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

For 2026-27 Batch onwards

Sr. No.	Subject	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
	First Semester (1st year of UG)				
1	Introduction to Computer Science	AI101	3-1-0	4	70
2	Introduction to Programming	AI103	3-0-2	4	85
3	English and Professional Communication	HS110	3-1-0	4	70
4	Basic Electrical and Electronics Engineering	AI105	3-0-2	4	85
5	Fundamentals of Engineering Mathematics	MA105	3-1-0	4	70
			Total	**20**	**380**
6	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	AIV01 / AIP01	0-0-10	5	200 (20 x 10)
	Second Semester (1st year of UG)				
1	Data Structures	AI102	3-1-2	5	100
2	Object Oriented Programming	AI106	3-0-2	4	85
3	Energy and Environmental Engineering	EG110	3-0-2	4	85
4	Linear Algebra and Statistics	MA106	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	**23**	**460**
7	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	AIV02 / AIP02	0-0-10	5	200 (20 x 10)
	Third Semester (2nd year of UG)				
1	Computer Organization	AI201	3-1-0	4	70
2	Database Management Systems	AI203	3-0-2	4	85
3	Design and Analysis of Algorithms	AI205	3-0-2	4	70
4	Discrete Mathematics	MA209	3-1-0	4	70
5	Signals and Systems	EC203	3-1-0	4	85
			Total	**20**	**380**
	Fourth Semester (2nd year of UG)				
1	Artificial Intelligence	AI202	3-0-2	4	85
2	Operating Systems	AI204	3-0-2	4	85
3	Automata and Formal Languages	AI206	3-1-0	4	70
4	Computer Networks	AI208	3-0-2	4	85
5	Microprocessor and Interfacing Techniques	AI232	3-0-2	4	85
			Total	**20**	**410**
6	Minor / Honor (M/H#1)	AI2AA	3-X-X	3/4	55/70/85
7	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	AIV04 / AIP04	0-0-10	5	200 (20 x 10)

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	Fifth Semester (3rd year of UG)				
1	Machine Learning	AI301	3-0-2	4	85
2	Data Science	AI303	3-0-2	4	85
3	Information Security and Cryptography (Optional Core)	AI331	3-0-2	4	85
4	Elective	AI3AA	3-X-X	3/4	55/70/85
5	Elective (Specialization#1)	AI3BB	3-X-X	3/4	55/70/85
			Total	**18-20**	**365-425**
6	MOOC		4-0-0	4	
7	Minor / Honor (M/H#2)	AI3CC	3-X-X	4	70/85
	Sixth Semester (3rd year of UG)				
1	Deep Learning	AI302	3-0-2	4	85
2	Cloud Computing	AI304	3-0-2	4	85
3	Reinforcement Learning	AI332	3-0-2	4	85
4	Elective	AI3DD	3-X-X	3/4	55/70/85
5	Elective (Specialization#2)	AI3EE	3-X-X	3/4	55/70/85
			Total	**18-20**	**365-425**
6	MOOC*		4-0-0	4	
7	Minor / Honor (M/H#3)	AI3FF	3-X-X	4	70/85
8	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	AIV06 / AIP06	0-0-10	5	200 (20 x 10)
	Seventh Semester (4th year of UG)				
1	Intelligent Multiagent and Expert Systems	AI401	3-0-2	4	85
2	Elective	AI4AA	3-X-X	3/4	55/70/85
3	Elective	AI4BB	3-X-X	3/4	55/70/85
4	Elective (Specialization#3)	AI4CC	3-X-X	3/4	55/70/85
5	Elective (Specialization#4)	AI4DD	3-X-X	3/4	55/70/85
			Total	**16-20**	**305-425**
6	Minor / Honor (M/H#4)	AI4EE	3-X-X	4	70/85
	Eighth Semester (4th year of UG)				
1	Industrial Internship/Professional Experience (Mandatory)	AIP08	0-0-40	20	800 (20 x 40)
			Total	**20**	**800**

*Applicable only to Students who are not enrolled in the fifth semester.

Sr. No.	**Optional Core**	**Code**	**Scheme L-T-P**
1	Object Oriented Programming	AI231	3-0-2
2	Micro processor and Interfacing Techniques	AI232	3-0-2
3	Information Security and Cryptography	AI331	3-0-2
4	Reinforcement Learning	AI332	3-0-2

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Sr. No.	Elective	Code	Scheme L-T-P
1.	Probabilistic Graphical Model	AIXXX	3-1-0
2.	IoT and Edge Computing	AIXXX	3-0-2
3.	Computer Graphics	AIXXX	3-0-2
4.	System Software	AIXXX	3-0-2
5.	Information Retrieval	AIXXX	3-0-2
6.	Cyber Physical Systems	AIXXX	3-0-2
7.	Optimization Techniques	AIXXX	3-1-0
8.	Big data analytics and Large-Scale Computing	AIXXX	3-0-2
9.	Computational Intelligence	AIXXX	3-0-2
10.	Human Computer Interaction	AIXXX	3-0-2
11.	Multimedia System & Applications	AIXXX	3-0-2
12.	Unmanned Aerial Vehicles Information System	AIXXX	3-0-2
13.	Natural Language Processing	AIXXX	3-0-2
14.	Image Processing and Computer vision	AIXXX	3-0-2
15.	High Performance Computing	AIXXX	3-0-2
16.	Social Network Analysis	AIXXX	3-0-2
17.	Digital Forensics	AIXXX	3-0-2
18.	Unmanned Aerial Vehicles Forensics	AIXXX	3-0-2
19.	Speech and Audio Processing	AIXXX	3-0-2
20.	Data Visualization	AIXXX	3-0-2
21.	Machine Learning for Security	AIXXX	3-0-2
22.	Service Oriented Architectures	AIXXX	3-0-2
23.	Game Theory	AIXXX	3-1-0
24.	AI for Bio-Medical Image Processing	AIXXX	3-0-2
25.	Surveillance Video Analysis	AIXXX	3-0-2
26.	Adversarial Machine Learning	AIXXX	3-0-2
27.	Secure Cloud Computing	AIXXX	3-0-2
28.	IoT & Sensor Data Analytics	AIXXX	3-0-2
29.	Robotics and its Applications	AIXXX	3-0-2
30.	Advanced Database Management System	AIXXX	3-0-2
31.	Innovation, Incubation and Entrepreneurship	AIXXX	3-0-2
32.	Research Methodology	AIXXX	3-1-0
33.	Bioinformatics	AIXXX	3-0-2
34.	Data Mining	AIXXX	3-0-2
35.	Drone and Automation Systems	AIXXX	3-0-2
36.	Animation and Rendering	AIXXX	3-0-2
37.	System Analysis and Simulation	AIXXX	3-0-2
38.	Applied Machine Learning	AIXXX	3-0-2
39.	Introduction to Quantum Computing	AIXXX	3-1-0

