function in python. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter-thread communication, deadlocks for threads, suspending & resuming threads. Object class, toString, equals, hashcode, Collection API, Collections, Developing Stack and Queue, Collections Class, List Stream, Set Stream, TreeSet, MapSteam, Generic Programming, Design Pattern Overview, Factory design pattern, Singleton design pattern, MVC.	
	GUI and Database Programming	**(09 Hours)**
	GUI Basics, Applet Programming, Swing vs AWT, Layout Manager, Event-Driver Programming, Creating User Interfaces, Menus, Toolbars, Dialogs, JTable, JTree. Introduction JDBC, Type of Drivers, Connection, Statement, Prepared statements, JDBC connection with SQL server.	

3. Practicals:
1. Student Management System in Java or Python
2. Banking System Simulation in Java or Python
3. File Operations with Exception Handling.
4. Producer-Consumer Problem with Multithreading
5. Employee Management System using Python OOPs concepts
6. Observer Pattern for Stock Market using Python OOPs concepts
7. Decorator Pattern for Pizza Ordering using Java
8. Strategy Pattern for Payment Processing using Python
9. Develop a basic student management system to add, delete, update, and view student records. Requirements: ● Create a form with fields like Student ID, Name, Age, Gender, Department, etc. ● Provide buttons for Add, Update, Delete, and View. ● Use a JTable to display the list of students. ● Use JDBC to connect to a MySQL database and perform CRUD operations.

4.	**Books Recommended**
1	Y. Daniel Liang, Introduction to Jave Programming, Comprehensive Version, Person
2	Khalid A. Mughal, A Programmer's Guide to Java Scjp Certification: A Comprehensive Primer.
3	Dr. R. Nageswara Rao, Core JAVA: An Integrated Approach, Includes All Versions upto Java 8, Dreamtech Press
4	Python Programming, Using Problem Solving Approach, Reema Thareja, Oxford university Press
5	Herbert Schildt, Java 2 Complete Reference, TMH, 2010.
6	Python Object-Oriented Programming - Fourth Edition, Steven F. Lott.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II	Scheme	L	T	P	Credit
ENERGY AND ENVIRONMENTAL ENGINEERING EG110		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	Explain the components of ecosystems, various biogeochemical cycles and importance of different urban network services
CO2	Differentiate between various types of environmental pollution along with their impacts and regulatory standards
CO3	Examine various global environmental issues and their management
CO4	Discuss the fundamental principles of energy, including classification, conservation and related policy frameworks and regulations.
CO5	Get acquainted with the concept of energy systems and their components

2.	Syllabus	
	ENVIRONMENT AND ECOSYSTEMS	**(10 Hours)**
	Introduction: Concept of an ecosystem - structure and functions of ecosystem; Components of ecosystem - producers, consumers, decomposers; Food chains, food webs, ecological pyramids, energy flow in ecosystem; Bio-geochemical cycles, hydrologic cycle Components of environment and their relationship, impact of technology on environment, environmental degradation, environmental planning of urban network services such as water supply, sewerage, solid waste management; closed loop cycle, concepts of sustainability	
	ENVIRONMENTAL POLLUTION	**(10 Hours)**
	Water, air, soil, noise, thermal and radioactive, marine pollution - sources, effects and engineering control strategies; Centralized and decentralized treatment system, Drinking water quality and standards, ambient air and noise standards	
	GLOBAL ENVIRONMENTAL ISSUES AND ITS MANAGEMENT	**(10 Hours)**
	Engineering aspects of climate change, concept of carbon credit, CO_2 sequestration, concepts of environmental impact assessment and environmental audit, life cycle assessment	
	BASICS OF ENERGY AND ITS CONSERVATION	**(07 Hours)**
	Classification of energy sources, Global and national energy scenario, Fossil and alternate fuels and its characterization. General aspects of energy conservation and management; Energy conservation act, Energy policy of company; Need for energy standards and labelling; Energy building codes.	

	INTRODUCTION TO ENERGY CONSERVATION SYSTEMS	**(08 Hours)**
	Energy conversion systems: Working principle, Basic components, General functioning and normal rating specifications of various energy conversion systems like Power plant, Pump, Refrigerator, Air-conditioner, Internal combustion engine, Solar PV cell, Solar water heating system, Biogas plant. Wind turbine, Fuel cells.	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practical**
1	Performance Test on a computerised single cylinder diesel engine
2	Performance Test on Three-cylinder petrol engine
3	Determination of COP of vapor compression refrigeration system
4	Study of General Motors Cruze Vehicle Automotive System
5	Study of MG Hector Vehicle Automotive Systems
6	Measurement of direct and diffused Solar radiation using pyranometer
7	Determination of I-V Characteristics of solar PV Panel
8	Study of electricity and or gas bill
9	Study of pollutants from diesel Engine
10	Study of pollutants from petrol Engine

4.	**Books Recommended**
1	Daniel B. Botkin & Edward AKeller, Environmental Sciences, John Wiley & Sons.
2	R. Rajagopalan, Environmental Studies, Oxford University Press.
3	Benny Joseph, Environmental Studies, TMH Publishers.
4	Dr. Suresh K. Dhameja, Environmental Studies, S. K. Kataria & Sons, 2007.
5	U. K. Khare, Basics of Environmental Studies, Tata McGraw Hill, 2011.

ADDITIONAL REFERENCE BOOKS	
1	C. S. Rao, Environmental Pollution Control Engineering, New Age International Publishers, 2018

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II DISCRETE MATHEMATICS MA126	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	acquire knowledge of sets, group and functions, graphs.
CO2	apply group theory, relations and lattice.
CO3	analyse functions, counting and based on mathematical logic.
CO4	evaluate formal verification of computer programmes.
CO5	design solutions for various types of problems in different disciplines like information security, optimization, mathematical analysis.

2.	**Syllabus**	
	INTRODUCTION	**(04 Hours)**
	Introduction to set theory, Basics of functions, Application of Functions in Computer Science Areas.	
	GROUP THEORY	**(08 Hours)**
	Basic Properties of Group, Groupoid, Semigroup & Monoid, Abelian Group, Subgroup, Cosets, Normal Subgroup, Lagrange's Theorem, Cyclic Group, Permutation Group, Homomorphism & Isomorphism of Groups, Basic Properties, Error Correction & Detection Code.	
	RELATION & LATTICES	**(06 Hours)**
	Definition & Basic Properties, Graphs Of Relation, Matrices Of Relation, Equivalence Relation, Equivalence Classes, Partition, Partial Ordered Relation, Posets, Hasse Diagram, Upper Bounds, Lower Bound, GLB & LUB Of Sets, Definition & Properties Of Lattice, Sub Lattice, Distributive & Modular Lattices, Complemented & Bounded Lattices, Complete Lattices & Boolean Algebra.	
	MATHEMATICAL LOGIC AND PROGRAM VERIFICATION	**(06 Hours)**
	Induction, Propositions, Combination Of Propositions, Logical Operators & Propositional Algebra, Equivalence, Predicates & Quantifiers, Interaction of Quantifiers with Logical Operators, Logical Interference & Proof Techniques, Formal Verification of Computer Programs (Elements of Hoare Logic).	
	COUNTING AND RECURRENCE RELATION	**(06 Hours)**
	First Counting Principle, Second Counting Principle, Permutation, Circular Permutations, Combination, Pigeonhole Principle, Recurrence Relations, Linear Recurrence Relations, Inclusion And Exclusion, Generating Functions.	
	BASICS OF GRAPHS	**(05 Hours)**

	Graph Definition, Graph Representation, Basic Concepts Of Finite & Infinite Graph, Incidence & Degree, Isomorphism, Subgraph, Walk, Path & Circuits, Cliques, Cycles and Loops, Operations On Graphs, Connected Graph, Disconnected Graph & Components, Complete Graph, Regular Graph, Bipartite Graph, Planar Graphs, Weighted Graphs, Directed & Undirected Graphs, Connectivity Of Graphs.	
	GRAPHS ALGORITHMS	**(10 Hours)**
	Flows, Combinatorics, Euler's Graph, Hamiltonian Paths & Circuits, Activity Planning and Critical Path, Planar Graphs: Properties, Graph Coloring, Vertex Coloring, Chromatic Polynomials, Edge Coloring, Planar Graph Coloring, Matching and Factorizations: Maximum Matching In Bipartite Graphs, Maximum Matching In General Graphs, Hall's Marriage Theorem, Factorization; Networks: Max-Flow Min-Cut Theorem, Menger's Theorem, Graph and Matrices; Probabilistic Graphical Models: Graphical models, Directed models: Bayesian network, Undirected model: Markov Random Fields, Dynamic model: Hidden Markov Model, Learning in Graphical models: Parameter estimation, Expectation Maximization.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials**
1	Problem solving on group theory.
2	Problem solving on relation and lattices.
3	Problem solving on mathematical logic and program verification.
4	Problem solving on counting and recurrence relation.
5	Problem solving on basics of graphs.
6	Problem solving on graph algorithms.

4.	**Books Recommended**
1	Rosen K.H., "Discrete Mathematics and Its Applications", 6/E, MGH, 2006.
2	Liu C.L., "Elements of Discrete Mathematics", MGH, 2000.
3	Deo Narsingh., "Graph theory with applications to Engineering & Computer Science", PHI, 2000.
4	J. A.Bondy and U. S. R.Murty, "Graph Theory", Springer, 2008.
5	V. K. Balakrishnan, "Theory and Problems of Graph Theory", Tata McGraw-Hill, 2007.

5.	**ADDITIONAL REFERENCE BOOKS**
1	Kolman B., Busby R.C. & Ross S., "Discrete Mathematical Structure", 5/E, PHI, 2003.
2	Tremblay J. P. & Manohar R., "Discrete Mathematical structure with applications to computer science", MGH, 1999.
3	D. B. West, “Introduction to Graph Theory”, 2nd Edition, PHI 2002.
4	G. Chatrand and O.R. Ollermann, “Applied and Algorithmic Graph Theory”, McGraw Hill, 1993.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II DIGITAL ELECTRONICS AND LOGIC DESIGN EC106	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	acquire knowledge about different types of diodes and circuits.
CO2	apply the knowledge of gates, Boolean algebra and operational amplifier in designing logical and integrated circuits.
CO3	analyse the logical, integrated, and operational amplifier based circuits.
CO4	evaluate the different circuits and compare their performance.
CO5	design ALU and control unit.

2.	Syllabus	
	PN DIODE AND TRANSITOR	**(07 Hours)**
	PN Diode Theory, PN Characteristic and Breakdown Region, PN Diode Application as Rectifier, Zener Diode Theory, Zener Voltage Regulator, Diode as Clamper and Clipper, Photodiode Theory, LED Theory, 7 Segment LED Circuit Diagram and Multi Colour LED, LASER Diode Theory and Applications, Bipolar Junction Transistor Theory, Transistor Symbols And Terminals, Common Collector, Emitter and Base Configurations, Different Biasing Techniques, Concept of Transistor Amplifier, Introduction to FET Transistor And Its Feature.	
	WAVESHAPING CIRCUITS AND OPERATIONAL AMPLIFIER	**(06 Hours)**
	Linear Wave Shaping Circuits, RC High Pass and Low Pass Circuits, RC Integrator and Differentiator Circuits, Nonlinear Wave Shaping Circuits, Two Level Diode Clipper Circuits, Clamping Circuits, Operational Amplifier OP-AMP with Block Diagram, Schematic Symbol of OP-AMP, 741 Package Style and Pinouts, Specifications of Op-Amp, Inverting and Non-Inverting Amplifier, Voltage Follower Circuit, Multistage OP-AMP Circuit, OP-AMP Averaging Amplifier, OP-AMP Subtractor.	
	BOOLEAN ALGEBRA AND SWITCHING FUNCTIONS	**(04 Hours)**
	Basic Logic Operation and Logic Gates, Truth Table, Basic Postulates and Fundamental Theorems of Boolean Algebra, Standard Representations of Logic Functions- SOP and POS Forms, Simplification of Switching Functions-K-Map and Quine-Mccluskey Tabular Methods, Synthesis of Combinational Logic Circuits.	
	COMBINATIONAL LOGIC CIRCUIT USING MSI INTEGRATED CIRCUITS	**(07 Hours)**

	Binary Parallel Adder; BCD Adder; Encoder, Priority Encoder, Decoder; Multiplexer and Demultiplexer Circuits; Implementation of Boolean Functions Using Decoder and Multiplexer; Arithmetic and Logic Unit; BCD to 7-Segment Decoder; Common Anode and Common Cathode 7-Segment Displays; Random Access Memory, Read Only Memory and Erasable Programmable ROMS; Programmable Logic Array (PLA) and Programmable Array Logic (PAL).	
	INTRODUCTION TO SEQUENTIAL LOGIC CIRCUITS	**(04 Hours)**
	Basic Concepts of Sequential Circuits; Cross Coupled SR Flip-Flop Using NAND or NOR Gates; JK Flip-Flop Rise Condition; Clocked Flip-Flop; D-Type and Toggle Flip-Flops; Truth Tables and Excitation Tables for Flip-Flops; Master Slave Configuration; Edge Triggered and Level Triggered Flip-Flops; Elimination of Switch Bounce using Flip-Flops; Flip-Flops with Preset and Clear.	
	SEQUENTIAL LOGIC CIRCUIT DESIGN	**(06 Hours)**
	Basic Concepts of Counters and Registers; Binary Counters; BCD Counters; Up Down Counter; Johnson Counter, Module-N Counter; Design of Counter Using State Diagrams and Table; Sequence Generators; Shift Left and Right Register; Registers with Parallel Load; Serial-In-Parallel-Out (SIPO) And Parallel-In-Serial-Out (PISO); Register using Different Type of Flip-Flop.	
	REGISTER TRANSFER LOGIC	**(04 Hours)**
	Arithmetic, Logic and Shift Micro-Operation; Conditional Control Statements; Fixed-Point and Floating-Point Data; Arithmetic Shifts; Instruction Code and Design Of Simple Computer.	
	PROCESSOR LOGIC DESIGN	**(03 Hours)**
	Processor Organization; Design of Arithmetic Logic Unit; Design of Accumulator.	
	CONTROL LOGIC DESIGN	**(04 Hours)**
	Control Organization; Hard-Wired Control; Micro Program Control; Control Of Processor Unit; PLA Control.	
	Practicals will be based on the coverage of the above topics separately.	**(28 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals**
1	Study of BJT Characteristics
2	Study of CE Amplifier
3	Study of RC Coupled / Tuned Amplifier
4	Study of FET Characteristics
5	Study of Diode Clipper Circuits

6	Study of Diode Clamper Circuits
7	Study and Implement RC Low Pass and High Pass Filter Circuits
8	Study and Implement RC Integrator Circuits
9	Study and Implement RC Differentiator Circuits
10	Full and Half-Adder/ Half-subtarctor Circuits using a serial Input
11	4-Bit Gray to Binary/ Binary to Gray Code convertor using Select input
12	Logic expression with the Help of MUX IC 74153
13	Flip-flops using NAND/ NOR Gate
14	Modulo-7 Ripple Counter
15	4-Bit Shift Left/Right Register
16	Sequence Generator

4.	**Books Recommended**
1	Schilling Donald L. and Belove E., "Electronics Circuits- Discrete and Integrated", 3rd Ed., McGraw-Hill, 1989, Reprint 2008.
2	Millman Jacob, Halkias Christos C. and Parikh C., "Integrated Electronics", 2nd Ed., McGraw-Hill, 2009.
3	Taub H. and Mothibi Suryaprakash, Millman J., "Pulse, Digital and Switching Waveforms", 2nd Ed., McGraw-Hill, 2007.
4	Mano Morris, “Digital Logic and Computer Design”, 5th Ed., Pearson Education, 2005.
5	Lee Samual, “Digital Circuits and Logic Design”, 1st Ed., PHI, 1998.