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40.	Responsible AI	AIXXX	3-1-0
41.	Big Data Analysis and Visualization	AIXXX	3-0-2
42.	Reinforcement Learning	AIXXX	3-0-0
43.	Introduction to Large Language Model	AIXXX	3-0-0
44.	Drone and Automation Systems	AIXXX	3-0-0
45.	Internet of Things and Edge Computing	AIXXX	3-0-0
46.	Block Chain and Its Applications	AIXXX	3-0-0
47.	Agentic AI	AIXXX	3-0-0
48.	Affective Computing	AIXXX	3-0-2
49.	AI for Sustainability	AIXXX	3-1-0
50.	Advanced Biometrics System & Security	AIXXX	3-0-2
51.	Recommender Systems	AIXXX	3-0-2

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B.Tech. I (AI) Semester – I INTRODUCTION TO COMPUTER SCIENCE (CORE-1) AI101	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 about computers and computational problem solving.
CO2	Design the solutions of computational problems using iterative and recursive methods using flowcharts and pseudo-codes.
CO3	Solve computational problems in different number systems.
CO4	Analyse the importance of different types of memory and evaluate the impact of different algorithms on memory.
CO5	Experiment with different operating systems such as Windows and Linux and write scripts to automate repetitive tasks.

2.	Syllabus	
	INTRODUCTION TO COMPUTER AND ITS ARCHITECTURE	**(04 Hours)**
	Introduction and Characteristics, Computer Architecture, Generations, Classifications, Applications, Central Processing Unit and Memory, Communication between various Units, Processor Speed, Multiprocessor System, Peripheral Buses, Motherboard Demonstration.	
	NUMBER SYSTEMS	**(06 Hours)**
	Introduction and type of Number System, Conversion between Number System, Arithmetic Operations in different Number System, Signed and Unsigned Number System.	
	COMPUTATIONAL PROBLEM SOLVING	**(08 Hours)**
	Program Development Cycle, Pseudocode, Flowchart, Representing Information as Bits, Binary System, Storing Integers, Storing Fractions, Examples of Computational Problems, Iterative and Recursive Approaches to Solve Computational Problems, Easy and Hard Computational Problems	
	MEMORY AND VARIOUS INPUT AND OUTPUT DEVICES	**(04 Hours)**
	Introduction to Memory, Input and Output Devices, Memory Hierarchy, Primary Memory and its Types, Secondary Memory, Classification of Secondary Memory, Various Secondary Storage Devices and their Functioning.	
	INTRODUCTION TO SYSTEM SOFTWARES AND PROGRAMMING LANGUAGES	**(03 Hours)**

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	Classification of Computer Languages, Introduction of Operating System, Evolution, Type and Function of OS, Unix Commands, Evolution and Classification of programming Language, Feature and Selection of good Programming Language, Development of Program, Algorithm and Flowchart, Program Testing and Debugging, Program Documentation and Paradigms, Characteristics of good Program.	
	WINDOWS OPERATING SYSTEM AND ITS ENVIRONMENT	**(03 Hours)**
	Introduction to GUI based OS, Configuration, Setup, Services, Network Configuration.	
	LINUX OPERATING SYSTEM AND ITS ENVIRONMENT	**(06 Hours)**
	Introduction to Linux OS, Configuration, Setup, Commands – Navigating File System, File Permissions (R/W/X), Access control and super user (sudo) privileges, Scripting basics, Bash Shell and Scripting, Network Configuration.	
	DEBUGGING TOOLS AND COMPILER OPTION	**(03 Hours)**
	Different Debugging tools, Commands, Memory dump, Register and Variable Tracking, Instruction and Function level debugging, Compiler Options, Profile Generation.	
	DATA COMMUNICATION, COMPUTER NETWORK AND INTERNET BASICS	**(04 Hours)**
	Data Communication and Transmission media, Multiplexing and Switching, Computer Network and Network Topology, Communication Protocols and Network Devices, Evolution and Basic Internet Term, Getting Connected to Internet and Internet Application, Email and its working, Searching the Web, Languages of Internet, Internet and Viruses.	
	SYSTEM AND NETWORK SECURITY BASICS	**(04 Hours)**
	Security Services, Security Attacks, and Security Mechanisms, Authentication, Password Strengths and Entropy, Access Control Mechanisms, Read/Write/Execute Permissions and Super User/Administrator Privileges, Introduction of HTTPS and Digital Certificates	
	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	Number System
2	Problem Solving using Algorithms
3	Problem Solving using Flowcharts
4	Linux Commands
5	Bash Shell Scripting

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.	Robert Sedgewick and Kevin Wayne, "Computer Science", Addison-Wesley.

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B.Tech. I (AI) Semester – I INTRODUCTION TO PROGRAMMING (CORE-2) AI103	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 fundamentals of C programming language.
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	
	OVERVIEW OF C PROGRAMMING LANGUAGE	**(02 Hours)**
	History of C, Importance of C, 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	**(03 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 AND EXPRESSIONS	**(03 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.	
	LIBRARY FUNCTIONS: INPUT, OUTPUT, MATHEMATICS, DATE AND TIME	**(03 Hours)**
	Reading Character from Keyboard, Printing Character on Screen, Reading String from Keyboard, Printing String on Screen, Formatting input and Output, difftime, clock, time, Math Functions: abs, fmod, reminder, log, log2, pow, sqrt, ceil, floor.	

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	DECISION MAKING AND BRANCHING	**(04 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.	
	DECISION MAKING AND LOOPING	**(05 Hours)**
	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, Dynamic Memory Allocation, Memory Management Functions: Malloc, Calloc, and Free, Using Pointers to Access Dynamically Allocated Memory Locations, Pointers with Arrays, Use of Pointers to Return Multiple Values From Functions, Sample Program: Linked List.	
	FILE MANAGEMENT	**(04 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().	
	PREPROCESSOR DIRECTIVES	**(02 Hours)**
	Macro Substitution, Importing a File, Compiler Control Directives.	

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	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	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.	E. Balagurusamy, “Programming in ANSI C”, Mc-Graw Hill.
2.	Brian W. Kernighan / Dennis Ritchie,“The C Programming Language”, Pearson.
3.	YashavantKanetkar, “Let us C”, BPB Publications.
4.	Harbison and Steele, “C: A Reference Manual”

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Department of Artificial Intelligence
B.Tech. Artificial Intelligence

B.Tech. I (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.	

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	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

ADDITIONAL REFERENCE BOOKS	
1	Laura J. Gurak and John M. Lannon. "Strategies for Technical Communication in the Workplace," Pearson, 2013.

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B.Tech. I (AI) Semester – I BASIC OF ELECTRICAL AND ELECTRONICS ENGINEERING AI105	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)**

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)

	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).	
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
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. Connect, set up, and operate a Cathode Ray Oscilloscope (CRO) for observing sinusoidal waveforms, and to measure key waveform parameters such as amplitude, frequency, and time period by adjusting control settings and analyzing the displayed signal.

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

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)

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

B.Tech. I (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)**

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	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

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

B.Tech. I (AI) Semester – II DATA STRUCTURES (CORE-3) AI102	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)**

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	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)**
	Practical 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)

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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
B.Tech. Artificial Intelligence

B.Tech. I (AI) Semester – II OBJECT ORIENTED PROGRAMMING AI106	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	

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	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	**(08Hours)**
	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.	
	(Total Contact Time: 45 Hours +30 Hours = 75 Hours)	

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
B.Tech. Artificial Intelligence

B.Tech. I (AI) Semester – II ENERGY AND ENVIRONMENTAL ENGINEERING EG110	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 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 eco system - producers, consumers, decomposers; Food chains, food webs, ecological pyramids, energy flow in eco system; 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, lifecycle 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.	**Practicals**
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
B.Tech. Artificial Intelligence

B.Tech. I (AI) Semester – II LINEAR ALGEBRA AND STATISTICS MA106	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).	

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	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.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
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B.Tech. I (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)**

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)

	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.	
	Practical will be based on the coverage of the above topics separately.	**(30Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practical**
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

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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 MothibiSuryaprakash, 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
B.Tech. Artificial Intelligence

B.Tech.1 /M.Sc. 1 Semester I/ 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, PrabhatPrakashan, 2021.
7	Sri Suresh Soni, Sources of our cultural heritage, PrabhatPrakashan, 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
B.Tech. Artificial Intelligence

B. Tech. II (AI) Semester – III COMPUTER ORGANIZATION AI201	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.	

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	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, Zvonko Vranesic, Safwat Zaky, "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
B.Tech. Artificial Intelligence

B. Tech. II (AI) Semester – III DATABASE MANAGEMENT SYSTEMS AI203	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.	

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	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

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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
B.Tech. Artificial Intelligence

B. Tech. II (AI) Semester – III DESIGN AND ANALYSIS OF ALGORITHMS AI205	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.	

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	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.	
	Practical 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
B.Tech. Artificial Intelligence

B. Tech. II (AI) Semester – III DISCRETE MATHEMATICS MA209	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.	

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	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.

1. 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.

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.

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)

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

B. Tech. II (AI) Semester – III 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 Z transform. 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)**

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)

	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 = 60 Hours)

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

4. <u>Books Recommended:</u>

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
Department of Artificial Intelligence
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B. Tech. II (AI) Semester – IV ARTIFICIAL INTELLIGENCE AI202	Scheme	L	T	P	Credit
		3	0	2	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)**

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	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, 0-201-40375-7.

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

B. Tech. II (AI) Semester – IV OPERATING SYSTEMS AI204	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.	

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	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.

5. 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.

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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.

ADDITIONAL REFERENCE BOOKS

1. Crawley, "Operating Systems - A Design Oriented Approach", 1/E, McGraw Hill, 1998.

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

B. Tech. II (AI) Semester – IV AUTOMATA AND FORMAL LANGUAGES AI206	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)**

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)

	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.	**Tutorials:**
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. Books Recommended:

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.

ADDITIONAL REFERENCE BOOKS

1. Sushil Kumar Azad, “Theory of Computation, An introduction to /automata, Formal Languages And Computability”, Dhanpat Ray & Co., New Delhi, 2005.
2. A.M. Natarajan, A.Tamilarasi, “Theory of computation”, New Age Publication, 1/E, 2003.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
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B. Tech. II (AI) Semester – IV COMPUTER NETWORKS AI208	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)**

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	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.	**Practicals:**
1	Study network configuration commands and computer network setup.
2	Implementation of different Data Link and MAC Layer protocols.
3	Implementation of 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.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Artificial Intelligence
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B. Tech. II (AI) Semester – IV MICROPROCESSOR AND INTERFACING TECHNIQUES AI232	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 different architectures, addressing modes and instructions of 8085/86.
CO2	Interface memory, I/O devices and interrupt controller with 8085/86 microprocessors
CO3	Analyse and compare the features of microprocessors and microcontrollers.
CO4	Describe the internal architecture and different modes of operations of a typical peripheral device.
CO5	Design and develop assembly language programs using 8085/86 instructions, software interrupts, subroutines, macros.

2.	Syllabus	
	INTRODUCTION TO MICROPROCESSOR EVOLUTION	**(03 Hours)**
	Introduction to Microprocessor and Development and its Operation.	
	ARCHITECTURE FEATURES OF 8085	**(04 Hours)**
	8085 Architecture and Pin out diagram, 8085 Operations.	
	INTRODUCTION SET AND PROGRAMMING OF 8085	**(06 Hours)**
	Data Transfer instructions, Arithmetic instructions and its examples, Logical Instructions and its examples, Branch, Stack, and I/O related instructions, How to write, assemble and execute assembly language programmes, Assembly language programming Practice Based on above instructions for 8085, Design Counters in 8085, Design Time delays in 8085, Stack & Subroutines: Restart, Conditional and Unconditional Call and Return Instructions, Advanced Subroutine Concepts, Code Conversion, 16-bit Data Operation.	
	PERIPHERAL & MEMORY INTERFACING WITH 8085	**(08 Hours)**
	Basic I/O Interfacing Concepts: Interfacing Display devices, Interfacing Input devices, Memory Interfacing: Absolute decoding, Parti al Decoding, Shadow Memory, Interfacing Peripherals: 8255A Programmable Peripheral Interface, Examples of Interfacing Keyboard and seven-segment Display, Examples of Bidirectional Data transfer Between Two Microcomputer, The 8254 (8253) Programmable Interval Timer, The 8259A Programmable Interrupt Controller, Direct Memory Access and 8237 DMA Controller, The 8279 Programmable Keyboard/Display Interface, Interfacing Scanned Multi plexed Displays and Liquid Crystal Displays, Interfacing a Matrix Keyboard, Serial I/O and Data Communication: Basic concepts in Serial I/O, Software Controlled Asynchronous Serial I/O, The 8085-Serial I/O lines: SOD and SID, Hardware Controlled Serial I/O Using Programmable Chips.	