ADDITIONAL REFERENCE BOOKS	
1	Malvin Albert & David J. Bates, "Electronic Principles", 7th edition, Tata McGraw Hill, 2007.
2	De Debashis, "Basic of Electronics", 1st Ed., Pearson Education, 2008.
3	Floyd and Jain, “Digital Fundamentals”, Pearson Education, 2006.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II INDIAN VALUE SYSTEM AND SOCIAL CONSCIOUSNESS HS120	Scheme	L	T	P	Credit
		2	0	0	02

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	interpret the important values that need to be cultivated
CO2	analyse the cultures depicted in Ramayana, Mahabharata, Jainism and Buddhism
CO3	review the structure of Indian knowledge system
CO4	discuss the significance of constitution of India
CO5	demonstrate social responsibility

2.	**Syllabus**	
	HUMAN VALUES AND CONSCIOUSNESS	**(08 Hours)**
	Human Values Definition and Classification of Values; The Problem of Hierarchy of Values and their Choice; Self-Exploration; 'Basic Human Aspirations; Right understanding, Relationship and Physical Facility; fulfilment of aspirations; Understanding Happiness and Prosperity, Harmony at various levels. What Is Consciousness? ; Can We Build A Conscious Machine?; Levels Of Consciousness; Mind, Matter And Beyond; Holistic Lifestyle; Dealing With Anxiety; Connecting Mind To Brain; Minds, Brains, And Programs.	
	INDIAN CULTURE AND HERITAGE	**(07 Hours)**
	Culture and its salient features: The Vedic – Upanishadic Culture and society, Human aspirations in those societies; Culture in Ramayana and Mahabharata: The Ideal Man and Woman, Concepts Maitri, Karuna, Seela, Vinaya, Kshama, Santi, Anuraga – as exemplified in the stories and anecdotes of the Epics; The Culture of Jainism: Jaina conception of Soul, Karma and liberation, Buddhism as a Humanistic culture; The four Noble truths of Buddhism; Vedanta and Indian Culture;	
	INDIAN KNOWLEDGE SYSTEM	**(08 Hours)**
	Indian knowledge as a unique system, Place of Indian knowledge in mankind's evolution, Relevance of Indian knowledge to present day and future of mankind, Nature of Indian Knowledge; Structure of Indian Knowledge: Types of knowledge (para, apara), The scientific and the unscientific, Instruments for gaining and verifying knowledge, Knowledge traditions: Lineages, Instruments - debate, epistemology and pedagogy, The inverted tree – axiomatic, deductive, empirical knowledge, and evolution of knowledge; Disciplines of Study: A brief outline of the subjects, the major contributions and theories along with timelines where	

	relevant: Mathematics; Astronomy; Physical Sciences; Cosmogony; Language studies; Astrology; Moral studies/righteousness; Statecraft and political philosophy	
	INDIAN CONSTITUTION	**(04 hours)**
	History of Making of the Indian Constitution; Philosophy of the Indian Constitution: Preamble; Salient Features; Contours of Constitutional Rights & Duties; Organs of Governance: Parliament; Composition; Qualifications and Disqualifications; Powers and Functions	
	SOCIAL RESPONSIBILITY	**(03 Hours)**
	Social Responsibility: Meaning and Importance, Different Approaches of Social Responsibility. Social Responsibility of Business towards different Stakeholders. Evolution and Legislation of CSR in India.	
	(Total Contact Time: 30 Hours)	

3.	**Books Recommended**
1	D. K. Chaturvedi, Professional Ethics Values and Consciousness, Ane Books Pvt. Ltd., 2023.
2	R.R. Gaur, R Sangal, G. P. Bagaria, Human Values and Professional Ethics, Excel Books, New Delhi, 2010.
3	A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
4	P R Rao, Indian Heritage and Culture, Sterling Publishers Pvt. Ltd, 1988.
5	D. Singh, Indian Heritage and Culture, APH Publishing Corporation, 1998.
6	Sri Prashant Pole, Treasure Trove of Indian knowledge, Prabhat Prakashan, 2021.
7	Sri Suresh Soni, Sources of our cultural heritage, Prabhat Prakashan, 2018.
8	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II COMPUTER ORGANIZATION IA201	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	acquire knowledge of basics of computer architecture, its components with peripheral devices, instruction set architecture, instruction execution using data path and control unit interface.
CO2	apply knowledge of combinational and sequential logic circuits to mimic simple computer architecture to solve the given problem.
CO3	analyze performance of various instruction set architecture, control unit, memories, various processor architectures.
CO4	evaluate programming solutions to implement fast methods of ALU, FP unit implementations, processor architectures and instruction set architectures.
CO5	implement fast methods of ALU, FP unit implementations and to design and develop hardware solution for given instruction coding scheme of an Instruction Set Architecture or vice versa using available technology tools.

2.	**Syllabus**	
	PROCESSOR BASICS	**(06 Hours)**
	Basics CPU Organization - Functional Units, Data Paths, Registers, Stored Program Concept, Data Representation - Basic Formats, Fixed and Floating Point Representation, Instruction Sets, Instruction Types, Instruction Formats, Addressing Modes, Designing of an Instruction Set, Data path Design, Concepts of Machine Level Programmig, Assembly Level Programming and High Level Programming.	
	ARITHMETIC AND LOGIC UNIT	**(08 Hours)**
	Arithmetic and Logical Operation and Hardware Implementation, Implementation of some Complex Operation: Fixed-Point Arithmetic Multiplication Algorithms-Hardware Algorithm, Booth Multiplication Algorithm, Division Algorithm, Divide Overflow Algorithm, Combinational ALU and Sequential ALU, Floating Point Arithmetic Operations.	
	CONTROL UNIT	**(07 Hours)**
	Basic Concepts, Instruction Interpretation and Execution, Hardwired Control, Microprogrammed Control, CPU Control Unit Design, Performance.	
	SUBROUTINE MANAGEMENT	**(04 Hours)**
	Concepts of Subroutine, Subroutine Call and Return.	

	MEMORY ORGANIZATION	**(06 Hours)**
	Concepts of Semiconductor Memory, Cpu-Memory Interaction, Organization of Memory Modules, Cache Memory and Related Mapping and Replacement Policies, Virtual Memory.	
	SYSTEM ORGANIZATION	**(06 Hours)**
	Introduction to InputAnd Output Processing, Working with Video Display Unit and Keyboard and Routine to Control them, Programmed Controlled I/O Transfer, Interrupt Controlled I/O Transfer, DMA Controller, Secondary Storage and Type Of Storage Devices, Introduction to Buses and Connecting I/O Devices to CPU and Memory.	
	PIPELINE CONTROL AND PARALLEL PROCESSING	**(08 Hours)**
	Instruction Pipelines, Pipeline Hazards, Pipeline Performance, Superscalar Processing, Introduction to Parallel Processing, Processor-Level Parallelism, Multiprocessor.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3. Tutorials:
1. Problems on data conversion in various formats and floating-point representation
2. Solving computations involving complex arithmetic operations and hardware implementation of the same
3. Interpretation of basic instruction execution and various addressing modes possible
4. Learning instruction set architecture level instructions for the high level language programming
5. Problems on memory management, mapping and replacement policies

4. Books Recommended:

1. John L. Hannessy, David A. Patterson, "Computer organization and Design", 3/E, Morgan Kaufmaan, reprint -2003.
2. Andrew S. Tanenbaum, "Structured Computer Organization", 6/E, PHI EEE, reprint 1995.
3. William Stallings, "Computer Organization & Architecture: Designing For Performance", 6/E, PHI, 2002.
4. Carl Hamacher, ZvonkoVranesic, SafwatZaky, "Computer Organization", 5/E, McGraw-Hill, 2002.
5. Morris Mano, "Computer Systems Architecture", 3/E, PHI, reprint 1997.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II DATABASE MANAGEMENT SYSTEMS IA203	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	understand different database models and query languages to manage the data for given real life application scenario.
CO2	apply the concept of database model, relational tables, normalization to solve different problems.
CO3	analyze the problems for designing the effective solution using procedural and nonprocedural languages and/or index.
CO4	evaluate the solution using transaction management, concurrency management, query performance and optimization, or recovery.
CO5	implement an efficient solution using industry standards for real life problems.

2.	**Syllabus**	
	INTRODUCTORY CONCEPTS OF DBMS	**(03 Hours)**
	Introduction, Applications of DBMS, Purpose of Database, Data Independence, Database System Architecture, Data Abstraction, Database users and DBA.	
	ENTITY RELATIONSHIP MODEL	**(06 Hours)**
	Basic Concepts, Design Process, Constraints, Keys, Design Issues, E-R Diagrams, Attribute Types, Mapping Cardinality, Types of Relationship, Weak/Strong Entity Sets, Extended E-R Features – Generalization, Specialization, Aggregation.	
	RELATIONAL MODELS	**(04 Hours)**
	Structure of Relational Databases, Domains, Relations, Mapping of ER Model to Relational Model, Relational Algebra – Fundamentals, Operators and Syntax, Relational Algebra Queries, Tuple Relational Calculus.	
	RELATIONAL DATABASE DESIGN	**(08 Hours)**
	Functional Dependency – Definition, Trivial and Non-trivial FD, Closure of FD Set, Closure of Attributes, Irreducible Set of FD, Normalization – 1Nf, 2NF, 3NF, Decomposition using FD-Dependency Preservation, BCNF, Multi- Valued Dependency, 4NF, Join Dependency and 5NF.	
	QUERY PROCESSING AND OPTIMIZATION	**(05 Hours)**

	Overview of Query Processing, Measures of Query Cost, Select Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions, Overview of Query Optimization, Transformation of Relational, Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views, Advanced Topics in Query Optimization.	
	TRANSACTION MANAGEMENT	**(06 Hours)**
	Transaction Concepts, Properties of Transactions, Serializability of Transactions, Testing for Serializability, Concurrent Executions of Transactions and Related Problems, Locking Mechanism, Solution to Concurrency Related Problems, Two-phase Locking Protocol, Deadlock, Isolation, Intent Locking, System Recovery, Recovery and Atomicity, Log-based Recovery.	
	SQL CONCEPT	**(05 Hours)**
	Basics of SQL, DDL,DML,DCL, Structure – Creation/Alteration, Defining Constraints – Primary Key, Foreign Key, Unique, Not Null, Check, IN Operator.	
	PL-SQL CONCEPT	**(04 Hours)**
	Cursors, Stored Procedures, Stored Function, Database Triggers.	
	ADVANCED TOPICS	**(04 Hours)**
	Data Security: Introduction, Discretionary Access Control, Mandatory Access Control, Data Encryption, Semi Structured Data and XML, Object Oriented and Object Relational DBMS, Distributed DBMS, NOSQL DBMS.	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals:**
1	Implementation for Physical data storage (Sequential, Index Sequential..)
2	Practicing DDL and DML Queries for database creation and managing the data
3	Develop a Database system for the real-life application scenario by managing the storage constrains
4	Practicing PL/SQL with the designed databases
5	Design considering Transaction management and concurrency control
6	Design of ER model-based example
7	Design of Relational model-based example
8	Design of Normalized form of database

4.	**Books Recommended:**
1	A Silberschatz, H. F. Korth, and S Sudarshan, "Database System Concepts", 6/E, TMH, 2010.
2	McFadden, F.Hoffer, Prescott: M. B "Modern database management", 8/E, Benjamin/Cummings Inc,2006.
3	C.J Date, "An Introduction to Database Systems", Publisher: Addison, Wesley, 8/E, 2003.
4	Raghu Ramakrishnan and Gehrke: "Database Management System", 3/E, WCB/McGraw-Hill, 2003.
5	Margaret H. Dunham, "Data Mining: Introductory and advanced topics", Pearson Education, 2003.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II DESIGN AND ANALYSIS OF ALGORITHMS IA205	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of course, students will be able to	
CO1	Acquire knowledge about the application of mathematical formula and technique to solve the problem and computational complexity analysis.
CO2	Apply the different algorithm design techniques for designing a solution of different applications.
CO3	Analyse the performance of algorithms using different algorithmic design techniques based on asymptotic or amortized or probabilistic methods.
CO4	Evaluate the correctness and implementation of algorithms using different methods of performance evaluation.
CO5	Design and innovate efficient algorithms in the field of computer science & engineering and industry related applications using the different algorithm design techniques.

2.	Syllabus	
	INTRODUCTION	**(06 Hours)**
	Introduction to Algorithms, Analysis and Design Techniques, Analysis Techniques: Mathematical, Empirical and Asymptotic Analysis. Recurrence Relations and Solving Recurrences, Mathematical Proof Techniques, Amortized Analysis, Probabilistic Analysis.	
	DIVIDE AND CONQUER APPROACH	**(06 Hours)**
	Sorting & Order Statistics, Divide and Conquer Technique, Various Comparison based Sorts, Analysis of the Worst-Case and the Best-Cases, Randomized Sorting Algorithms, Lower Bound on Sorting, Non-comparison based Sorts, Medians and Order Statistics, Min-Max Problem, Polynomial Multiplication, Fast Fourier Transform.	
	GREEDY DESIGN TECHNIQUES	**(08 Hours)**
	Basic Greedy Control Abstraction, Motivation, Thirsty Baby Problem, Formalization, Activity Selection and its Variants, Huffman Coding, Horn Formulas, Tape Storage Problem, Container Loading Problem, Knapsack Problem, Graph Algorithms, Graph algorithms: All-pairs Shortest Paths, Topological Ordering of DAG, DFS in Directed Graphs, Strongly Connected Components, Minimum Spanning Trees, Single Source Shortest Paths, Maximum Bipartite Cover Problem, Network Flows: Ford Fulkerson Algorithm, Max-flow Min-cut Theorem, Polynomial Time Algorithms for Max-flow.	
	DYNAMIC PROGRAMMING	**(08 Hours)**
	Motivation, Matrix Multiplication Problem, Assembly Line Problem, Coin Changing Problem, Longest Common Subsequence, 0/1 Knapsack problem, All-pairs Shortest Path Problems, Dynamic Programming Control Abstraction, Optimal Binary Search Tree.	

	SEARCHING ALGORITHMS	**(05 Hours)**
	Backtracking, N-Queens Problem, Sum of Subset Problem, Complexity Analysis, Branch & Bound, Least Cost Branch & Bound (LCBB), LCBB Complexity Analysis, 15-Puzzle Problem, Traveling Sales Person Problem.	
	NUMBER THEORETIC ALGORITHMS	**(06 Hours)**
	Number Theoretic Notions, GCD, Modular Arithmetic, Chinese Remainder Theorem, Generators, Cyclic Groups, Galois Fields, Applications in Cryptography, Primality Testing.	
	NP-COMPLETE PROBLEMS	**(06 Hours)**
	Polynomial Time, Verification, NP-completeness, Search Problems, Reductions, Dealing with NP-Completeness, Approximation Algorithms, Local Search Heuristics.	
	Practicals will be based on the coverage of the above topics.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Programs on writing basic algorithms, representation using pseudocode, and analysing time complexity
2. Programs on solving recurrence relations using substitution method, recursion tree method and Master Theorem, and verifying results through implementation
3. Programs on divide and conquer algorithms including Merge Sort, Quick Sort and Heap Sort, and analysing their best, average and worst case complexities
4. Programs on randomized algorithms and non-comparison sorting techniques such as Randomized Quick Sort, Counting Sort and Radix Sort, and finding order statistics (kth smallest/largest element)
5. Programs on greedy algorithms including Activity Selection Problem, Fractional Knapsack Problem and Huffman Coding, and analysing correctness of greedy approach
6. Programs on graph algorithms including DFS, Topological Sorting, Single Source Shortest Path (Dijkstra and Bellman-Ford), Minimum Spanning Tree (Prim's and Kruskal's) and Network Flow using Ford-Fulkerson Algorithm
7. Programs on dynamic programming problems including Matrix Chain Multiplication, Longest Common Subsequence, 0/1 Knapsack and Coin Change Problem, and analysing optimal substructure and overlapping subproblems
8. Programs on backtracking and branch and bound techniques including N-Queens Problem, Sum of Subsets Problem and Traveling Salesperson Problem, and analysing state space tree and pruning techniques