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	8085 INTERRUPT MANAGEMENT	**(04 Hours)**
	Interrupts and its Types in 8085, Interrupt Vector Table, Priority of Interrupts, Programming using Interrupts.	
	8086 ARCHITECTURE	**(04 Hours)**
	8086 Architecture, Pin Out Diagram and its Features, Registers of 8086.	
	INSTRUCTION SET OF 8086	**(06 Hour)**
	Data Transfer Instructions and Examples based on it, Arithmetic Instructions and Examples based on it, Logical Instructions, Comparison Instructions, Jump Instructions, Examples based on Logical, Comparison, Jump Instructions, Various 8086 Assembler Directives, Examples based on Various Assembler Directives, What are Procedures in 8086?, Procedure-based Examples in 8086, What are Macros in 8086? Macros-based Examples in 8086.	
	PERIPHERAL & MEMORY INTERFACING WITH 8086	**(04 Hour)**
	Interfacing Peripherals:- 8255A: Examples of Interfacing Keyboard and Seven-segment Display, Interfacing with Alphanumeric Displays, Examples of Bidirectional Data Transfer Between Two Microcomputer, 8254, 8259A, and 8279 Interfacing with 8086.	
	8086 INTERRUPTS MANAGEMENT AND APPLICATIONS	**(03 Hour)**
	8086 Interrupts and Interrupts Responses, Interrupt Pointer Table, Hardware Interrupt, Software Interrupts, Interrupt Applications.	
	RECENT TRENDS IN MICROPROCESSORS	**(03 Hour)**
	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	Introduction of 8085 kit and Installation of 8085 simulator
2	Assembly Language Programming based on Data transfer and Arithmetic and Logic instructions
3	Assembly Language Programming based on Branch operations
4	Assembly Language Programming based on stack and subroutines
5	Assembly Language Programming based on Code conversions
6	Assembly Language Programming based on counter and time delays
7	Introduction of 8086 Microprocessor and Installation of TASM, TLINK, TD, and DEBUG
8	Assembly Language Programming based on 8086 instruction and assembler directives
9	Practical based on 8085 interfacing

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4. Books Recommended:

1. Sentil kumar N, Saravanan M and Jeevananthan S, “Microprocessors and Microcontrollers” 2/E, Oxford University Press, 2018.
2. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", 6/E, Penram International Publishing (India) Pvt. Ltd., 2013.
3. Douglas V Hall, "Microprocessors and Interfacing: Programming & Hardware", 3/E, TMH, 2013
4. Brey, “The Intel Microprocessors", 8/E, Pearson Education, 2009.Andrew Ilachinski, “Cellular Automata”, 1st Ed., World Scientific, 2001.
5. A K Ray and K M Bhurchandi, "Advanced Microprocessors & Peripherals: Architecture Programming & Interfacing", 2/E, TMH, 2006.

ADDITIONAL REFERENCE BOOKS

1. Abel Peter and Nizamuddin, "IBM PC Assembly Language and Programming", 5/E, Pearson Education, 2001.

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

B. Tech. III (AI) Semester – V MACHINE LEARNING AI301	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)**

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	Deep Neural Networks, Deep learning models/algorithms: CNN, RNN, Deep belief networks, Auto-encoders, LSTM	
	APPLICATIONS	**(06 Hours)**
	Signal Processing Application, Biometric 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 a dataset.
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.

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

B. Tech. III (AI) Semester – V DATA SCIENCE AI303	Scheme	L	T	P	Credit
		3	0	2	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	**(04 Hours)**
	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	**(04 Hours)**
	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	**(08 Hours)**
	Data Flattening, Filtering and Chunking, Feature Scaling, Shingling of Documents, Locality Sensitive Hashing for Documents, Distance Measures, LSH Families for Other Distance Measures.	

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	MINING DATA STREAM	**(06 Hours)**
	Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Moments, Windows, Clustering for Streams.	
	ADVANCED DATA ANALYSIS	**(10 Hours)**
	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	**(05 Hours)**
	NLP in Customer Service, Energy Consumption analysis, Healthcare diagnostics, fraud detection and other applications.	
	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	Write a Map Reduce program of word count on Hadoop
2	Execute the commands related to HDFS like ls, mkdir, cat etc.
3	Develop association rule mining on product recommendation application.
4	Implement a data stream mining approach, analysis and visualization.
5	To explore and implement time series analysis and its applications.
6	Do detailed data analysis on any medical dataset.
7	Sentiment analysis for Business Applications.
8	Develop a classification model that classify Reddit Posts.
9	Design a system that predicts malicious URL.
10	Develop a recommendation system, such as movie recommendation, product recommendation.

4. Books Recommended:

1. Cathy O'Neil and Rachel Schutt, Doing Data Science: Straight Talk from the Frontline, 1st Edition O'Reilly Media, 2013, ISBN: 978-1449358655
2. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'reilly Media, 2015, ISBN: 9781491901687.

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3. Anand Rajaraman 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.

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

B. Tech. III (AI) Semester – V INFORMATION SECURITY AND CRYPTOGRAPHY AI331	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	

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	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. Forouzan, Behrouz A., "Cryptography & network security", 3rd Edition, McGraw-Hill, Inc., 2007.

4. Schneier, Bruce, "Applied cryptography: protocols, algorithms, and source code in C", 2nd Edition, john wiley & sons, 2007.

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

B. Tech. III (AI) Semester – V GAME THEORY AI351	Scheme	L	T	P	Credit
		3	0	0	03

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.	

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	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)

3. 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
B.Tech. Artificial Intelligence

B. Tech. III (AI) Semester – V INTRODUCTION TO QUANTUM COMPUTING AI353	Scheme	L	T	P	Credit
		3	0	0	03

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	
		(Total Contact Time = 45 Hours)

3. 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
B.Tech. Artificial Intelligence

B. Tech. III (AI) Semester – V HUMAN COMPUTER INTERACTION AI355	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 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	

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	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)	
	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 Based on Evaluating the Usability of a GUI Prototype Using Heuristic Evaluation
2. Practical Based on Heuristic Evaluation of a Mobile Application
3. Designing a Dialogue System Using Finite State Machines (FSM) and State Charts
4.Practical Based on Evaluating User Task Performance Using Fitts' Law and Keystroke-Level Model (KLM) from the GOMS Family
5. Experiment on the Analysis of Multi-Key Press Hindi Text Input Method Using Model Human Processor (MHP)
6. Practical Based on Cognitive Analysis and GUI Design for a Mobile-Based Matrimonial Application
7. Experiment Design and Data Analysis Using One-Way ANOVA
8. Practical Based 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.

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

B. Tech. III (AI) Semester – V NATURAL LANGUAGE PROCESSING AI357	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, HuggingFace)
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	

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	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.
5. Online Tutorials: Hugging Face, PyTorch, Sklearn, Stanza, NLTK, Spacy
6. 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
B.Tech. Artificial Intelligence

B. Tech. III (AI) Semester-VI DEEP LEARNING AI302	Scheme	L	T	P	Credit
		3	0	2	4

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 (Alex Net), Network using Blocks (VGG), Network in Network (NiN), Multi-Branch Networks (Google Net), Batch Normalization, Layer Normalization, Instance Normalization, Group Normalization, Residual Networks (Res Net), Densely Connected Network (Dense Net), 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	

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

B. Tech. III (AI) Semester – VI CLOUD COMPUTING AI304	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)**

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	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
B.Tech. Artificial Intelligence

B. Tech. III (AI) Semester-VI REINFORCEMENT LEARNING AI332	Scheme	L	T	P	Credit
		3	0	2	4

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.	

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	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 +30 Hours = 75 Hours)	

3. Practicals:
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).

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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. Reinforcement Learning with OpenAI Gym" by Alessio Stalla
5. Hands-On Reinforcement Learning with Python by Sudharsan Ravichandiran

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

B. Tech. III (AI) Semester – VI ROBOTICS AND ITS APPLICATIONS AI352	Scheme	L	T	P	Credit
		3	0	0	03

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	

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	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	
		(Total Contact Time = 45 Hours)

3. 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

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

B. Tech. III (AI) Semester – VI RESPONSIBLE AI AI354	Scheme	L	T	P	Credit
		3	0	0	03

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	

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	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	
		(Total Contact Time = 45 Hours)

3. 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
B.Tech. Artificial Intelligence

B. Tech. III (AI) Semester – VI HIGH PERFORMANCE COMPUTING AI356	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	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.	Syllabus	
	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.
6. https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html

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

B.Tech. III (AI) Semester – VI BIG DATA ANALYSIS & VISUALIZATION AI358	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,	

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	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
B.Tech. Artificial Intelligence

B.Tech. IV (AI) Semester – VII INTELLIGENT MULTIAGENT AND EXPERT SYSTEMS AI401	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	

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

B.Tech. (AI) Semester – VII AFFECTIVE COMPUTING AI451	Scheme	L	T	P	Credit
		3	0	2	4

1. Course Outcomes (COs): At end of the Course student will be able to	
CO1	Explain fundamental theories of emotion including discrete, dimensional, appraisal-based, and process models; analyze their computational representations
CO2	Analyze emotion recognition from unimodal (for example, face/speech/text/physiological signals) and multimodal signals.
CO3	Develop emotionally intelligent interactive systems including emotion regulation, empathetic agents, and social robots
CO4	Critically analyze ethical, legal, social, and privacy implications of affective computing; propose mitigation strategies
CO5	Design and conduct emotion elicitation experiments; implement research tools for affective computing

2.	Syllabus	
	FOUNDATIONS OF AFFECTIVE COMPUTING AND EMOTION THEORIES	**(06 Hours)**
	Fundamentals of Affective Computing: Definition, history, scope, applications Emotion Theory: Discrete models (Ekman), dimensional models (Valence-Arousal), appraisal models (OCC), process/regulation models (Gross, Scherer) Role of emotion in cognition/learning/decision-making; emotional intelligence	
	FACIAL EXPRESSION ANALYSIS	**(06 Hours)**
	Facial Action Units (FACS), micro-expressions Feature extraction: geometric, appearance, deep learning (CNNs, transfer learning) Datasets: AffectNet, FER2013, CK+, SFEW Challenges: occlusion, lighting, bias, privacy	
	SPEECH AND AUDIO-BASED EMOTION RECOGNITION	**(06 Hours)**
	Prosodic/acoustic features: pitch, energy, MFCC, spectral features ML & deep learning: SVM, HMM, RNNs, Wav2Vec Integration with facial/text modalities Datasets: IEMOCAP, RAVDESS Real-world issues: noise, language, speaker differences	
	TEXT AND LINGUISTIC-BASED EMOTION RECOGNITION	**(05 Hours)**
	NLP for emotions: sentiment vs. emotion detection Feature engineering: lexicons, word embeddings (Word2Vec, BERT, RoBERTa)	

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	Transformer models, context, sarcasm & negation Datasets: SemEval, Twitter corpora, Reddit	
	PHYSIOLOGICAL SIGNAL-BASED EMOTION RECOGNITION	**(05 Hours)**
	Neuroscience of emotion: brain areas, ANS activity EEG/ECG/GSR processing: artifact removal, band power Machine learning, deep learning for biosignals Wearable sensors, privacy & challenges	
	MULTIMODAL EMOTION RECOGNITION	**(07 Hours)**
	Fusion fundamentals: synchronization, feature-level (early), decision-level (late), hybrid, attention, graph-based Datasets: IEMOCAP, AffWild, multimodal corpora System design: missing modalities, generalization, real-time, privacy	
	EMOTIONALLY INTELLIGENT INTERACTIVE SYSTEMS & APPLICATIONS	(05 Hours)
	Emotion regulation and models (Gross, RL, OCC), empathetic agents, social robots HCI, learning, healthcare, autism/applications, HR Ethics: fairness, explainability, privacy, social impact	
	EXPERIMENTAL DESIGN AND RESEARCH TOOLS	(05 Hours)
	Affect elicitation, annotation, IRB, tools (EEGLAB, OpenCV, MNE), experimental protocol, statistical analysis	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Tutorials:**
1	Facial/speech/text emotion recognition apps
2	EEG/ECG emotion classification
3	Multimodal fusion
4	Design of emotion elicitation experiment
5	Wearable system real-time demo
6	HCI and robot interaction
7	Ethical scenario evaluation
8	Dataset curation/annotation and model explainability/explainable AI demo.
9	Studying the problem of class imbalance in emotion classification
10	Capstone Project: Building Empathetic AI [End-to-end Affectively Intelligent Artifact (team/individual)]

4. Books Recommended:

1. Picard, R. W. (1997). *Affective Computing*. MIT Press
2. Tao, J., Tan, T., & Picard, R. (2005). *Affective Computing and Intelligent Interaction* (Springer)
3. Barrett, L. F. et al. (2019). "Emotional Expression Reconsidered." *Trends in Cognitive Sciences*
4. Goodfellow, I., Bengio, Y., Courville, A. (2016). *Deep Learning*. MIT Press
5. IEEE Transactions on Affective Computing

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

B.Tech. IV (AI) Semester – VII PROBABILISTIC GRAPHICAL MODELS AI453	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 Probability Theory and different distributions.
CO2	Understand the concepts and workings of undirected, directed graphical models, and factor graphs.
CO3	Apply different inference techniques in graphical models.
CO4	Understand and estimate the parameters in graphical models; understand the concepts of structured learning.
CO5	Design and develop graphical models for different tasks.