4.	**Books Recommended:**
1	Cormen, Leiserson, Rivest, Stein," Introduction to Algorithms", 3/E, MIT Press, 2009.
2	J. Kleinberg, E. Tardos, "Algorithm Design", 1/E, Pearson Education, Reprint 2006.
3	SartajSahni, "Data Structures, Algorithms and Applications in C++", 2/E, Universities Press/Orient Longman, 2005
4	Sara Baase, Allen van Gelder," Computer Algorithms: Introduction to Design & Analysis, 3/E, Pearson Education, 2000.
5	Knuth, Donald E., "The Art of Computer Programming, Vol I &III", 3/E, Pearson Education, 1997.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II SIGNALS AND SYSTEMS EC203	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	Describe Signals and Systems with their classifications
CO2	Describe Z-transform and its properties
CO3	Analyse discrete-time system with Z-transform
CO4	Understand the process of sampling and aliasing error.
CO5	Analyze Discrete Time Fourier Transform and Discrete Fourier Transform for LTI systems

2.	**Syllabus**	
	INTRODUCTION	**(05 Hours)**
	Introduction to Signal and its Classification, Concept of Frequency in Continuous-Time and Discrete-Time Signal.	
	DISCRETE TIME SIGNAL AND SYSTEM	**(08 Hours)**
	Discrete-Time Signals and basic operations, Discrete Time Systems, Linear Time-Invariant Systems, Properties of LTI Systems, Causal LTI Systems Described by Difference equations.	
	Z-TRANSFORM	**(08 Hours)**
	Z-transform, Properties of Region of convergence, Inverse Z-transform, properties of Ztransform. Z-transform for LTI systems with pole-zero patterns	
	SAMPLING	**(08 Hours)**
	Sampling theorem, Periodic Sampling, Frequency-Domain Representation of Sampling, Reconstruction of sampled signals, Aliasing error, sampling theorem, Sampling of Bandlimited Signals	
	DISCRETE TIME FOURIER TRANSFORM (DTFT) and DISCRETE FOURIER TRANSFORM (DFT)	**(08 Hours)**
	DTFT and it's convergence, Properties of DTFT, Sampling the Fourier Transform, The Discrete Fourier Transform, Properties of the Discrete Fourier Transform.	
	FREQUENCY DOMAIN ANALYSIS OF LINEAR TIME-INVARIANT SYSTEMS	**(08 Hours)**
	Frequency Domain Representation of Discrete-Time Systems, Frequency Response for Rational systems Functions, Frequency Response of LTI Systems, System analysis with frequency domain representation. Time domain and Frequency domain aspects of ideal and non-ideal filters	

	(Total Contact Time: 45 Hours+ 15 Hours = 60Hours)

3. Tutorial:
1. Introduction to Signals and Systems
2. Basic Signal Operations
3. Fourier Series and Fourier Transform
4. Laplace Transform and Its Applications
5. Z-Transform and Discrete-Time Signal Analysis
6. Convolution and Correlation
7. Sampling Theorem and Signal Reconstruction
8. Linear Time-Invariant (LTI) Systems
9. Frequency Response and Filtering
10. Modulation and Communication Systems

4. Books Recommended:

1. Barry Van Veen Simon Haykin, "Signals and Systems", 2nd Ed., Wiley, 2007
2. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, "Signals and Systems Prentice Hall India", 2nd Ed., Pearson, 2009.
3. B.P. Lathi, "Principles of Linear Systems and Signals", 2nd Ed., oxford, 22 Jul 2009
4. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms, and Applications", 4th Ed., PHI, 2007.
5. Robert A. Gable, Richard A. Roberts, "Signals & Linear Systems", 3rd Ed., John Wiley, 1995.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – II AUTOMATA AND FORMAL LANGUAGES IA211	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	acquire knowledge of the basis of theory of computation, different computational problems and the importance of automata as a modelling tool of computational problems.
CO2	to apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
CO3	analyse the solutions for different problems and argue formally about correctness on different restricted machine models of computation.
CO4	evaluate and Identify limitations of computational models and possible methods of proving them.
CO5	design the solution in the forms of different types of machine with correctness proof and able to develop different system software.

2.	**Syllabus**	
	INTRODUCTION	**(06 Hours)**
	Basic Mathematical Objects: Sets, Logic, Functions, Relations, Strings, Alphabets, Languages; Mathematical Induction: Inductive Proofs, Principles, Recursive Definitions, Set Notation.	
	FINITE AUTOMATA AND REGULAR EXPRESSIONS	**(12 Hours)**
	Finite State Systems, Deterministic Finite Automata; Nondeterministic Finite Automata, Nondeterministic Finite Automata with Epsilon, Applications, Kleene' Theorem; Two-way Finite Automata, Finite Automata with Output, Regular Languages & Regular Expressions, Properties of Regular Sets: The Pumping Lemma for Regular Sets, Closure Properties, Decision Properties of Regular Languages, Equivalence and Minimization of Automata, Moore and Mealy Machines.	
	CONTEXT FREE GRAMMARS	**(14 Hours)**
	Definition, Derivation Trees & Ambiguity, Inherent Ambiguity, Parse Tree, Application of CFG, Simplification of CFG, Normal Form of CFG, Chomsky Normal Form and Chomsky Hierarchy, Unrestricted Grammars, Context-Sensitive Languages, Relations between Classes of Languages, Properties of Context Free Languages: The Pumping Lemma, Closure Properties, Decision Properties of CFL.	
	PUSHDOWN AUTOMATA	**(06 Hours)**
	Definitions, Languages of PDA, Equivalence of PDA and CFG , Deterministic PDA.	
	TURING MACHINES	**(07 Hours)**

	Turing Machine Model, Language of a Turing Machine (TM), Programming Techniques of the TM, Variations of TM, Multiple TM, One-Tape and Multi-Tape TM, Deterministic and Non deterministic TM, Universal TM, Churche Thesis, Recursively Enumerable Languages, Decidability, Reducibility, Intractable Problem Classes of Problems NP Hard, NP Complete.	
	Tutorials will be based on the coverage of the above topics.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**<u>Tutorials:</u>**
1	Problem statements based on Regular Language and Finite Automata.
2	Questions based on Context Free Grammar.
3	Problems regarding Push Down Automata.
4	Solving Problems for Turing Machine.
5	Decidable and Undecidable Problems.

4.	**<u>Books Recommended:</u>**
1	Michael Sipser, “Introduction to the Theory of Computation”,Cengage Learning, 3/E, 2013.
2	John C Martin, “Introduction to Languages & the Theory of Computation”, 3/E, Tata McGraw-Hill, 2011.
3	John E. Hopcroft, Rajeev Motwani, Jeffrey Ullman, “Introduction to Automata theory, languages computation, 3/E, Pearson India, 2008.
4	Daniel I A Cohen, “Introduction to Computer Theory”, John Wiley & Sons, 2/E, Reprint 2008.
5	Andrew Ilachinski, “Cellular Automata”, 1st Ed., World Scientific, 2001.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV ARTIFICIAL INTELLIGENCE IA202	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**1**	**0**	**04**

1. Course Outcomes (COs): **At end of the program, students will be able to**	
CO1	understand the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
CO2	apply various knowledge representation technique, searching techniques, constraint satisfaction problem and example problems- game playing techniques.
CO3	analyse the current scope, potential, limitations, and implications of intelligent systems.
CO4	evaluate the AI techniques suitable for recent areas of applications like expert systems, neural networks, fuzzy logic, robotics, natural language processing, and computer vision.
CO5	design a real world problem for implementation and understand the dynamic behaviour of a system.

2.	**Syllabus**	
	INTRODUCTION TO AI	**(05 Hours)**
	Intelligent Agents, AI Techniques, AI-Problem formulation, AI Applications, Production Systems, Control Strategies.	
	KNOWLEDGE REPRESENTATION	**(06 Hours)**
	Knowledge Representation Using Predicate Logic, Introduction to Predicate Calculus, Resolution, Use of Predicate Calculus, Knowledge Representation Using other Logic-Structured Representation of Knowledge.	
	PRODUCTION SYSTEM	**(06 Hours)**
	Defining the Problems as a State Space Search, Production Systems, Production Characteristics, Production System Characteristics, Forward and Backward, State-Space Search, Problem Solving Methods – Problem Graphs, Matching, Indexing.	
	PROBLEM-SOLVING THROUGH SEARCH	**(06 Hours)**
	Generate and Test, BFS, DFS, Blind, Heuristic, Problem-Reduction, A, A*, AO*, Minimax, Constraint Propagation, Neural, Stochastic, and Evolutionary Search Algorithms, Sample Applications, Measure of Performance and Analysis of Search Algorithms, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis, Issues in the Design of Search Programs.	
	KNOWLEDGE INFERENCE	**(06 Hours)**

	Knowledge Representation -Production Based System, Frame Based System; Inference – Backward Chaining, Forward Chaining, Rule Value Approach; Fuzzy Reasoning – Certainty Factors, Bayesian Theory-Bayesian Network-Dempster – Shafer Theory; Symbolic Logic Under Uncertainty: Non-Monotonic Reasoning, Logics for Non-Monotonic Reasoning; Statistical Reasoning : Probability and Bayes Theorem, Certainty Factors, Probabilistic Graphical Models, Bayesian Networks, Markov Networks, Fuzzy Logic.	
	GAME PLAYING AND PLANNING	**(06 Hours)**
	Overview and Example Domain: Overview, Minimax, Alpha-Beta Cut-Off, Refinements, Iterative Deepening, The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques.	
	NATURAL LANGUAGE PROCESSING	**(05 Hours)**
	Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing, Spell Checking.	
	EXPERT SYSTEMS	**(05 Hours)**
	Expert Systems, Architecture of Expert Systems, Roles of Expert Systems, Knowledge Acquisition, Meta Knowledge, Heuristics, Typical Expert Systems – MYCIN, DART, XOON, Expert Systems Shells.	
	Practicals will be based on the coverage of the above topics using prolog.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals:**
1	Practical assignment to understanding basic concepts of prolog.
2	Practical assignment to implement various search strategies.
3	Practical assignment to implement various algorithm based on game theory.
4	Implementation of heuristic based search techniques.
5	Implementation of neural network based application.
6	Implementation of fuzzy logic based application.
7	Implementation of fuzzy inference engine for an application.
8	Implementation of neuro-fuzzy based system.

4.	**Books Recommended:**
1	Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.
2	Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.
3	Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann, 1998,
4	W. Patterson, 'Introduction to Artificial Intelligence and Expert Systems', Prentice Hall of India, 2010.
5	I. Bratko, "Prolog Programming for Artificial Intelligence", 3/E, Addison-Wesley, 2001,

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV OPERATING SYSTEMS IA204	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of course, students will be able to	
CO1	understand the significance of operating system in computing devices, exemplify the communication between application programs and hardware devices through system calls.
CO2	compare and illustrate various process scheduling algorithms.
CO3	apply appropriate memory and file management schemes.
CO4	illustrate various disk scheduling algorithms.
CO5	design access control and protection-based modules for an operating system.

2.	Syllabus	
	OPERATING SYSTEM OVERVIEW	**(04 Hours)**
	Operating System (OS) Objectives, Evolution, Types, Major Achievements, Modern Operating Systems, Virtual Machines, OS Design Considerations for Multiprocessor and Multicore.	
	PROCESSES AND THREADS	**(05 Hours)**
	Process Concept, Process States, Process Description, Process Control Block, PCB as a Data Structure in Contemporary Operating Systems, Process Hierarchy, Processes vs Threads, Types of Threads, Multicore and Multithreading, Case Study: Linux & Windows Process and Thread Management and its Related System Calls.	
	CONCURRENCY: MUTUAL EXCLUSION AND SYNCHRONIZATION	**(05 Hours)**
	Principles of Concurrency, Mutual Exclusion, Semaphores, Monitors, Message Passing, Readers/Writers Problem.	
	CONCURRENCY: DEADLOCK AND STARVATION	**(05 Hours)**
	Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Dining Philosopher's Problem, Case Study: Linux & Windows Concurrency Mechanism.	
	SCHEDULING	**(08 Hours)**
	Uniprocessor Scheduling: Long Term Scheduling, Medium Term Scheduling, Short Term Scheduling, Scheduling Algorithms: Short Term Scheduling Criteria, Use of Priorities, Alternative Scheduling Policies, Performance Comparison, Fair-Share Scheduling. Multiprocessor Scheduling: Granularity, Design Issue, Process Scheduling, Thread Scheduling, Real-Time Scheduling: Characteristics of RTOS, Real-Time Scheduling, Deadline Scheduling,	

	Rate Monotonic Scheduling, Priority Inversion. Case Study: Linux & Windows Scheduling.	
	MEMORY MANAGEMENT	**(05 Hours)**
	Memory Hierarchy, Static and Dynamic Memory Allocation, Overview of Swapping, Multiple Partitions, Contiguous and Non-Contiguous Memory Allocation, Concepts of Simple Paging, Simple Segmentation.	
	VIRTUAL MEMORY	**(05 Hours)**
	Virtual Memory Concepts, Paging and Segmentation using Virtual Memory, Protection and Sharing, Fetch Policy, Placement Policy, Replacement Policy, Resident Set Management, Cleaning Policy, Load Control, Case Study: Linux & Windows Memory Management.	
	I/O MANAGEMENT AND DISK SCHEDULING	**(04 Hours)**
	I/O Device, Organisation of the I/O Function, Operating System Design Issue, I/O Buffering, Disk Scheduling, RAID, Disk Cache, Case Study: Linux & Windows I/O.	
	FILE MANAGEMENT	**(04 Hours)**
	Overview of : Files & File Systems, File Structure, File Management Systems, File Organisation and Access, B-tree, File Directories, File Sharing, Record Blocking, Secondary Storage Management, File System Security, Case Study: Linux & Windows File System.	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours= 75 Hours)	

3.	**Practicals:**
1	Introduction to Basic and Advance commands of Linux.
2	Introduction to Shell Script and programs based on it.
3	Practical based on different Memory management scheme.
4	Practical based on different Process scheduling algorithm.
5	Practical based on different Disk scheduling algorithm.
6	Process synchronization and deadlock.
7	Practical based on file management system.
8	Practical based on input output device management.

4.	**Books Recommended:**
1	Silberschatz, Galvin and Gagne, "Operating System Concepts", 10/E, John Wiley & Sons, 2018.
2	W. Stallings, "Operating Systems: Internals and Design Principles", 9/E, Pearson Pub., 2017.

3	W Richard Stevens, Stephen A Rago, "Advanced Programming in the UNIX Environment"; 3/E, Addison Wesley Professional, 2013.
4	Kernighan & Pike, "UNIX programming Environment", 2/E, PHI-EEE, 2001.
5	A Tanenbaum, A Woodhull, "Operating Systems - Design and Implementation", 3/E, PHI EEE, 2006.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV COMPUTER NETWORKS IA208	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	understand computer network models and services offered at different layers of network protocol stack.
CO2	apply knowledge of data communication, data transmission techniques using various transmission media to deliver error free data and communicate with multiple nodes.
CO3	analyse various routing methods to identify effective routing protocols.
CO4	evaluate network performance by means of transport and flow control protocols, Congestion Control protocols and Quality of services.
CO5	create a computer network application using modern network tools and simulation softwares.

2.	**Syllabus**	
	INTRODUCTION	**(06 Hours)**
	Overview of Computer Networks and Data Communication, Computer Networking Protocols and Standards, Types of Computer Networks, Network Topology, Protocol Hierarchies and Design Issues, Interfaces and Services, Networking Devices, OSI and TCP/IP Reference Models.	
	PHYSICAL LAYER	**(06 Hours)**
	Physical Layer Design Issues, Data Transmission Techniques, Multiplexing, Transmission Media, Asynchronous Communication, Wireless Transmission, ISDN, ATM, Cellular Radio, Switching Techniques and Issues.	
	LOGICAL LINK CONTROL LAYER	**(06 Hours)**
	LLC Design Issues, Framing, Error and Flow Control, Framing Techniques, Error Control Methods, Flow Control Methods, PPP and HDLC.	
	MEDIUM ACCESS CONTROL LAYER	**(06 Hours)**
	MAC Layer Design Issues, Channel Allocation Methods, Multiple Access Protocols - ALOHA, CSMA, CSMA/CD Protocols, Collision Free Protocols, Limited Contention Protocols, LAN Architectures, IEEE -802 Standards, Ethernet (CSMA/CD), Token Bus, Token Ring, DQDB, FDDI, Bridges and Recent Developments.	
	NETWORK LAYER	**(07 Hours)**

	Network Layer Design Issues, Routing Algorithms and Protocols, Congestion Control Algorithms and QoS, Internetworking, Addressing, N/W Layer Protocols and Recent Developments.	
	TRANSPORT LAYER	**(07 Hours)**
	Transport Layer Design Issues, Transport Services, Sockets, Addressing, Connection Establishment, Connection Release, Flow Control and Buffering, Multiplexing, Transport Layer Protocols, Real Time Transport Protocol (RTP), Stream Control Transmission Protocol (SCTP), Congestion Control, QoS and Recent Developments, Virtualization, Network Functions Virtualization(NFV), Software Defined Networks.	
	APPLICATION LAYER	**(07 Hours)**
	Client Server Model, Domain Name System (DNS), Hyper Text Transfer Protocol (HTTP), Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP) and Recent Developments.	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours= 75 Hours)	

3.	**<u>Practicals:</u>**
1	Study network configuration commands and computer network setup.
2	Implementation of different Data Link and MAC Layer protocols.
3	Implementationof different Network Layer protocols.
4	Implementation of different Transport and Application Layer protocols.
5	Design and configure a network systems using modern network simulator softwares.
6	Implementation of Secured Socket Layer protocol.
7	Implementation of ICMP based message transmission over network.
8	Implementation of SMTP protocol for mail transfer.

4.	**Books Recommended:**
1	William Stalling, "Data and Computer Communication", 10/E, Pearson India, 2017.
2	B. Forouzan, "Data Communication and Networking", 5/E, McGraw Hill, 2017.
3	Douglas E. Comer, "Internetworking with TCP/IP Volume – I", 6/E Pearson India, 2015.
4	Andrew S. Tanenbaum, "Computer Network", 5/E, Pearson India, 2013.
5	W. Richard Stevens, "TCP/IP Illustrated Volume - I", 2/E, Addison Wesley, 2011.

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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV MACHINE LEARNING IA206	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	acquire knowledge of pattern recognition, regression, classification, clustering algorithms and statistics.
CO2	apply different classification, regression, machine learning algorithms and modelling.
CO3	analyze the data patterns and modelling for applying the learning algorithms.
CO4	evaluate the performance of an algorithm and comparison of different learning techniques.
CO5	design solution for real life problems like biometric recognition, natural language processing and its related applications using various tools and techniques of machine learning.

2.	**Syllabus**	
	INTRODUCTION TO MACHINE LEARNING AND RELATED MATHEMATICS	**(08 Hours)**
	Introduction to Machine Learning, Why Machine Learning?, Types, Applications of M/L, Python libraries for ML, Fundamentals- Scalars, vectors, tensors, Equations, matrix, determinant, norms, kernel, Eigen values and Eigen vectors, introduction to probability and statistics, stochastic descent	
	DATA SAMPLING, PRE-PROCESSING AND PERFORMANCE EVALUATION	**(06 Hours)**
	Data sampling, Data preprocessing, Training, Validation, Testing, Performance Evaluation	
	SUPERVISED LEARNING	**(08 Hours)**
	Classification and Regression, Linear Regression, Logistic Regression, k-Nearest Neighbors, Naive Bayes Classifiers, Decision Trees, Support vector machine, Bagging, Boosting, Recommender system	
	ARTIFICIAL NEURAL NETWORKS	**(05 Hours)**
	Artificial neural network- Neurons, Multilayered networks, Backpropagation model, RBM, Recurrent networks, Applications of Neural Networks	
	UNSUPERVISED LEARNING AND DIMENSIONALITY REDUCTION TECHNIQUES	**(07 Hours)**
	Clustering: k-Means Clustering, Density-based clustering, Agglomerative Clustering, Association rules, Dimensionality reduction, Principal Component Analysis, Linear Discriminant Analysis	
	DEEP LEARNING	**(05 Hours)**
	Deep Neural Networks, Deep learning models/algorithms: CNN, RNN, Deep belief networks, Auto-encoders, LSTM	

	APPLICATIONS	**(06 Hours)**
	Signal Processing Application, Biometric Recognition, Face and Speech Recognition, Information Retrieval, Natural Language Processing, Robotics and other case studies	
	(Total Contact Time: 45 Hours+ 30 Hours = 75 Hours)	

3. Practicals:
1. Handle missing values, normalize features, and perform exploratory data analysis (EDA) on a given dataset.
2. Implement linear regression using gradient descent and evaluate it using Mean Squared Error (MSE).
3. Build a logistic regression model for binary classification and evaluate using accuracy, precision, recall, and F1-score.
4. Implement the K-NN algorithm from scratch and evaluate it on a classification dataset.
5. Build a decision tree classifier from scratch and visualize the tree after training on adataset.
6. Implement the K-Means algorithm from scratch and apply it for clustering on a given dataset.
7. Implement PCA and reduce a high-dimensional dataset to two components, then visualize the data.
8. Train a Random Forest classifier on a dataset and evaluate performance with accuracy and confusion matrix
9. Build and train a simple feedforward neural network for classification tasks using a deep learning framework.
10. ML project development

4. Books Recommended:

1. Tom Mitchell, Machine Learning, McGraw-Hill Science/Engineering/Math
2. Ian Goodfellow, Yoshua Bengio, Aaaron Courville, Franchis Bach, Deep Learning (Adaptive Computation and Machine Learning series), MIT Press, 2017
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, Second edition
4. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, 1st Edition, Springer, 2006.
5. Geoff Dougherty, “Pattern Recognition and Classification: An Introduction”, 1st Edition, Springer, 2013.

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Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV DATA SCIENCE IA212	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At end of the Course student will be able to**	
CO1	understand types of data and various data science approaches.
CO2	apply various data pre-processing and manipulation techniques including various distributed analysis paradigm using hadoop and other tools and perform advance statistical analysis to solve complex and large dataset problems.
CO3	analyze different large data like text data, stream data, graph data.
CO4	interpret and evaluate various large datasets by applying Data Mining techniques like clustering, filtering, factorization.
CO5	design the solution for the real-life applications.

2.	**Syllabus**	
	INTRODUCTION	**(04Hours)**
	Examples, Applications and Results Obtained Using Data Science Techniques, Overview of the Data Science Process. Types of Data and Data Representations, Acquire Data, Process and Parse Data, Data Manipulation, Data Cleaning, Exploratory Data Analysis.	
	STATISTICS FOR DATA SCIENCE	**(04Hours)**
	The Dimensionality Problem, Singular Value Decomposition (SVD), Principal Component Analysis (PCA), Descriptive and Inferential statistics, Populations and Samples, Hypothesis testing.	
	PARADIGMS FOR DATA MANIPULATION, LARGE SCALE DATA SET	**(08 Hours)**
	Mapreduce (Hadoop), Query Large Data Sets in Near Real Time with Pig and Hive, Moving from Traditional Warehouses to Map Reduce, Distributed Databases, Distributed Hash Tables.	
	TEXT ANALYSIS	**(08Hours)**
	Data Flattening, Filtering and Chunking, Feature Scaling, Shingling of Documents, Locality Sensitive Hashing for Documents, Distance Measures, LSH Families for Other Distance Measures.	
	MINING DATA STREAM	**(06Hours)**

	Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Moments, Windows, Clustering for Streams.	
	ADVANCED DATA ANALYSIS	**(10Hours)**
	Link Analysis, Mining of Graph, Frequent Item Sets Analysis, High Dimensional and Hierarchical Clustering, Recommendation Systems, Collaborative filtering. Visualization, Data Summaries, Data Storytelling, ML Model-Checking and Comparison.	
	CASE STUDIES	**(05Hours)**
	NLP in Customer Service, Energy Consumption analysis, Healthcare diagnostics, fraud detection and other applications.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60Hours)	

3.	**Tutorials**
1	MapReduce Word Count on Hadoop
2	HDFS Commands and Operations
3	Association Rule Mining for Product Recommendation
4	Data Stream Mining, Analysis, and Visualization
5	Time Series Analysis and Its Applications
6	Detailed Data Analysis on a Medical Dataset
7	Classification Model for Reddit Post Categorization
8	Malicious URL Prediction System
9	Building a Recommendation System
10	Case Study

4.	**Books Recommended**
1	Cathy O'Neil and Rachel Schutt, Doing Data Science: Straight Talk from the Frontline, 1st EditionO'Reilly Media, 2013, ISBN: 978-1449358655
2	Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O’reilly Media, 2015, ISBN: 9781491901687.
3	AnandRajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, 2nd Edition, Cambridge University Press, 2014, ISBN: 9781107077232.
4	Peter Bruce, Andrew Bruce, “Practical Statistics for Data Scientists: 50” by, 1st Edition, O’reilly publishing house, 2017, ISBN: 9781491952962.
5	Joel Grus, J. “Data science from scratch”, 1st Edition, O'Reilly Media, 2015, ISBN: 9781491901410.

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Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V DEEP LEARNING IA301	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Identify problems that could be solved using Deep learning.
CO2	Understand major components and key concepts of CNN, RNN, GAN, and Transformers.
CO3	Understand recent advancements in GANs.
CO4	Analyze and apply deep learning models for image and text tasks.
CO5	Design applications of Deep learning in Pytorch and Keras.

2.	**Syllabus**	
	Introduction to Deep learning	**(09 Hours)**
	Motivation and History of Deep Learning, Overview of Applications (e.g., Vision, Speech, NLP), Supervised learning, Unsupervised learning, Reinforcement learning, Artificial Neural Networks (ANNs) ,Shallow neural network, From fully Connected Layers to Convolutions, Convolutions for images, Padding and Stride, Pooling, Activation Functions: Sigmoid, ReLU, Tanh, Forward and Backpropagation Algorithms, Convolution Neural Networks (LeNet) and floating point operations (FLOP), Gradient Descent, Optimization Algorithms in Deep learning, Weight Initialization and Regularization Techniques, Hyperparameter Tuning (Learning Rate, Batch Size), Overfitting and Underfitting	
	Modern Convolution Neural Networks	**(05 Hours)**
	Deep Convolution Neural Networks (AlexNet), Network using Blocks (VGG), Network in Network (NiN), Multi-Branch Networks (GoogLeNet), BatchNormalization, Layer Normalization, Instance Normalization, Group Normalization, Residual Networks (ResNet), Densely Connected Network (DenseNet), Transfer Learning and Fine-Tuning, Applications: Image Classification, Object Detection.	
	Modern Recurrent Neural Networks	**(08 Hours)**
	Working with sequences, Converting Raw Text into Sequence Data, Basic of Language models, Recurrent Neural Networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Applications: Text Generation, Sentiment Analysis	
	Introduction to Generative Modeling	**(08 Hours)**
	Generative modeling, Auto-encoder, Variational Auto encoders (VAE), Generative Adversarial Networks (GANs), GAN Training and loss function, GAN Challenges, Mode Collapse, Variants of GANs (DCGAN, cGAN, WGAP, WGAN-GP), Applications: Image Synthesis, Style Transfer	
	Applications of GANs and Advanced Topics	**(06 Hours)**

	Image-to-Image Translation (pix2pix), Neural Style Transfer (Style GAN), Face Manipulation, Superresolution, Inpainting, Image Segmentation, future of Generative Modeling, Explainable AI (XAI)	
	Introduction to Transformers and its Applications	**(09 Hours)**
	Attention Mechanisms, Natural Language, Transformer Language Models, Sequence-to-Sequence transformers, Vision Transformers. Text classification, Question Answering, Translation, Text Generation, future of Transformers, Applications: Machine Translation, BERT, GPT	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours +30 Hours = 75 Hours)	

3. Practicals:
1. Basic Programming on deep learning frameworks Pytorch/Keras deep learning frameworks
2. Image classification using difference CNN architecture in Pytorch/Keras.
3. Transfer Learning of pretrained models on MNIST dataset.
4. Time-Series Forecasting with the LSTM Model in Pytorch/Keras.
5. Deep learning Techniques for image segmentation in Pytorch/Keras.
6. Autoencoders using MNIST Handwritten digits in Pytorch/Keras.
7. GAN for generating synthetic image on MNIST Handwritten digits dataset.
8. DCGAN for generating synthetic image on CIFAR dataset.
9. Text classification using Transformer and Fine-tune a pre-trained Transformer (e.g., BERT) for sentiment analysis.
10. Minor Project on classification and synthetic image generation and Deploy a trained DL model as a REST API using Flask.

4. Books Recommended:
1. Dive into Deep Learning: Book by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola.
2. Deep Learning. Book by Ian Goodfellow and Yoshua Bengio and Aaron Courville, The MIT
3. Deep Learning Foundations and Concepts, Book by, Christopher M. Bishop, Hugh Bishop
4. Josh Patterson and Adam Gibson, “Deep learning: A practitioner's approach”, O'Reilly Media, First Edition, 2017
5. Seth Weidman, Deep Learning from Scratch: Building with Python from First Principles, O'Reilly

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Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V CLOUD COMPUTING IA303	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.
CO2	Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost.
CO3	Identify resource management fundamentals, i.e. resource abstraction, sharing and sandboxing and outline their role in managing infrastructure in cloud computing.
CO4	Analyze various cloud programming models and apply them to solve problems on the cloud.
CO5	Will understand cloud security concepts, identify risks, and apply security measures to protect cloud environments.

2.	Syllabus	
	OVERVIEW OF COMPUTING PARADIGM AND INTRODUCTION TO CLOUD COMPUTING	**(06 Hours)**
	Recent trends in computing, evolution of cloud computing, Cloud computing (NIST model), properties, characteristics and disadvantages, role of open standards.	
	CLOUD COMPUTING ARCHITECTURE	**(05 Hours)**
	Cloud computing stack, Service models (XAAS), Deployment models.	
	INFRASTRUCTURE AS A SERVICE	**(05 Hours)**
	Introduction, Hypervisors, Resource virtualization, examples.	
	PLATFORM AND SOFTWARE AS A SERVICE	**(08 Hours)**
	Introduction, Cloud Platform and Management, Web services, Web 2.0, Web OS examples.	
	SERVICE MANAGEMENT IN CLOUD COMPUTING	**(06 Hours)**
	Service Level Agreements (SLAs), Billing & Accounting, comparing scaling hardware, economics of scaling, managing data.	
	CLOUD SECURITY	**(07 Hours)**
	Infrastructure security, Data security and storage, Identity and Access Management, Access Control, Trust and Reputation, Authentication in Cloud computing.	
	CASE STUDY ON OPEN SOURCE AND COMMERCIAL CLOUDS	**(08 Hours)**
	Eucalyptus, VMware Cloud and Other case studies	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Evaluation of Platform as a Service
2. Development and Deployment of Software as a Service
3. Exploration of Service Management in Cloud Computing
4. Study of Cloud Backup and Disaster Recovery
5. Analysis of Cloud Cost Optimization

6. Implementation of Infrastructure and Data Protection
7. Configuration of identity, Access Control and Authentication in Cloud Computing
8. Installation and management of Eucalyptus Cloud
9. Configuration and deployment of VMware Cloud

4. Books Recommended:

1. Barrie Sosinsky: "Cloud Computing Bible", Wiley-India, 2010
2. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski: "Cloud Computing: Principles and Paradigms", Wiley, 2011
3. Nikos Antonopoulos, Lee Gillam: "Cloud Computing: Principles, Systems and Applications", Springer, 2012
4. Ronald L. Krutz, Russell Dean Vines: "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010
5. Tim Mather, Subra Kumara swamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly Media, 2009.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – IV INFORMATION SECURITY AND CRYPTOGRAPHY IA309	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	understands the key concept and mathematical background of cryptography.
CO2	apply the concept of security mechanisms from the application developer's perspective.
CO3	analyse security mechanisms while trying to satisfy the required security services.
CO4	evaluate different information hiding and authentication techniques.
CO5	design and develop the security solution depending on the organisation's requirements.