2.	Syllabus	
	Introduction	**(08 Hours)**
	Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.	
	Undirected and Directed Graphical Models	**(09 Hours)**
	Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters)	
	Factor Graphs	**(08 Hours)**
	Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	
	Inference in Graphical Models	**(08 Hours)**
	Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum Product); Approximate Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering.	
	Learning in Graphical Models	**(08 Hours)**

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	Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.	
	Use Cases of Probabilistic Graphical Models	**(04 Hours)**
	Image Segmentation, Sequence Labeling Tasks in NLP, Audio Processing using Hidden Markov Models, Markov Fields, and Conditional Random Fields	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	Frameworks: Python, Numpy, scipy, PyCrfsuite, pgmpy, hmmlearn, pykov	
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3. Practicals:
1. Introduction to Probability Theory
2. Introduction to Directed and Undirected Graphical Models
3. Introduction to Factor Graphs
4. Exact and Approximate Inference using Graphical Models
5. Gaussian Belief Propagation
6. Parameter Estimation of Graphical Models
7. Maximum Entropy, Structured Predictions, Maximum Entropy Markov Model
8. Sequence Labeling Tasks in different domains

4. Books Recommended:

1. Probabilistic Graphical Models: Principles and Techniques by Daphne Koller and Nir Friedman. MIT Press.
2. Modeling and Reasoning with Bayesian networks by Adnan Darwiche.
3. Bayesian Reasoning and Machine Learning by David Barber.
4. Graphical models, exponential families, and variational inference by Martin J. Wainwright and Michael I. Jordan.
5. Machine learning: a probabilistic perspective by Kevin Murphy, MIT Press

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

B. Tech. IV (AI) Semester – VII INFORMATION RETRIEVAL AI455	Scheme	L	T	P	Credit
		3	1	0	4

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 + 15 Hours =60 Hours)	

3. Tutorials:
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
10. Next-Generation Information Retrieval (Neural IR, Multimodal IR, Transformer-based Retrieval)

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
B.Tech. Artificial Intelligence

B. Tech. IV (AI) Semester – VII Internet of Things and Edge Computing AI457	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	Identify the hardware and software components, challenges of Internet of Things
CO2	Assess different Internet of Things technologies, architectures resource management and their applications.
CO3	Understand fundamentals of Edge computing and its applications in low latency and critical real-time computing scenarios
CO4	Evaluating different techniques for distributed data analytics over edge devices like edge data centre.
CO5	Analyze the performance and issues of the applications developed using edge architecture and platforms.

2.	Syllabus	
	INTRODUCTION	**(03 Hours)**
	Definition and Characteristics of Internet of Things (IoT) - Challenges and Issues - Physical Design of IoT - Logical Design of IoT - IoT Functional Blocks.	
	IOT COMMUNICATION ARCHITECTURES AND PROTOCOLS	**(05 Hours)**
	Control Units – Communication modules – Bluetooth – Zigbee – WiFi – GPS - IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP) – MQTT - Wired Communication - Power Sources	
	TECHNOLOGIES AND RESOURCE MANAGEMENT IN IOT	**(12 Hours)**
	Four pillars of IoT paradigm: RFID, Wireless Sensor Networks, Supervisory Control and Data Acquisition (SCADA) - M2M - IoT Enabling Technologies: Big Data Analytics, Cloud Computing, Embedded Systems. Programming the Microcontroller for IoT. Scalability: Network Configuration Protocol, Open vSwitch Database Management Protocol - Routing and Protocols: Collection Tree, LOADng.	
	INTRODUCTION TO EDGE COMPUTING	**(05 Hours)**

	Introduction to Cloud and its limitations to support low latency and RTT. From Cloud to Edge computing: Waves of innovation. Introduction to Edge Computing Architectures. Edge Computing to support User Applications (5G-Slicing, self-driving cars and more) Concepts of distributed systems in edge computing such as time ordering and clock synchronization, distributed snapshot, etc.	
	MANAGEMENT OF EDGE APPLICATIONS AND SERVICES	**(10 Hours)**
	Introduction to Edge Data Center, Lightweight Edge Clouds and its services provided by different service providers. Introduction to docker container and Kubernetes in edge computing. Design of edge storage systems like key-value stores	
	EDGE PLATFORMS AND USE CASES	**(10 Hours)**
	Introduction to MQTT and Kafka for end-to-end edge pipeline. Edge analytics topologies for M2M and WSN network (MQTT), Use cases of machine learning for edge sensor data in predictive maintenance, image classifier and self-driving cars. Deep Learning On-Device inference at the edge to support latency-based application	
	Tutorials will be based on the coverage of the above topics.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Practicals**
1	To study IoT Development Simulation Kit and Development Environment.
2	Internet Controlled LEDs.
3	System to create Temperature Logger.
4	Development of Home Automation System.
5	Use of Soil Moisture Sensor in agriculture-based applications.
6	Use of Light Color Control for planning and simulating traffic.
7	Develop a Home Security System.
8	Use of Parking Sensor, Water Level Control, Street Light Control for different applications.

4.	**Books Recommended**
1.	The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2.	S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
3.	Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 2019, 1 st Edition, Wiley Publications, USA.
4.	Fog and Edge Computing: Principles and Paradigms", Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), Wiley, 2019
5.	Cloud and Distributed Computing: Algorithms and Systems", Rajiv Misra, Yashwant Patel, Wiley 2020.

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

B.Tech. (AI) Semester – VIII AI FOR SUSTAINABILITY AI459	Scheme	L	T	P	Credit
		3	1	0	4

1. Course Outcomes (COs): At end of the Course student will be able to	
CO1	Understand how AI accelerates sustainability across sectors
CO2	Analyze real-world sustainability challenges using datasets
CO3	Build AI models that optimize energy use, reduce emissions, and support climate resilience.
CO4	Evaluate ethical, environmental, and regulatory considerations of AI systems.
CO5	Apply AI-driven decision-making for sustainable operations.

2.	Syllabus	
	INTRODUCTION TO AI FOR SUSTAINABILITY	**(04 Hours)**
	The role of AI in achieving Net Zero, Tech Zero, and Tech Positive Goals, Sustainability frameworks, AI benefits for sustainability: Predictive efficiency, Climate adaptation, Sustainable product development, Understanding sustainability KPIs: carbon emissions, energy footprints.	
	AI FOR ENVIRONMENTAL SUSTAINABILITY & CLIMATE MODELING	**(06 Hours)**
	AI in climate risk prediction and resilience, Early warning systems for natural disasters using ML/Deep Learning, AI for environmental forecasting (weather, floods, droughts), AI for natural resource management (water, forests, minerals), Satellite imagery, AI for environmental monitoring	
	AI IN ENERGY SYSTEMS, SMART CITIES & INFRASTRUCTURE OPTIMIZATION	**(08 Hours)**
	AI for renewable energy forecasting (solar, wind), Smart Energy grid optimization, Microgrid Energy management system, Energy trading markets and blockchain Smart building optimization:, energy scheduling, HVAC prediction, Transportation optimization: route planning, EV charging prediction, AI in water and waste management	
	AI FOR SUSTAINABLE INDUSTRY, AGRICULTURE, AND SUPPLY CHAINS	**(08 Hours)**
	AI in supply chain decarbonization and optimization, Crop yield prediction, Data center optimization using AI, Digital twins for manufacturing sustainability,	
	SUSTAINABLE AI: GREEN AI, MODEL OPTIMIZATION & CARBON-AWARE COMPUTING	**(08 Hours)**