2.	**Syllabus**	
	Introduction to Information Security and Cryptography	**(03 Hours)**
	Elements of Information Security, Security Attacks, Security Services, Basic Terminology in Cryptography, Types, Goals of cryptography	
	Data Encryption Techniques	**(08 Hours)**
	Encryption methods, substitution ciphers: The caesar cipher, mono alphabetic cipher, play fair cipher, hill cipher, one-time pad cipher, transposition cipher, Shift Cipher, Affine Cipher, Permutation Cipher, Stream Ciphers, Cryptanalysis	
	Data Encryption and Advanced Encryption Standards	**(09 Hours)**
	Block ciphers, festal cipher, data encryption standard, working and cracking of DES, Concept of advanced encryption standard, Key generation, encryption and decryption procession of AES, advantages of AES.	
	Number Theory	**(06 Hours)**
	Prime number, Modular arithmetic, Fermat's theorem, Euler's theorem, Chinese remainder theorem	
	Symmetric Ciphers	**(06 Hours)**

	Concept of Symmetric cipher, blowfish encryption, RC5, RC4, IDEA	
	Public Key cryptosyatem	**(06 Hours)**
	Public key cryptography, key length and encryption strength, applications of public key cryptography, RSA algorithm	
	Key management and Authentication	**(07 Hours)**
	Diffie-Hellman key exchange, authentication methods, message digest MD2, MD4 , MD5 , SHA, kerberos, X.509, digital signature	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Implement a Caesar Cipher to encrypt and decrypt messages by shifting characters.
2. Develop a program to implement the Monoalphabetic Cipher for encryption and decryption of text.
3.Create a Playfair Cipher encryption and decryption algorithm using digraphs.
4. Implement the Hill Cipher for encrypting a message using a 2x2 matrix.
5.Write a program for a Shift Cipher that shifts characters by a fixed number for encryption and decryption.
6. Implement the Affine Cipher, which involves using mathematical transformations (multiplication and addition) for encryption and decryption.
7. Demonstrate the working of DES encryption and decryption using a simple block cipher approach.
8. Implement the AES encryption algorithm and compare its performance with DES using different modes (e.g., ECB, CBC).
9. Simulate the Diffie-Hellman Key Exchange algorithm to securely share a secret key over an insecure channel.
10.Implement MD5 and SHA (e.g., SHA-1, SHA-256) to generate message digests and verify the integrity of messages.

4. Books Recommended:
1. Stinson, Douglas R., “Cryptography: theory and practice”, 3rd Edition, Chapman and Hall/CRC, 2005.
2. Stallings, William, “Cryptography and network security: principles and practice”, 7th Edition, Upper Saddle River: Pearson, 2017.
3.Create a Playfair Cipher encryption and decryption algorithm using digraphs.
4. Forouzan, Behrouz A., “Cryptography & network security”, 3rd Edition, McGraw-Hill, Inc., 2007.
5. Schneier, Bruce, “Applied cryptography: protocols, algorithms, and source code in C”, 2nd Edition, john wiley & sons, 2007.

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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V LINEAR AND NONLINEAR OPTIMIZATION IA307	Scheme	L	T	P	Credit
		3	1	0	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Formulate and Solve Linear Programming Problems.
CO2	Apply Techniques for Unconstrained Nonlinear Optimization.
CO3	Solve Constrained Nonlinear Optimization Problems.
CO4	Implement and Utilize Optimization using standard Software Packages.
CO5	Analyze and Model Real-World Optimization Problems.

2.	**Syllabus**	
	Introduction	**(04 Hours)**
	Sets, functions, sequences, continuity, differentiability, gradients, Taylor series expansion. Vectors, matrices, norms, symmetric matrices, eigenvalue decomposition, positive semidefinite and positive definite matrices	
	Linear Optimization	**(07 Hours)**
	Linear programming, linear algebra, geometry of polyhedra, the simplex method, duality, primal dual algorithms, opt: applications to integer linear programs	
	Convex sets and functions	**(06 Hours)**
	Convex sets, examples and properties, Convex functions, strict and strong convexity, examples, and convexity preserving operations, Equivalent definitions of convexity under differentiability assumptions	
	Unconstrained Optimization	**(08 Hours)**
	Maxima, minima, stationary point, saddle point, local and global maximum/minimum, First order and second order conditions for optimality, Linear, quadratic and convex optimization problems, examples, Benefits of convexity	
	Constrained Optimization	**(08 Hours)**
	Constrained optimization problem, feasible set, Lagrangian, KKT conditions, Linear and quadratic optimization, Duality for convex optimization theorem of alternatives, Farkas' lemma	
	Algorithms for Optimization	**(07 Hours)**
	Gradient descent with fixed step size, line search and Armijo-Goldstein rule, Newton method and variations, Conjugate gradient and Quasi-newton methods, Algorithms for constrained optimization: Projected gradient descent, dual ascent, alternating direction method of multipliers	

	Applications	**(05 Hours)**
	Applications in statistics, machine learning and computer science	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3. Tutorials:
1. Introduction to Linear Programming & Graphical Method
2. Simplex Method (Maximization)
3. Simplex Method (Minimization) & Special Cases
4. Duality and Sensitivity Analysis
5. Introduction to Unconstrained Nonlinear Optimization
6. Calculating gradients and Hessians, applying steepest descent
7. Newton's Method & Conjugate Gradient Methods
8. Constrained Optimization: Lagrange Multipliers
9. Karush-Kuhn-Tucker (KKT) Conditions
10. Real-World Applications & Case Studies

4. Books Recommended:

1. Convex optimization by Boyd, Stephen, and Lieven Vandenberghe
2. Linear and nonlinear programming by Luenberger, David G., and Yinyu Ye
3. Nonlinear programming by Bertsekas, Dimitri P.
4. Numerical optimization by Nocedal, Jorge and Wright, Stephen. . Springer, 1999
5. Linear and Nonlinear Optimization by Igor Griva, Stephen G. Nash, and Ariela Sofer

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Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V GAME THEORY IA351	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	Learn how individuals and organizations make rational choices in competitive and cooperative environments
CO2	Explore different types of games, including zero-sum, non-zero-sum, cooperative, and non-cooperative games
CO3	Study equilibrium concepts to predict and explain strategic interactions in various scenarios.
CO4	Apply game-theoretic principles to economics, business, politics, social sciences and technology
CO5	Enhance analytical abilities to model and solve strategic problems effectively

2.	Syllabus	
	INTRODUCTION TO GAME THEORY	**(06 Hours)**
	Definition, scope, applications, types of games (cooperative vs. non-cooperative, zero-sum vs. non-zero-sum), basic terminology, strategic interactions in economics and social sciences.	
	STRATEGIC FORM GAMES AND NASH EQUILIBRIUM	**(08 Hours)**
	Normal-form representation, dominant and dominated strategies, best response analysis, Nash equilibrium, mixed strategies, existence and computation of equilibria.	
	EXTENSIVE FORM GAMES AND SUBGAME PERFECTION	**(07 Hours)**
	Sequential games, extensive-form representation, backward induction, subgame perfect equilibrium, perfect information vs. imperfect information games, applications in bargaining	
	REPEATED AND STOCHASTIC GAMES	**(06 Hours)**
	Infinitely repeated games, folk theorems, strategies for cooperation, stochastic games, Markov strategies, applications in long-term strategic interactions.	
	BAYESIAN GAMES AND INCOMPLETE INFORMATION	**(06 Hours)**
	Games with asymmetric information, Bayesian Nash equilibrium, signaling and screening, auction theory, mechanism design, applications.	
	COOPERATIVE GAME THEORY AND BARGAINING SOLUTIONS	**(06 Hours)**
	Core, Shapley value, bargaining games (Nash and Rubinstein models), coalition formation, applications in business and international negotiations.	
	APPLICATIONS AND ADVANCED TOPICS	**(06 Hours)**

	Evolutionary game theory, mechanism design, matching markets, voting and fair division, real-world applications in economics, politics, and AI-driven strategy models.
	(Total Contact Time: 45 Hours+ 15 Hours = 60 Hours)

3. Tutorials:
1. Identify and eliminate dominated strategies in normal-form games.
2. Compute pure and mixed strategy Nash equilibria using best response analysis.
3. Solve sequential games by applying backward induction.
4. Analyze long-term strategic interactions and cooperation in infinitely repeated games.
5. Solve games where players have private information.
6. Study different auction formats and optimal bidding strategies.
7. Analyze how coalitions form and distribute payoffs in cooperative games.
8. Explore strategic negotiation models and their real-world applications.
9. Understand evolutionarily stable strategies (ESS) in dynamic games.
10. Apply game-theoretic concepts to business, politics, and cybersecurity.

4. Books Recommended:
1. Y. Narahari, "Game Theory and Mechanism Design: 4 (IISc Lecture Notes Series)," World Scientific Publishing Co Pvt Ltd, May 07, 2014, ISBN-13: 978-9814525046
2. Anna R. Karlin and Yuval Peres, "Game Theory, Alive," American Mathematical Society, Apr 27, 2017, ISBN-13: 978-1470419820 [Available Online].
3. Roger B. Myerson, "Game Theory: Analysis of Conflict," Harvard University Press, September 1997, ISBN-13: 978-0674341159.
4. Martin J. Osborne, "An Introduction to Game Theory," Oxford University Press, 2003, ISBN- 13: 978-0195128956.
5. D. Fudenberg and J. Tirole, "Game Theory," Indian Edition by Ane Books, 2005, ISBN-13: 978-8180520822.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V INTRODUCTION TO QUANTUM COMPUTING IA353	Scheme	L	T	P	Credit
		3	1	0	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Understanding Quantum Computing Fundamentals
CO2	Analyzing Quantum Computing Applications
CO3	Develop Quantum Circuits Using Qiskit
CO4	Explore NISQ Era and Industrial Applications
CO5	Applying Quantum Circuit Models to solve problems

2.	**Syllabus**	
	Foundations	**(08 Hours)**
	Hilbert spaces (finite dimensional). Axioms of quantum probability. Quantum vs Classical probability.	
	IBM Quantum Perspective, Q Mission in India	**(08 Hours)**
	IBM Quantum Composer and Quantum Lab using Qiskit, Quantum Computing Applications, Quantum Computing Basics,	
	Quantum Computing	**(11 Hours)**
	Turing machines, Boolean circuits, Quantum Circuits, Universality. Simon's problem, Phase finding, Shor's algorithm, Grovers algorithm, Probability amplification. Some applications.	
	Quantum Information processing	**(06 Hours)**
	Quantum error correction.Knill-Laflamme theorem, Stabiliser codes	
	Quantum Algorithms	**(07 Hours)**
	Oracles, Deustch Jozsa, Grover's Algorithm with Hands-on, etc.	
	Quantum Algorithms for NISQ	**(05 Hours)**
	NISQ era Quantum Algorithms for VQE/QAOA and industrial applications	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3. Tutorials:
1. Tutorial on Quantum Circuits and Quantum Composer
2. Tutorial on the Deutsch-Jozsa Algorithm
3. Tutorial on Grover's Search Algorithm
4. Tutorial on Shor’s Algorithm for Integer Factorization
5. Tutorial on Quantum Error Correction Using the Three-Qubit Bit-Flip Code
6. Tutorial on the Deutsch-Jozsa Algorithm for Distinguishing Constant and Balanced Functions
7. Tutorial on Variational Quantum Eigensolver (VQE) for Finding the Ground State Energy of a Molecule

4. Books Recommended:

1. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum information, Cambridge University Press (2010)
2. Eleanor G. Rieffel, Wolfgang H. Polak, Quantum Computing: A Gentle Introduction (Scientific and Engineering Computation), MIT Press (2014)
3. Hiu Yung Wong, Introduction to Quantum Computing: From a Layperson to a Programmer, Springer Nature
4. Qiskit Textbook: https://qiskit.org/textbook/preface.html

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V INFORMATION RETRIEVAL IA355	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	understand the fundamentals of Information Retrieval (IR) systems
CO2	apply text processing and indexing techniques for efficient retrieval
CO3	analyze ranking models and evaluation metrics in IR
CO4	implement machine learning techniques for IR tasks
CO5	explore advanced and next-generation IR techniques

2.	**Syllabus**	
	Introduction	**(06 Hours)**
	Overview of Information Retrieval Systems: Definition and objectives of IR systems, Functional overview of IR systems, Relationship with Database Management Systems, Digital Libraries, and Data Warehouses. Fundamentals of Information Retrieval: History and evolution of IR, Components of an IR system, Key issues in IR.	
	Text Processing and Indexing	**(07 Hours)**
	Basic Text Processing: Tokenization, Stopwords, Stemming, Lemmatization, Zipf's law, Heap's law, Error Detection and Correction: Hamming distance, Longest Common Subsequence, Levenshtein edit distance, Indexing and Data Structures: Soundex algorithm, Inverted File Structure, N-Gram Data Structures.	
	Ranking Models	**(06 Hours)**
	Ranking Models: Vector Space Model, TF-IDF, Probabilistic Retrieval Model, Generative Model, Probabilistic Ranking Principle, Binary Independence Model	
	Evaluation Metrics and Relevance Judgment in Information Retrieval	**(05 Hours)**
	Precision, Recall, F-measure, Mean Reciprocal Rank (MRR), Mean Average Precision (MAP), Normalized Discounted Cumulative Gain (NDCG), Test Collection and Relevance Judgments: Designing test collections, Relevance judgments.	
	Unsupervised Learning Approaches in Information Retrieval	**(06 Hours)**
	Retrieval using Unsupervised Techniques: Word embeddings, Clustering-based retrieval, Topic modeling), Dimensionality reduction techniques, Anomaly detection in retrieval.	
	Supervised Learning Approaches in Information Retrieval	**(06 Hours)**
	Learning to Rank for retrieval, Classification-based retrieval, Neural networks for ranking, Deep learning models (e.g., BERT, Transformer-based retrieval), Feature engineering for IR, Ensemble methods in retrieval.	

	Next-Generation Information Retrieval	**(09 Hours)**
	Neural Information Retrieval, Multimodal Information Retrieval, Cross-modal retrieval, Vision-language models (CLIP), Chatbot-based search, Real-Time and Streaming IR	
	(Total Contact Time: 45Hours + 30 Hours =75 Hours)	

3. Practicals:
1. Introduction to Information Retrieval Systems
2. Text Processing Techniques (Tokenization, Stemming, Lemmatization, Stop words)
3. Statistical Foundations in IR (Zipf's Law and Heap's Law)
4. Indexing Techniques and Data Structures (Inverted Index, N-Grams, Soundex)
5. Error Detection and Correction in IR (Edit Distance, LCS, Hamming Distance)
6. Ranking Models (Vector Space Model, TF-IDF, Probabilistic Models)
7. Evaluation Metrics and Relevance Judgments (Precision, Recall, MAP, NDCG)
8. Unsupervised Learning in IR (Clustering, Topic Modeling, Word Embeddings)
9. Supervised Learning and Learning-to-Rank in IR

4. Books Recommended:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze. Introduction to Information Retrieval, Cambridge University Press, 2008. ISBN-13: 978-0521865715.
2. Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack. Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, ISBN-13: 978-0262026512.
3. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman. Mining of Massive Datasets, Cambridge University Press, 2011. ISBN: 978-1107077232.
4. Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – V NATURAL LANGUAGE PROCESSING IA357	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	Understand the fundamental concepts of NLP and its applications.
CO2	Understand and Implement text preprocessing techniques (tokenization, stemming, lemmatization, etc.)
CO3	Apply various feature engineering, word embeddings, and other deep learning methods for NLP tasks.
CO4	Build and evaluate NLP models for text classification, information extraction, and sequence to sequence modeling tasks
CO5	Utilize NLP tools and libraries (NLTK, spaCy, scikit-learn, transformers, Pytorch, Hugging Face)
CO6	Design and implement a complete NLP project.

2.	Syllabus	
	Introduction to NLP	**(05 Hours)**
	What is NLP? History and applications of NLP, Challenges in NLP, NLP pipeline, Basic language processing: Regular expressions, finite state automata and its applications	
	Text Preprocessing	**(07 Hours)**
	Tokenization, stemming, and lemmatization, Stop word removal, Handling noisy text, n-gram Language Model, Smoothing Techniques	
	Representations for NLP	**(08 Hours)**
	Bag of Words (BoW), TF-IDF, N-grams, Word embeddings: Word2Vec, GloVe, FastText, Contextualized word embeddings: BERT, RoBERTa, Unsupervised Word Embeddings	
	Text Classification	**(08 Hours)**
	ML Approaches (Naive Bayes, Support Vector Machines (SVMs), Logistic Regression, Decision Trees and Random Forests, Multi-Layer Perceptron), Deep Learning approaches using contextual embeddings, different text classification tasks, Evaluation metrics: Accuracy, precision, recall, F1-score.	
	Sequence Labeling Tasks	**(08 Hours)**
	Part-of-Speech (POS) tagging, Chunking, Constituency and Dependency Parsing, Named Entity Recognition (NER), Relation extraction, Shallow Parsing, Multi-Task Learning, Evaluation metrics for sequence prediction tasks	
	Sequence-to-Sequence Modeling	**(09 Hours)**

	Recurrent Neural Networks (RNNs), LSTMs, GRUs, Encoder-decoder architecture, Attention mechanisms, Beam search, transformers, encoder-only and decoder-only models, Applications: Machine translation, Text summarization, Question and Answering, Evaluation metrics used for MT, Summarization, and Q&A	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Text Preprocessing
2. Feature Engineering and different text representations
3. Build and evaluate text classification models using ML and DL approaches
4. Perform POS tagging, NER, and other syntactic analysis using spaCy/Stanza
5. Implement Sequence Labeling models using HMM, MEMM, CRF, Seq2Seq models
6. Implement a sequence-to-sequence model for different task using various architectures
7. Develop a complete NLP project (e.g., spam detection, news article classification, chatbot).

4. Books Recommended:

1. *Speech and Language Processing, Daniel Jurafsky and James H. Martin*
2. Natural Language Processing with Transformers, Lewis Tunstall, Leandro von Werra, Thomas Wolf
3. Natural Language Processing with Python by Bird, Klein, and Loper
4. Natural Language Processing, Pushpak Bhattacharyya, Aditya Joshi
5. Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, O'Reilly Media, Inc.
3. Online Tutorials: Hugging Face, PyTorch, Sklearn, Stanza, NLTK, Spacy
4. Latest research papers from top tier conferences (ACL, NEURIPS, AAAI, NAACL, COLING, CONLL, SIGIR, IJCNLP, LREC)

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI **HIGH PERFORMANCE COMPUTING** **IA302**	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**0**	**2**	**04**

1. <u>Course Outcomes (COs):</u> **At the end of the course, students will be able to**	
CO1	Learn concepts, issues and limitations related to parallel computing architecture and software development.
CO2	Apply different parallel models of computation, parallel architectures, interconnections and various memory organization in modern high-performance architectures.
CO3	Analyze the algorithms to map them onto parallel architectures for parallelism.
CO4	Evaluate the performance of different architectures and parallel algorithms with different aspects of real time problems.
CO5	Design parallel programs for shared-memory architectures and distributed-memory architectures using modern tools like OpenMP and MPI, respectively for given problems.

2.	**<u>Syllabus</u>**	
	PARALLEL PROCESSING CONCEPTS	**(08 Hours)**
	Levels of Parallelism (Instruction, Transaction, Task, Thread, Memory, Function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc.), Architectures: N wide Superscalar Architectures, Multi-core, Multi-threaded.	
	FUNDAMENTAL DESIGN ISSUES IN PARALLEL COMPUTING	**(06 Hours)**
	Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.	
	FUNDAMENTAL LIMITATIONS FACING PARALLEL COMPUTING	**(06 Hours)**
	Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their Limitations, Power-Aware Computing and Communication, Power-Aware Processing Techniques, Power-Aware Memory Design, Power-Aware Interconnect Design, Software Power Management	
	PARALLEL PROGRAMMING	**(11 Hours)**
	Programming Languages and Programming-Language Extensions for HPC, Inter-Process Communication, Synchronization, Mutual Exclusion, Basics of Parallel Architecture, Parallel Programming Parallel Programming with OpenMP and (Posix) Threads, Message Passing with MPI.	
	PARALLEL PROGRAMMING WITH CUDA	**(10 Hours)**
	Processor Architecture, Interconnect, Communication, Memory Organization, and	

	Programming Models in High Performance Computing Architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Micro architecture and Intel Nehalem Micro architecture), Memory Hierarchy and Transaction Specific Memory Design, Thread Organization.	
	ADVANCED TOPICS	**(04 Hours)**
	Petascale Computing, Optics in Parallel Computing, Quantum Computers.	
	Practicals will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Practical to implement and analyze matrix multiplication using task and thread-level parallelism on a multi-core processor.
2. To implement an edge detection algorithm (e.g., Sobel filter) using CUDA, leveraging SIMT architecture and memory-level parallelism.
3. Practical to implement the classic producer-consumer problem using semaphores to manage synchronization between multiple threads.
4. To implement parallel merge sort using task-based parallelism and analyze task dependencies and performance.
5. To evaluate how power-aware processing techniques (like Dynamic Voltage and Frequency Scaling - DVFS) affect CPU performance, energy consumption, and latency under different workloads.
6. Practical to implement parallel matrix multiplication using OpenMP, demonstrating the concepts of parallelism, synchronization, and mutual exclusion in shared-memory systems.
7. Practical Based on Distributed Sorting Using MPI
8. Practical to analyze the performance of CUDA cores by implementing a parallel vector addition algorithm, focusing on thread organization, memory hierarchy (global, shared, and register memory), and communication within GPU threads

4. Books Recommended:
1. John L. Hennessy and David A. Patterson, “Computer Architecture -- A Quantitative Approach”, 5th Edition, Morgan Kaufmann Publishers, 2017, ISBN 13: 978-0-12-383872-8.
2. Barbara Chapman, Gabriele Jost and Ruud van der Pas, “Using OpenMP: portable shared memory parallel programming”, The MIT Press, 2008, ISBN-13: 978-0-262-53302-7.
3. Pacheco S. Peter, “Parallel Programming with MPI”, Morgan Kaufman Publishers, 1992, Paperback ISBN: 9781558603394.
4. Marc Snir, Jack Dongarra, Janusz S. Kowalik, Steven Huss-Lederman, Steve W. Otto, David W. Walker, “MPI: The Complete Reference, Volume2”, The MIT Press, 1998, ISBN: 9780262571234.
5. Pacheco S. Peter, “Parallel Programming with MPI”, Morgan Kaufman Publishers, 1992, Paperback ISBN: 9781558603394. https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI CYBER PHYSICAL SYSTEM IA304	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Understand the fundamental principles of Cyber-Physical Systems.
CO2	Identify the key components and architecture of CPS.
CO3	Apply basic design principles for creating CPS.
CO4	Understand real-time computing and communication constraints in CPS.
CO5	Analyze and apply CPS in real-world application domains.

2.	**Syllabus**	
	Introduction to Cyber-Physical Systems	**(04Hours)**
	Definition and characteristics of CPS, Historical development of CPS and their importance, Key examples of CPS: Autonomous vehicles, industrial automation, healthcare, smart grids, smart cities, Overview of CPS architecture: physical components, computational systems, communication networks, Difference between classical systems and CPS	
	Core Components of Cyber-Physical Systems	**(05 Hours)**
	Physical Components: Sensors, actuators, embedded systems, and hardware platforms, Computational Components: Embedded processors, real-time operating systems, and software algorithms, Communication Networks: Wired and wireless communication, IoT protocols, and network latency, Feedback Loops: Interaction between physical systems and their digital counterparts	
	Cyber-Physical Systems Architecture	**(08 Hours)**
	System Architecture Models: Layered architecture (perception, control, and actuation layers), Data Flow in CPS: Sensing, processing, decision-making, and actuation, Integration Challenges: Synchronization of physical and computational processes, system interdependence, Edge and Cloud Computing in CPS: The role of distributed computing	
	Real-Time Systems and Constraints in CPS	**(08 Hours)**
	Real-time computing and control in CPS, Timing constraints: Deadline-sensitive tasks, scheduling, and resource allocation, Real-time operating systems (RTOS) and their role in CPS, Handling delay, jitter, and synchronization in CPS, Real-Time Scheduling for Cyber-Physical Systems, Safety and reliability in real-time systems	
	Sensors and Actuators in CPS	**(08 Hours)**
	Types of sensors: Temperature, pressure, motion, proximity, etc.,Sensor calibration and data acquisition techniques, Actuators and control techniques: Combining data from multiple	

	sensors to improve accuracy and decision-making, Wireless sensors and Internet of Things (IoT) in CPS, Real time sensing and communication	
	Communication Protocols for CPS	**(08 Hours)**
	Wired and wireless communication technologies in CPS, IoT protocols (e.g., MQTT, CoAP, Zigbee), Communication latency, bandwidth, and throughput, Security and privacy issues in CPS communication, Network topology and design considerations for distributed CPS	
	Applications and Case Studies	**(04 Hours)**
	Smart Grids, Autonomous Vehicles, Healthcare CPS, Industrial CPS (Industry 4.0), Autonomous Systems and Robotics	
	(Total Contact Time: 45 Hours +30 Hours = 75 Hours)	

3. Practicals:
1. Building a Simple CPS Prototype: Using Raspberry Pi/Arduino for sensor integration
2. Simulation of a Smart Grid System: Using Simulink or similar tools
3. Implementing a Secure IoT-Based CPS
4. Simulation tools for CPS validation (e.g., MATLAB/Simulink, Simulink Real-Time, LabVIEW)
5. Development of home automation system
6. Creating an environment for monitoring and managing various factors to optimize crop production in agriculture
7. Development of air quality monitoring system
8. Simulation of Autonomous Vehicle Navigation
9. Develop a system to optimize traffic signals based on real-time congestion.
10. Monitor machinery health using vibration, temperature, and current sensors.

4. Books Recommended:
1. Cyber-Physical Systems: From Theory to Practice by Rajesh K. Gupta and Phillip A. Laplante
2. Principles of Cyber-Physical Systems - Rajeev Alur
3. Machine Learning for Cyber-Physical Systems" by Nuno J. G. Gomes
4. Introduction to Embedded Systems — A Cyber— Physical Systems Approach" - E. A. Lee, Sanjit Seshia
5. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI BIG DATA ANALYTICS & VISUALIZATION IA306	Scheme	L	T	P	Credit
		3	0	2	04

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	To learn the basics of big data, its characteristics, big data management issues, processing and applications with the help of big data platforms and storage models for big data management..
CO2	To learn the management and analysis of big data using technology like Hadoop, NoSql, MapReduce, PIG & HIVE
CO3	To apply the data mining algorithms on big data for scalability of the real time applications.
CO4	To develop research interest towards advances in data mining by analyzing the available approaches with the help of evaluating parameters.
CO5	To Visualize big data to perform decision making in real world problems

2.	Syllabus	
	INTRODUCTION	**(04 Hours)**
	Definition of Big Data, Source of Big Data, Convergence of Key Trends, Unstructured Data, Industry Examples of Big Data, Web Analytics, Fraud and Risk Associated with Big Data, Credit Risk Management, Big Data in Algorithmic Trading, Healthcare, Medicine, Marketing and Advertising, Big Data Technologies, Introduction to Hadoop and Spark, Open Source Technologies, Cloud, Mobile Business Intelligence, Crowd Sourcing Analytics, Inter and Trans Firewall Analytics.	
	BIG DATA ANALYTICS	**(06 Hours)**
	Big Data Processing: Batch Data Processing and Stream Data Processing, Computing Environments for Big Data Analytics, Implementation of Batch and Real Time Event Processing: Integration of Disparate Data Stores/Data Lake, Mapping Data to the Programming Framework, Connecting and Extracting Data from Storage, Transforming Data for Processing, Querying.	
	DISTRIBUTED FILE SYSTEM HADOOP	**(08 Hours)**
	Introduction, HDFS Daemons, Different Methods to HDFS Access, Hadoop, Features, Google File System Features, Phases involved in Map Reduce, Architecture, Execution of MapReduce Jobs, Monitoring the progress of job flows, Building Blocks of Hadoop MapReduce. Data format, Analyzing data with Hadoop, Scaling Out, Hadoop Streaming, Hadoop Pipes, Design of Hadoop Distributed File System, MapReduce, HDFS Concepts: Java Interface, Data Flow, Hadoop I/O, Data integrity, Compression, Serialization, Avro, File-based Data Structures, Mahout	

	BIG DATA ANALYSIS WITH HBASE, SPARK, HIVE and PIG	**(08 Hours)**
	HBase, Data Model and Implementations, HBase Clients, HBase Examples, Praxis, Cassandra, Cassandra data Model, Cassandra Examples, Cassandra Clients, Hadoop Integration, Hive, Data Types and File Formats, HiveQL Data Definition, HiveQL Data Manipulation, HiveQL Queries, Applications on Big Data Using Pig and Hive, Data Processing Operators in Pig, Fundamentals of ZooKeeper, K-Means Clustering, Decision Trees, Random Forests, Recommenders, Table in Spark, Higher Level Declarative Programming, Network Structure, Computing Graph Statistics.	
	BIG DATA STORAGE MODELS	**(08 Hours)**
	Introduction, NoSQL Databases, Need, Types, Comparison with RDBMS, Architecture and Features Databases: Distributed Hash-table, Key-Value Storage Model, MongoDB Query Language, Document Storage Model, Graph Models, Lambda Architecture, Data Ingestion, Design and Provision Compute Resources, Storage Streaming Units, Configuration of Clusters for Latency and Throughput, Output Visualization	
	INTRODUCTION TO DATA VISUALIZATION	**(05 Hours)**
	Data Visualization, Design, Data and Tasks, Data Types, Dataset Types, Basic Charts and Plots, Use of Statistical Indicators, Multivariate Data Visualization, Principles of Perception, Color, Design, and Evaluation, Graphical Integrity, Data-Ink Ratio, Aspect Ratios & Scales. Formats-Static Graphs, Interactive Graphs, Infographics, Websites, Animated Videos, GIFs. Strategies-Qualitative and Text-Based Data, Color-Coding, Timelines, Calendars, and Diagrams, Filtering, Parallel Coordinates, Aggregation.	
	DATA VISUALISATION FORMAT, CATEGORY AND TOOLS	**(06 Hours)**
	Visual Story Telling, Messaging, Effective Presentations, Design for Information, Visualization and Arts, Visualization Systems, Database Visualization, Redesign Principles and Design Dimensionality, Rapidly Prototype Visualizations, Quantitatively and Qualitatively Evaluation of Visualizations. Visual Story Telling, Messaging, Database Visualization, Rapidly Prototype Visualizations, Quantitatively and Qualitatively Evaluation of Visualizations, Other Data Visualisation Tools, Excel, R, Tableau, Python	
	Practicals will be based on the coverage of the above topics.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 70 Hours)	

3.	**Practicals**
1	Working with various functions of Hadoop MapReduce.
2	Develop a MapReduce program to calculate the frequency of a given word in agiven file.
3	Working with pySpark and RDDs.
4	Develop a Java application to find the maximum temperature using Spark
5	Regression and classification in Spark.
6	Data analysis with PCA in Spark.
7	Write queries to sort and aggregate the data in a table using HiveQL.

8	Develop a program to calculate the maximum recorded temperature by yearwise for the weather dataset in Pig Latin
9	Hands-on with MLlib and SparkSQL.
10	Use cases and implementation for Big data management and large scale machine learning algorithms.