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	Environmental costs of AI: energy, water, rare-earth dependency. Carbon footprint of training large AI models, Principles of Green AI: Carbon-aware workload scheduling. Sustainable computing infrastructure: Renewable-powered data centers.	
	ETHICS, GOVERNANCE & FUTURE TRENDS IN SUSTAINABLE AI	**(6 Hours)**
	Social sustainability: Bias, fairness, and transparency, AI and misinformation, Economic sustainability, Governance: Explainability and accountability frameworks, Autonomous climate-aware systems	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials:**
1	Predict electricity demand from real dataset
2	Train an RL agent for simple energy scheduling
3	Image classification lab: detect land use changes from satellite images.
4	Build a small climate model using time-series data
5	Crop disease detection using CNNs on PlantVillage dataset.
6	Build a supply chain forecasting model (demand + inventory).
7	Compare energy/compute metrics of optimized vs. non-optimized models.
8	Implement model pruning or quantization.
9	Build a Python/Streamlit dashboard to visualize sustainability metrics.
10	Land classification/deforestation detection.

4. Books Recommended:

1. AI FOR SUSTAINABILITY: The basics of AI impact revolution by Ms. Lidia Esther Aviles
2. Artificial Intelligence and Machine Learning for Sustainable Development, Innovations, Challenges, and Applications By Pawan Whig, Pavika Sharma, Nagender Aneja, Ahmed A. Elngar, Nuno Silva
3. Sustainable AI: AI for sustainability and the sustainability of AI. AI Ethics , van Wynsberghe, A.
4. Sustainable AI: Tools for Moving Towards Green AI by Raghvendra Selvan
5. AI for the Sustainable Development Goals, by Henrik Skaug Sætra
6. Latest research papers from top tier Conferences and Journals

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

B.Tech. (AI) Semester-VII Advanced Biometric Systems and Security AI461	Scheme	L	T	P	Credit
		3	1	0	4

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)**

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	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 = 45 Hours)	

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

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

B. Tech. IV (AI) Semester – VII INTRODUCTION TO LARGE LANGUAGE MODELS AI463	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 Large Language Models and its applications.
CO2	Understand and Implement different types of language models
CO3	Apply various word embeddings, neural language models, and other deep learning methods for different tasks.
CO4	Build and evaluate LLMs for different tasks such question answering, dialog systems, summarization, code generation
CO5	Utilize LLMs using transformers, Pytorch, HuggingFace, Ollama libraries
CO6	Design and implement a complete project using LLMs

2.	Syllabus	
	Introduction	**(05 Hours)**
	Introduction to NLP, NLP Pipeline, Applications of NLP, Introduction to Statistical Language Models, Statistical Language Models: Advanced Smoothing and Evaluation	
	Introduction to Deep Learning and Word Representations	**(08 Hours)**
	Introduction to Deep Learning (Perceptron, ANN, Backpropagation, CNN), Introduction to PyTorch, Word2Vec, GloVe, fastText, Tokenization Strategies, Byte Pair Encodings, Subword Embeddings, Unsupervised Representations	
	Neural Language Models	**(08 Hours)**
	CNN, RNN, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling, Attention in Sequence-to-Sequence Models, Memory Networks	
	Introduction to Transformers	**(04 Hours)**
	Self and Multi-Head Attention, Positional Encoding and Layer Normalization, Implementation of Transformers using PyTorch	
	Transformer Architectures and Fine-Tuning Strategies	**(09 Hours)**
	ELMo, BERT (Encoder-only Model), GPT (Decoder-only Model), T5 (Encoder-decoder model), Introduction to HuggingFace, Instruction Fine-tuning, Instruction Fine-tuning, In-context Learning and Prompting Techniques, Alignment with Human Feedback (RLHF), Parameter-efficient Adaptation (Prompt Tuning, Prefix Tuning, LoRA)	

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	Retrieval-Augmented Inference and Generation	**(05 Hours)**
	Introduction to Knowledge Graphs, Distinction between graph neural networks and neural KG inference, Retrieval augmentation techniques: Key-value memory networks in QA for simple paths in KGs, pointer networks, reading comprehension, REALM, RAG	
	Overview of Recently Popular Models	**(06 Hours)**
	GPT-4, Llama-3, Claude-3, Code-Llama, Mistral, and Gemini, Multi-modal LLMs - LLaVa, Open-VLA Ethical NLP – Bias and Toxicity, Evaluation Benchmarks	
	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. Statistical Language Modeling and Smoothing Techniques
2. Different Word and Subword Representations
3. Introduction to Pytorch, transformers, and HuggingFace frameworks
4. Neural Language Models and Encoder-Only Models (BERT and its variants)
5. Decoder-Only Models (GPT-2, Llama), T5 (Encoder-Decoder Models)
6. RAG models and Knowledge Graph Inferencing
7. Develop a complete project using LLMs(e.g., chatbot, Q&A system, dialog generation, image captioning).

4. Books Recommended:

1. *Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025. ISBN : 9789363864740*
2. *Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd and 3rd edition, Pearson Press, 2008.*
3. *Jacob Eisenstein, Natural Language Processing, First edition,The MIT Press, 2019.*

5. Reference Books:

1. Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, O'Reilly Media, Inc.
2. Online Tutorials: Hugging Face, PyTorch, Llama, Ollama, LLMStudio
3. Latest research papers from top tier conferences (ACL, NEURIPS, AAAI, NAACL, COLING, CONLL, SIGIR, IJCNLP, LREC, TACL etc.)