4.	**Books Recommended**
1.	Tom White, “HADOOP: The definitive Guide”, O Reilly 2012
2.	Michael Minelli, Michele Chambers, Ambiga Dhiraj, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley.
3.	Alberto Cairo, “The Truthful Art: Data, Charts, and Maps for Communication” 1/E, Berkeley, California: New Riders, 2016, ISBN: 9780321934079
4.	Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, “Advanced Analytics with Spark”, O'Reilly.
5.	Jure Leskovec, Stanford Univ. Anand Rajaraman, Milliway Labs, Jeffrey D. Ullman, “Mining of Massive Datasets”, Cambridge University Press

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI RESPONSIBLE AI IA352	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	Understand the fundamental concepts of Responsible AI
CO2	Understand the concept of fairness, privacy, and bias in AI
CO3	Understand different kinds of risks and ways to mitigate them
CO4	Understand the explainability of AI systems
CO5	Apply Responsible AI techniques to different use cases

2.	Syllabus	
	Introduction	**(05 Hours)**
	Recent AI Capabilities Improvement, imminent risks from AI Models: Toxicity, bias, goal misspecification, adversarial examples etc., Long-term risks from AI Models: Misuse, Misgeneralization, Rogue Artificial General Intelligence	
	Principles of Response AI (RAI)	**(05 Hours)**
	Transparency, Accountability, Safety, Robustness and Reliability, Privacy and Security, Fairness and non-discrimination, Human-Centred Values, Inclusive and Sustainable development, Interpretability	
	Types of Risks and Mitigation Strategies	**(08 Hours)**
	Recap of Deep Learning Techniques, Language/Vision Models, AI Risks for Gen models, Adversarial Attacks – Vision, NLP, Superhuman Go agents, ML Poisoning Attacks like Trojans, Implications for current and future AI safety, Mitigation Techniques	
	Explainability of AI Systems	**(07 Hours)**
	Explainability, Imminent and Long-term potential for transparency techniques, Mechanistic Interpretability, Representation Engineering, model editing and probing, Critiques of Transparency for AI Safety	
	Privacy and Fairness	**(06 Hours)**
	Privacy & Fairness in AI, Breaches of Data Privacy, Algorithmic Bias and Discrimination, Surveillance and Tracking, Lack of Transparency, Data Security Vulnerabilities, Overcoming Challenges and Safeguarding Privacy in AI	
	Evaluation Metrics and Regulations	**(07 Hours)**

	Metrics and Tools for RAI - measuring bias/fairness, adversarial testing, explanations (LIME/SHAP/SailencyMap/CAM/GradCam), audit mechanisms , Regulation landscape - DPDP act (India), GDPR (EU), EU AI act, US presidential declaration, Ethical approvals, informed consent, participatory design, future of work, Indian context	
	RAI Use Cases	**(07 Hours)**
	RAI in Legal, Health care, Education and other domains, Policy issues in RAI	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
		(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)

3. Tutorials:
1. Introduction to Responsible AI & Bias Detection
2. Fairness Metrics and Mitigation Techniques
3. Explainable AI (XAI)
4. Privacy and Security in AI
5. Transparency and Accountability
6. Human-Centered AI and User Trust

4. Books Recommended:
1. Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way, Springer, Virginia Dignum
2. The Cambridge Handbook of Responsible Artificial Intelligence, Silja Voeneky et al.
3. The Oxford Handbook of Ethics of AI, Markus D. Dubber et al.
4. Latest research papers from top tier conferences (ACL, AAAI, TACL etc.)

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI RECOMMENDER SYSTEMS IA354	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**1**	**0**	**04**

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	Describe foundational concepts and major paradigms of recommender systems.
CO2	Apply neighborhood-based and model-based collaborative filtering techniques for generating recommendations.
CO3	Develop content-based recommender systems using appropriate feature engineering and learning models.
CO4	Evaluate recommender systems using standard offline, online, and user-centric metrics.
CO5	Analyze advanced paradigms such as group, multi-criteria, multi-objective, and multi-stakeholder recommendation.

2.	**Syllabus**	
	Introduction to Recommender Systems	**(08 Hours)**
	Foundations and goals: principles, applications, types of ratings, missing values, collaborative filtering basics. Recommender approaches: content-based, knowledge-based, utility-based, demographic, hybrid. Advanced types and challenges: context-aware, time/location-aware, social and trustworthy systems, cold-start, group and multi-criteria, attack-resistance, privacy concerns, application domains.	
	Neighborhood-Based Collaborative Filtering	**(08 Hours)**
	Neighborhood models: rating matrix properties, predicting ratings, similarity and distance functions. User & Item-based CF: peer group selection, long-tail effect, computational complexity. Advanced methods: clustering, dimensionality reduction, regression-based CF, bias handling, SLIM models. Graph-based CF: user-item graph, random walks, Katz measure, user-user and item-item graphs.	
	Model-Based Collaborative Filtering	**(08 Hours)**
	Model-based approaches: decision trees, rule-based CF, Naive Bayes, association models, neural recommender models. Latent factor models: MF, SGD, ALS, bias learning, regularization, implicit feedback. Extended models: SVD variants, NMF, handling likes/dislikes. Hybrid systems: latent-neighborhood fusion, optimization and accuracy considerations.	
	Content-Based Recommender Systems	**(07 Hours)**
	Foundations and design: components, feature extraction, content analysis. Feature engineering & representation: text, product, web, music recommendation. Learning models: Gini, entropy, chi-square, nearest neighbor, Bayes, rule-based and regression models. Advanced topics: explanations, integration with collaborative filtering.	
	Evaluation of Recommender Systems	**(07 hours)**
	Evaluation paradigms: offline, online, user studies. Metrics: accuracy, coverage, novelty, serendipity, diversity, trust and scalability. Validation methods: Netflix Prize, hold-out, cross-validation, train-test splits. Ranking and errors: RMSE, MAE, comparison with classification	

	metrics.	
	Advanced Topics in Recommender Systems	**(07 Hours)**
	Advanced paradigms: group recommender systems, multi-stakeholder recommender systems, multi-objective and multi-criteria recommendation. Decision modeling: aggregation strategies, preference fusion, trade-off modeling, fairness and constraints, personalization and conflict resolution, evaluation considerations for multi-objective systems.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3. Tutorial:	
1.	Compute user–user and item–item similarities (Cosine, Pearson, Jaccard) on a small rating matrix and generate top-N recommendations.
2.	Implement prediction functions for user-based and item-based collaborative filtering. Compare results and analyze the long-tail impact.
3.	Build a simple matrix factorization model using SGD or ALS on a toy dataset. Evaluate RMSE/MAE and study the effect of regularization.
4.	Extract content features (TF-IDF, tags, categories) from a small movie/product dataset and build a basic content-based recommender.
5.	Combine CF and content-based features to develop a hybrid recommender. Compare performance with individual models.
6.	Compute accuracy (RMSE, MAE), ranking (precision@k, recall@k), and novelty/diversity metrics on sample recommendation outputs.

4. Books Recommended:	
1.	Aggarwal, C. C. (2016). Recommender Systems: The Textbook. Springer, Cham. ISBN: 978-3-319-29657-9 (Hardcover); 978-3-319-80619-8 (Softcover); 978-3-319-29659-3 (eBook).
2.	Ricci, F., Rokach, L., & Shapira, B. (Eds.). (2022). Recommender Systems Handbook (3rd ed.). Springer, New York. ISBN: 978-1-0716-2196-7 (Hardcover); 978-1-0716-2199-8 (Softcover); 978-1-0716-2197-4 (eBook).
3.	Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). Recommender Systems: An Introduction. Cambridge University Press. ISBN: 978-0-521-49336-9.
4.	Falk, K. (2019). Practical Recommender Systems. Manning Publications. ISBN: 978-1-61729-270-5.
5.	Kar, P., Roy, M., & Datta, S. (2024). Recommender Systems: Algorithms and Their Applications. Springer, Singapore. ISBN: 978-981-97-0537-5 (Hardcover); 978-981-97-0540-5 (Softcover); 978-981-97-0538-2.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI REINFORCEMENT LEARNING IA356	Scheme	L	T	P	Credit
		3	1	0	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Develop a clear understanding of the foundational concepts in RL, such as agents, environments, states, actions, rewards, and policies.
CO2	Learn to model decision-making problems as Markov Decision Processes (MDP).
CO3	Explore advanced algorithms like Deep Q-Networks,Policy Gradient methods, and Actor-Critic models.
CO4	Explore the integration of RL with deep learning to solve high-dimensional and complex problems.
CO5	Apply RL techniques to simulate and solve real-world problems in various domains, such as games, robotics, and finance.

2.	**Syllabus**	
	Introduction to Reinforcement Learning	**(06 Hours)**
	Introduction: Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of ML. Probability Basics: - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	
	Markov Decision Processes (MDP)	**(06 Hours)**
	Markov Decision Process Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Bellman equations for MRPs. Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
	Dynamic Programming (DP)	**(06 Hours)**
	Prediction and Control by Dynamic Programing dynamic programing definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, convergence of policy evaluation and value iteration algorithms, DP extensions.	
	Monte Carlo (MC) Methods	**(06 Hours)**
	Basics of Monte Carlo Methods, First-visit vs. Every-visit MC, model free RL, Monte Carlo control, On policy and off policy learning, Importance sampling, Monte Carlo for control: Exploring starts and ε-greedy methods.	

	Temporal Difference (TD) Learning	**(06 Hours)**
	Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	
	Function Approximation Methods	**(09 Hours)**
	Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares, Experience replay in deep Q-Networks. Deep-Reinforcement Learning Need and Applications, Types of Deep-RL : Deep Q-Network (DQN) , Policy Gradient [Advantage Actor-Critic (A2C/A3C), DDPG, PPO] , Alpha zero	
	Policy Gradients	**(06 Hours)**
	Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	
	(Total Contact Time: 45 Hours +15 Hours = 60 Hours)	

3. Tutorials:
1. RL Basics Goal: Understand the RL problem and simulate basic environments. Activity: Use OpenAI Gym to explore environments like CartPole and FrozenLake.
2. Solving MDPs Goal: Implement and solve MDPs using Dynamic Programming. Activity: Write Python scripts for Policy Iteration and Value Iteration.
3. Monte Carlo Methods Goal: Apply Monte Carlo methods for policy evaluation. Activity: Implement First-visit and Every-visit Monte Carlo methods in a custom environment.
4. TD Learning Goal: Explore TD methods for prediction and control. Activity: Implement SARSA and Q-learning on the FrozenLake environment.
5. Deep Reinforcement Learning (DQN) Goal: Introduce neural networks for approximating value functions. Activity: Implement DQN for solving the CartPole environment.
6. Policy Gradients Goal: Explore policy-based methods. Activity: Implement the REINFORCE algorithm in a simple RL environment
7. Actor-Critic Goal: Combine value-based and policy-based methods.

Activity: Implement an Actor-Critic algorithm for a continuous action-space problem
8. RL Applications Goal: Apply RL to solve a real-world problem. Activity: Train an RL agent for a custom-designed environment or game.
9. Multi-agent RL Goal: Introduce multi-agent interaction dynamics. Activity: Simulate a multi-agent RL problem using the PettingZoo library.
10. Capstone Project Goal: Develop a full-fledged RL application. Activity: Design and train an RL agent for a complex problem (e.g., a custom robotics task or game).

4. Books Recommended:
1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2n Edition MIT Press
2. Marco Wiering and Martijn van Otterlo, Eds Reinforcement Learning: State-of-the-Art, Springer Science & Business Media ,2012
3. Deep Reinforcement Learning Hands-On, 2nd Edition by Maxim Lapan,2018.
4. Deep Reinforcement Learning Hands-On, 2nd Edition by Maxim Lapan,2018.
5. Hands-On Reinforcement Learning with Python by Sudharsan Ravichandiran

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI ADVANCED BIOMETRIC SYSTEMS AND SECURITY IA358	Scheme	L	T	P	Credit
		3	1	0	04

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	To understand the principles and technologies behind various biometric systems
CO2	To explore the integration of multiple biometric modalities for enhanced security
CO3	To analyze potential attack mechanisms and vulnerabilities in biometric systems.
CO4	To learn about privacy-enhancing technologies and their application in biometric systems.
CO5	To evaluate the quality of biometric samples and understand its impact on system performance.

2.	**Syllabus**	
	Introduction to Biometric Systems	**(04Hours)**
	Overview of biometric systems, Applications of biometrics in security and identification, Biometric system architecture: Enrollment, verification, and identification	
	Fingerprint and Vein Recognition	**(05 Hours)**
	Fingerprint patterns and features, Fingerprint sensing technologies (optical, capacitive, ultrasonic), Feature extraction and matching algorithms, Challenges in fingerprint recognition (e.g., dry/wet fingers, scars), Principles of vein pattern recognition, Near-infrared imaging for vein recognition, Feature extraction and matching techniques, Advantages and limitations of vein recognition	
	Face Recognition (Including 3D Data)	**(08 Hours)**
	2D vs. 3D face recognition, Feature extraction techniques (e.g., Eigenfaces, Local Binary Patterns), Deep learning approaches for face recognition, Challenges in face recognition (e.g., lighting, pose variation)	
	Iris Recognition	**(08 Hours)**
	Anatomy of the iris and its uniqueness, Iris image acquisition and preprocessing, Iris recognition algorithms (e.g., Daugman's algorithm), Challenges in iris recognition (e.g., occlusions, reflections)	
	Speaker Recognition	**(04 Hours)**
	Fundamentals of Speaker Recognition, Speech Signal Processing Basics, Feature Extraction for Speaker Recognition, Modeling Techniques for Speaker Recognition	
	Multimodal Biometrics	**(07 Hours)**

	Concept of multimodal biometric systems, Fusion techniques (e.g., feature-level, score-level, decision-level fusion), Case studies of multimodal biometric systems, Advantages of multimodal systems over unimodal systems, Speech and Audio Processing	
	Attack Mechanisms Against Biometric Systems	**(05 Hours)**
	Types of attacks: Spoofing, replay, and Trojan horse attacks, Vulnerabilities in biometric sensors and databases, Countermeasures and anti-spoofing techniques, Deep fake detection and Attack, Morphing Attack and Detection, Case studies of real-world biometric system, LLM Vulnerability	
	Privacy-Enhancing Technologies	**(04 Hours)**
	Privacy concerns in biometric systems, Homomorphic encryption and its application in biometrics, Secure multi-party computation for biometric data, Differential privacy and its role in biometric systems	
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	Tutorials
1	Generic biometric system architecture: enrollment, verification, identification, templates, performance metrics (FAR, FRR)
2	Fingerprint anatomy, global patterns (arch, loop, whorl) and minutiae features.
3	Near-infrared imaging principle for finger/hand vein capture and preprocessing.
4	2D vs 3D face data, acquisition issues (pose, illumination, occlusion).
5	CNN-based pipelines for face detection, alignment, embedding extraction (e.g., FaceNet-style representation).
6	Iris anatomy, uniqueness, image acquisition (near-infrared cameras) and preprocessing (segmentation, normalization, enhancement).
7	Speech signal processing basics, common features (MFCCs, spectrograms) and simple modeling techniques (GMM/i-vector/x-vector overview).
8	Multimodal Biometric Systems and Fusion
9	Attacks, Deepfakes, and Liveness
10	Privacy-Enhancing Technologies for Biometrics

4.	**Books Recommended**
1	Biometric Systems: Technology, Design and Performance Evaluation" by James Wayman, Anil Jain, et al
2	"Handbook of Biometrics" by Anil K. Jain, Patrick Flynn, and Arun A. Ross
3	"Introduction to Biometrics" by Anil K. Jain, Arun Ross, and Karthik Nandakumar.
4	Introduction to Biometrics, Anil K. Jain , Arun A. Ross , Karthik Nandakumar , Thomas Swearingen, 2025

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Department of Artificial Intelligence

Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VI IMAGE PROCESSING AND COMPUTER VISION IA308	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	understand building approaches of digital image processing systems, image models and Mathematical tools for image processing.
CO2	apply spatial filtering, frequency domain filtering, image restoration and color image processing Techniques for over all image improvement.
CO3	analyse various image compression methods for effective storage management without Degrading the image quality.
CO4	evaluate various morphology, segmentation and object recognition methods to gain high level of understanding of content of an image.
CO5	create an image processing application in the development of computer vision, machine learning, deeplearning domains.

2.	Syllabus	
	INTRODUCTION	**(04 Hours)**
	Image Model, Image Sensing and Acquisition, Sampling and Quantization, Mathematical Tool for Digital Image Processing, Types of Digital Images, Image File Formats, Colour Fundamentals and Models.	
	INTENSITY TRANSFORMATION AND SPATIAL FILTERING	**(07 Hours)**
	Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing and Sharpening Spatial Filters.	
	FILTERING IN FREQUENCY DOMAIN	**(06 Hours)**
	Sampling and Fourier Transform, Discrete Fourier Transform (DFT), 2-D DFT, Filtering in the Frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Selective Filtering	
	IMAGE RESTORATION AND COLOR IMAGE PROCESSING	**(08 Hours)**
	Image Degradation/ Restoration Process, Noise Models, Spatial Filtering and Frequency Domain Filtering for Noise Reduction, Linear Position-Invariant Degradations, Estimating the Degradation Function, Filtering, Image Reconstruction from Projection. Color Models, Color Transformation, Smoothing and Sharpening, Color Based Image Segmentation.	
	IMAGE COMPRESSION	**(06 Hours)**
	Image Compression Fundamentals, Classification of Image Compression Algorithms, Types of Redundancy, Lossless Compression Algorithms, Lossy Compression Algorithms, Image and Video Compression Standards and its Variations.	