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

B. Tech. IV (AI) Semester – VII	Scheme	L	T	P	Credit
Agentic AI **AI465**		**3**	**0**	**2**	**04**

1.	**Course Outcomes (COs):** **At end of the Course student will be able to**
CO1	Explain the principles, architectures, and decision-making foundations of agentic artificial intelligence, including classical agents, LLM-based agents, and agentic workflows.
CO2	Design and implement LLM-based agents capable of reasoning, planning, tool usage, and memory integration using modern agent frameworks.
CO3	Develop and evaluate multi-step and multi-agent systems, incorporating reliability, safety, and evaluation mechanisms for autonomous behavior.
CO4	Analyze deployment, cost, safety, and governance challenges of agentic AI systems
CO5	Propose appropriate mitigation strategies for challenges of agentic AI systems

2.	**Syllabus**	
	FOUNDATIONS OF AGENTIC ARTIFICIAL INTELLIGENCE	**(06 Hours)**
	Evolution of AI, Symbolic systems, Machine learning, Deep learning and Large Language Models, limitations of single-prompt generative systems, Intelligent agents and agentic AI systems, differences between chatbots, workflows and autonomous agents, agent–environment interaction loop, PEAS framework, rationality and utility-based decision making, autonomy, and adaptability in agents, classical agent architectures including reactive, model-based, goal-based and utility-based agents, Belief–Desire–Intention (BDI) architecture and conceptual mapping to modern LLM agents, motivation for agentic workflows in real-world applications.	
	DECISION MAKING AND PLANNING FOUNDATIONS FOR AGENTS	**(07 Hours)**
	Sequential decision-making problems, Agent behavior using Markov Decision Processes (MDPs), state space, action space, transition dynamics and reward functions, stochastic policies and deterministic policies, value functions and action-value functions, Bellman expectation and Bellman optimality equations, planning using value iteration and policy iteration, convergence intuition and role of discount factor, modeling uncertainty and partial observability, Partially Observable Markov Decision Processes (POMDPs), belief state representation and updates, limitations of classical planning models.	
	LARGE LANGUAGE MODELS AS REASONING AND PLANNING ENGINES	**(06 Hours)**
	Transformers, self-attention overview, next-token prediction, reasoning behavior, in-context learning, prompt engineering principles, zero-shot, few-shot and instruction-based prompting, chain-of-thought reasoning and intermediate reasoning traces, self-consistency and sampling-based reasoning, reflection and self-critique mechanisms, plan-then-execute architectures, ReAct-style reasoning and acting loops, hierarchical task decomposition using LLMs, reasoning	

	limitations including hallucinations, overconfidence, exposure bias, context window constraints.	
	AGENTIC WORKFLOWS AND MODERN LLM AGENT FRAMEWORKS	**(06 Hours)**
	Agent loop abstractions in modern LLM frameworks, separation of planner, executor and critic components, controller-based agent architectures, workflow graphs and state-machine representations, deterministic versus adaptive agent workflows, tool-aware planning, verifier, evaluator agents, retry and fallback strategies, trace-based debugging of agent behavior, error propagation in multi-step reasoning, reliability patterns in agent frameworks, comparison of autonomous agents.	
	TOOL-USING AGENTS AND MODEL CONTEXT PROTOCOL (MCP)	**(08 Hours)**
	Tool-augmented LLM agents, tools as external action interfaces, structured outputs, schema-based function calling, tool selection, routing strategies, chaining, composing tools in workflows, API integration and execution management, handling tool failures, retries, partial completion, grounding model outputs, Model Context Protocol (MCP), separation of model inference from environment interaction, context providers, tool providers, standardized agent–tool interfaces, sandboxing, permission control, secure execution in agent frameworks.	
	MEMORY, RETRIEVAL, AND CONTEXT MANAGEMENT IN AGENTS	**(06 Hours)**
	Context window limitations and context overflow, short-term working memory in agents, long-term persistent memory, vector embeddings, semantic representations, similarity search, nearest-neighbor retrieval, Retrieval-Augmented Generation (RAG) pipelines, document chunking, indexing strategies, episodic memory, experience replay, memory summarization, compression, session persistence, design of stateful LLM agents.	
	MULTI-AGENT SYSTEMS AND COLLABORATIVE LLM AGENTS	**(06 Hours)**
	Fundamentals of multi-agent systems, cooperative and competitive agent interactions, centralized versus decentralized coordination, basic game-theoretic intuition for agent interaction, coordination and negotiation strategies, role-based LLM agent design, communication between agents, structured message passing and protocols, debate and deliberation-based agent architectures, supervisor–worker, manager–executor models, task delegation, workload balancing, scalability and orchestration challenges.	
	EVALUATION, SAFETY, DEPLOYMENT, AND GOVERNANCE OF AGENTIC AI	**(06 Hours)**
	Challenges in evaluating agentic AI systems, defining task success for multi-step agents, automated evaluation using LLM judges, human-in-the-loop evaluation, regression testing for agent workflows, adversarial and stress testing, safety risks in autonomous and tool-using agents, prompt injection, tool misuse attacks, approval gates, constrained execution, alignment challenges, goal mis-specification and reward hacking, Cost modeling, latency analysis, deployment architectures for agent frameworks, monitoring, logging and observability, ethical, legal and governance considerations for agentic AI.	
	Practicals will be based on the coverage of the above topics separately.	**(30 Hours)**
		(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)

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3.	**Practicals:**
1	Compare zero-shot, chain-of-thought, and self-consistency prompting using an instruction-tuned LLM on reasoning problems and report accuracy differences.
2	Design a plan-then-execute LLM agent that explicitly generates a task plan and sequentially executes it for multi-step real-world tasks, and analyze failure cases.
3	Implement a ReAct (Reason-Act-Observe) agent with a Wikipedia search tool and evaluate its reasoning traces.
4	Build a tool-using LLM agent with structured function calling and analyze tool invocation correctness and error recovery.
5	Develop a retrieval-augmented generation (RAG) agent using vector embeddings and FAISS to answer questions from a collection of research PDFs and compare it with a non-RAG baseline.
6	Implement a Reflexion-based agent that critiques its own failed solutions and demonstrate performance improvement on logical or coding tasks.
7	Create a multi-agent debate system with two arguing agents and one judge agent to improve factual accuracy on complex question-answering tasks.
8	Design a long-horizon autonomous agent with a task queue and prioritization mechanism to complete an open-ended research objective.
9	Demonstrate prompt-injection attacks on an LLM agent and implement safety mechanisms such as approval gates and tool sandboxing to mitigate them.
10	Build an end-to-end agentic AI application integrating planning, tools, memory, evaluation, and safety, and present a detailed architecture and failure analysis.

4. Books Recommended:

1. Reinforcement Learning: An Introduction, Richard S. Sutton, Andrew G. Barto, MIT Press, 2nd Edition
2. Multi-Agent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 1st Edition
3. Multi-Agent Reinforcement Learning: Foundations and Modern Approaches, Stefano V. Albrecht, Filippos Christianos, Lukas Schäfer, MIT Press, 1st Edition
4. Planning Algorithms, Steven M. LaValle, Cambridge University Press, 1st Edition
5. AI Agents in Action, Michael Lanham, Manning Publications, 2nd Edition
6. Building Applications with AI Agents, Michael Albada, O'Reilly Media, 1st Edition
7. Natural Language Processing with Transformers, Lewis Tunstall, Leandro von Werra, Thomas Wolf, O'Reilly Media, 1st Edition
8. Artificial Intelligence: Foundations of Computational Agents, David L. Poole, Alan K. Mackworth, Cambridge University Press, 2nd Edition