	MORPHOLOGY AND SEGMENTATION	**(07 Hours)**
	Erosion and Dilation, Opening and Closing, Morphological Algorithms, Grey Scale Morphology, Point, Line and Edge Detection, Thresholding, Region based Segmentation, Segmentation using Morphological Watersheds, Use of Motion in Segmentation	
	ADVANCED TOPICS	**(07 Hours)**
	Image Representation and Description, Object Recognition and Recent Developments.	
	Practicals will be based on the coverage of the above topics separately.	**(45 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Perform image acquisition, sampling, and quantization on a digital image. Convert the image into RGB, Grayscale, and HSV color models and display the results.
2. Perform Histogram Processing on a digital image by computing and displaying its histogram, applying histogram equalization, and analyzing the effects on image contrast.
3. Implement frequency domain filtering by applying a Low-Pass (Smoothing) and High-Pass (Sharpening) Filter using the Fourier Transform. Analyze the effects on the image.
4. Implement and analyze a Lossless Compression Algorithm (e.g., Huffman Coding or Run-Length Encoding) on a grayscale image. Compare the original and compressed file sizes.
5. Apply a Lossy Compression Algorithm (e.g., JPEG Compression using Discrete Cosine Transform - DCT) on an image. Observe the effects of different compression levels on image quality and file size.
6. Perform Morphological Operations (Erosion, Dilation, Opening, and Closing) on a binary image. Analyze their effects on object shapes and noise removal.
7. Implement Edge Detection and Image Segmentation using Thresholding and Watershed Algorithm. Compare the results of different edge detection techniques (Sobel, Canny, Prewitt)
8. Perform Boundary and Region-Based Shape Representation for an object in a binary image. Extract shape descriptors such as area, perimeter, and centroid.
9. Implement Feature-Based Object Recognition using corner detection (Harris Corner Detector or FAST) and analyze how well the algorithm detects object features.
10. Perform image acquisition and preprocessing, apply histogram equalization for enhancement, use spatial and frequency domain filtering, implement edge detection and segmentation using morphological operations, and finally, apply feature extraction for object recognition in a given image. Analyze the effects of each step.

4. Books Recommended:
1. Rafael C. Gonzales and Richard E. Woods, "DigitalImageProcessing",4/E, Pearson Education,2018.
2. Anil K. Jain, "FundamentalsofDigitalImageProcessing",1/E, PearsonIndia,2015.
3. S. Jayaraman, T. Veerakumar and S. Esakkirajan, "DigitalImageProcessing",1/E, TMG,2017
4. S. Sridhar, "Digital Image Processing", 2/E, Oxford University Press,2016.
5. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing",1/E, Pearson Education, 2006.

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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VII RESEARCH METHODOLOGY IA403	Scheme	L	T	P	Credit
		1	1	0	02

1. Course Outcomes (COs): **At the end of the course, students will be able to**	
CO1	to understand the different research methodologies in different areas.
CO2	be able to apply the concepts in writing, presentation, and simulating different experiments.
CO3	be able to analyze the proposed work with existing approaches in the literature and interpret the research design through project development and case study analysis using appropriate tools
CO4	be able to execute the technical presentation, and organization in writing the report and papers.
CO5	be able to design the algorithms and proof learned and communicate effectively through proper organization and presentation.

2.	**Syllabus**	
	INTRODUCTION	**(02 Hours)**
	Research: Definition, Characteristics, Motivation and Objectives, Research Methods vs Methodology, Types of Research – Descriptive vs Analytical, Applied vs Fundamental, Quantitative vs Qualitative, Conceptual vs Empirical.	
	METHODOLOGY	**(02 Hours)**
	Research Process, Formulating the Research Problem, Defining the Research Problem, Research Questions, Research Methods vs. Research Methodology.	
	LITERATURE REVIEW	**(02 Hours)**
	Review Concepts and Theories, Identifying and Analyzing the Limitations of Different Approaches.	
	FORMULATION AND DESIGN	**(02 Hours)**
	Concept and Importance in Research, features of a Good Research Design, Exploratory Research Design, Concept, Types and Uses, Descriptive Research Designs, Concept, Types and Uses, Experimental Design: Concept of Independent & Dependent Variables	
	DATA MODELING AND SIMULATIONS	**(02 Hours)**
	Mathematical Modeling, Experimental Skills, Simulation Skills, Data Analysis and Interpretation.	
	TECHNICAL WRITING AND TECHNICAL PRESENTATIONS	**(02 Hours)**

	CREATIVITY AND ETHICS IN RESEARCH, INTELLECTUAL PROPERTY RIGHTS	**(01 Hours)**
	TOOLS AND TECHNIQUES FOR RESEARCH	**(02 Hours)**
	Methods to Search Required Information Effectively, Reference Management Software, Software for Paper Formatting, Software for Detection of Plagiarism.	
	(Total Contact Time: 15 Hours+ 15 Hours = 30 Hours)	

3. Tutorials:
1. Introduction to Research Methodology
2. Research Design and Its Types
3. Sampling Techniques
4. Data Collection Methods
5. Literature Review and Referencing
6. Qualitative Research Methods
7. Quantitative Research Methods
8. Data Analysis and Interpretation
9. Writing a Research Proposal
10. Reporting and Publishing Research

4. Books Recommended:
1. John W. Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", SAGE Publications Ltd.
2. C.R. Kothari,"Research Methodology: Methods and Techniques", New Age International Publishers.
3. David Silverman,"Qualitative Research", SAGE Publications Ltd.
4. Norman K. Denzin and Yvonna Sessions Lincoln," Handbook of Qualitative Research", SAGE Publications Ltd.
5. Michael Quinn Patton," Qualitative Research and Evaluation Methods", SAGE Publications Ltd.

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Integrated B.Tech. (AI) and M. Tech. (AI)

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VII ROBOTICS AND APPLICATIONS IA405	Scheme	L	T	P	Credit
		3	0	2	04

1. Course Outcomes (COs): At the end of the course, students will be able to	
CO1	Apply fundamental principles of mathematics, science, and engineering to analyze and model robotic systems.
CO2	Design and implement robot control algorithms for various robotic tasks.
CO3	Utilize computer vision and machine learning techniques for robot perception and navigation.
CO4	Evaluate and select appropriate robotic systems for specific applications.
CO5	Develop and execute robot programs in simulation and/or on physical robotic platforms.
CO6	Analyze the ethical and societal impact of robotics and AI.

2.	Syllabus	
	Introduction	**(05 Hours)**
	What is a robot? History and evolution of robotics, Types of robots: Industrial, service, mobile, etc. Basic components of a robot: Manipulators, actuators, sensors, control systems, Applications of robotics in various fields: Manufacturing, healthcare, exploration, etc., Introduction to Robot Operating System (ROS).	
	Robot Kinematics	**(08 Hours)**
	Coordinate frames and transformations, Forward kinematics: Denavit-Hartenberg (DH) parameters, Inverse kinematics: Analytical and numerical solutions, Jacobian matrix and singularities, Mobile robot kinematics: Differential drive, Ackermann steering.	
	Robot Dynamics	**(07 Hours)**
	Lagrangian mechanics, Equations of motion for robots, Inertia matrices and dynamic models, Force and torque analysis, Robot simulation.	
	Robot Control	**(08 Hours)**
	Control system fundamentals: Feedback control, PID control, Robot arm control: Joint space control, operational space control, Mobile robot control: Path following, trajectory tracking, Adaptive control and learning control (brief introduction)	
	Robot Perception	**(07 Hours)**
	Introduction to computer vision: Image processing, feature extraction, 3D vision: Depth sensing, stereo vision, Object recognition and tracking, Sensor fusion	
	Robot Planning	**(05 Hours)**

	Path planning: Search algorithms (A*, Dijkstra's), sampling-based methods (RRT), Motion planning: Trajectory generation, obstacle avoidance, Task planning: Hierarchical planning, task decomposition	
	AI in Robotics	**(05 Hours)**
	Introduction to machine learning for robotics, Reinforcement learning for robot control and navigation, Natural language processing for human-robot interaction, Ethical and societal implications of AI in robotics	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Introduction to ROS and Robot Simulation
2. Robot Kinematics and Control
3. Computer Vision for Robotics
4. Robot Navigation and Planning
5. Robot Programming and Applications
6. Integrating different modules (perception, planning, control)
Frameworks: ROS (Robot Operating System), Gazebo (Robot Simulator), OpenCV (Computer Vision Library), PyTorch

4. Books Recommended:
1. Introduction to Robotics: Mechanics, Control, and Design by John J. Craig
2. Robotics: Modelling, Planning and Control by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo
3. Robot Dynamics and Control by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar
4. Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard, and Dieter Fox
5. ROS for Robotics Programming by Lentin Joseph

Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VIII INTELLIGENT MULTIAGENT AND EXPERT SYSTEMS IA402	Scheme	L	T	P	Credit
		3	0	2	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	understand the fundamentals of multi-agent systems: Grasp the core concepts, architectures, and challenges of multi-agent systems.
CO2	design and implement multi-agent systems: Apply techniques for designing, implementing, and analyzing multi-agent systems.
CO3	apply knowledge representation and reasoning techniques: Utilize knowledge representation languages and reasoning algorithms for building intelligent agents.
CO4	develop expert systems: Design and implement expert systems using various knowledge representation and reasoning techniques.
CO5	evaluate and analyze intelligent systems: Critically evaluate the performance and limitations of intelligent systems, including multi-agent and expert systems.

2.	**Syllabus**	
	Introduction to Artificial Intelligence and Multi-Agent Systems	**(06 Hours)**
	Introduction to Artificial Intelligence: What is AI, History and Milestones, Multi-Agent Systems: Definition and characteristics, Types of agents: reactive, deliberative, hybrid, Agent architectures: BDI, SOAR, Challenges and limitations	
	Knowledge Representation and Reasoning	**(08 Hours)**
	Knowledge Representation Languages: Propositional and first-order logic, Semantic networks and ontologies, Frame-based representations, Reasoning Techniques: Inference rules - Modus Ponens, Modus Tollens, Forward and backward chaining, Uncertainty reasoning: Bayesian networks, fuzzy logic, Constraint satisfaction problems	
	Multi-Agent Coordination and Negotiation	**(07 Hours)**
	Coordination Mechanisms: Centralized and decentralized coordination, Task allocation and scheduling, Negotiation and bargaining strategies, Communication Protocols, Message passing and shared memory, Cooperation and Competition	
	Learning in Multi-Agent Systems	**(06 Hours)**
	Reinforcement Learning: Single-agent reinforcement learning, Multi-agent reinforcement learning, Machine Learning Techniques: Supervised learning, Unsupervised learning, Semi-supervised learning, Learning from Human Behavior: Imitation learning, Apprenticeship learning	

	Expert Systems	**(10 Hours)**
	Expert System Architecture: Knowledge base, Inference engine, User interface, Explanation facility, Knowledge Acquisition Techniques: Knowledge elicitation, Machine learning for knowledge acquisition, Expert System Applications: Medical diagnosis, Financial analysis	
	Ethical and Social Implications of Multi-Agent and Expert Systems	**(08 Hours)**
	Ethical Considerations: Bias and fairness, Privacy and security, Accountability and transparency, Social Impact: Increase in Productivity, Impact on Jobs, Impact on Policy Design	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75Hours)	

3. Practicals:
1. Introduction to Python for AI: Basic Python Programming Constructs, Numpy, Scipy, Pandas, Matplotlib, Seaborn for Data Processing and Visualization
2. Implementing simple rule-based expert system
3. Implementing forward and backward chaining algorithms
4. Building a Semantic Network with Knowledge Representation and Inference Rules
5. Designing a Simple Multi-Agent System using a simulation environment (like MASON, NetLogo)
6. Implementing Negotiation Strategies using a negotiation protocol (e.g., FIPA-ACL) to simulate agent negotiation
7. Building a Medical Diagnosis Expert System using a knowledge-based system to diagnose diseases based on symptoms and uncertainty reasoning techniques
8. Developing a Financial Advisor Expert System
9. Reinforcement Learning for Multi-Agent Systems to learn optimal policies through interaction with the environment
10. Machine Learning for Agent Behavior to learn agent behaviors from data
11. Ethical AI Design and Development, Analyzing real-world AI systems for potential biases and harms

4. Books Recommended:

1. Russell, S., & Norvig, P. (2016). Artificial Intelligence: A Modern Approach. Pearson.
2. Wooldridge, M. J. (2009). An Introduction to MultiAgent Systems. John Wiley & Sons.
3. Giarratano, J., & Riley, G. (2021). Expert Systems: Principles and Programming. Cengage Learning.
4. Gerhard Welss (1999). Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence
5. Victor Dibia (2024). Multi-Agent Systems with AutoGen

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Integrated B. Tech. (AI) and M. Tech. (AI) Semester – VIII HUMAN COMPUTER INTERACTION IA404	Scheme	L	T	P	Credit
		3	1	0	04

1. **Course Outcomes (COs):** **At the end of the course, students will be able to**	
CO1	Understand the history of HCI, human abilities, interaction styles, and computing paradigms.
CO2	Apply usability concepts and prototyping techniques to design user-friendly GUIs.
CO3	Implement HCI guidelines like Shneiderman's rules, Norman's principles, and Nielsen's heuristics for system evaluation.
CO4	Design dialog systems using FSMs, Petri nets, and model-based techniques like GOMS and Fitts' law.
CO5	Conduct HCI experiments, task modeling (HTA, CTT), and data analysis to improve system usability.

2.	**Syllabus**	
	HCI foundation	**(03 Hours)**
	history, human abilities, state of the art in computing technology, interaction styles and paradigms	
	Interactive system design	**(05 Hours)**
	Concept of usability definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques	
	Guidelines in HC	**(08 Hours)**
	Shneiderman's eight golden rules, Norman's seven principles, Norman's model of interaction, Nielsen's ten heuristics with example of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough	
	Dialog Design	**(05 Hours)**
	Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and (classical) Petri Nets in dialog design	
	Model-based Design and evaluation	**(08 Hours)**
	Basic idea, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS), Fitts' law and Hick Hyman's law, Model-based design case studies	
	Cognitive architecture, and Design -Case Studies	**(08 Hours)**
	Introduction to CA, CA types, relevance of CA in IS design, Model Human Processor (MHP), Case Study 1- Multi Key press Hindi Text Input Method on a Mobile Phone, Case Study 2 - GUI	

	design for a mobile phone based Matrimonial application, Case Study 3 Employment Information System for unorganised construction workers on a Mobile Phone.	
	Empirical research methods in HCI and task modeling and analysis	**(08 Hours)**
	Introduction (motivation, issues, research question formulation techniques, Experiment design and data analysis (with explanation of one-way ANOVA), Hierarchical task analysis (HTA), Engineering task models and Concur Task Tree (CTT)	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3. Tutorials:
1. Tutorial on Evaluating the Usability of a GUI Prototype Using Heuristic Evaluation
2. Tutorial Based on Heuristic Evaluation of a Mobile Application
3. Tutorial on Finite State Machines (FSM) and State Charts
4. Tutorial on Fitts' Law and Keystroke-Level Model (KLM)
5. Tutorial on the Analysis of Model Human Processor (MHP)
6. Tutorial on Cognitive Analysis for a Mobile-Based Matrimonial Application
7. Tutorial on One-Way ANOVA
8. Tutorial on Hierarchical Task Analysis (HTA) and Modeling with Concur Task Tree (CTT)

4. Books Recommended:

1. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.
3. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint).
4. J. M. Caroll (ed.), HCI Models, Theories and Frameworks: Towards a Multidisciplinary Science (Interactive Technologies), Morgan Kauffman, 2003.