AC: 22/2/26
Item No. 1.1.8

SIES (Nerul) College of Arts, Science & Commerce
RISE WITH EDUCATION

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

(Affiliated to University of Mumbai)

RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES

SYLLABUS FOR

B.SC (COMPUTER SCIENCE)

(WITH EFFECT FROM THE ACADEMIC YEAR 2026-2027)

Sr. No.	Heading	Particulars
1	Title of the course	B. Sc (COMPUTER SCIENCE)
2	Semesters	V and VI
3	Level	UG
4	Pattern	04 years & 08 semesters CBGS
5	To be implemented from	From Academic year 2026-27 in a progressive manner

Date: 21nd Feb, 2026.

Signature:

Dr. Koel Roychoudhury
AC Chairperson

Dr. Sheeja Ravi
Head of the Department

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SIES(Nerul) College of Arts, Science and Commerce (Autonomous)

Department of Computer Science

NEP Credit Structure for 2026 - 27

Semester	Major	Minor	Electives (Any one)	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum Cr/ Sem.
V	Artificial Intelligence **(3+1P credits)** Information and Cyber Security **(3+1P Credits)** Science of Language Processing **(2 Credits)**	Statistical Methods **(3+1P Credits)**	Game Programming (Or) Linux Server Administration **(3+1P credits)**	Mobile Application Development (2 Credit)	____	Field Project-Research work (2 credit)	22
Total	**10**	**4**	**4**	**2**		**2**	**22**

Semester	Major	Minor	Elective (Any One)	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum Cr/ Sem
VI	Machine Learning **(3+1P Credits)** Wireless Sensor Networks **(3+1P Credits)** Remote Sensing (2 Credit)	Fuzzy Computational Logic **(4 credits)**	Information Retrieval (OR) IoT Technologies **(4 Credits)**		-	On Job Training **(4 Credits)**	22
Total	**10**	**4**	**4**	**-**	**-**	4	**22**

SCHEME OF MODULES

Semester V			
Serial No.	**Course Code**	**Credits**	**Course Name**
I	**Major Department Specific Course (DSC)**		
1	U25CS5MJ01	03	Artificial Intelligence
2	U25CS5MJP01	01	Practical of Artificial Intelligence
3	U25CS5MJ02	03	Information and Cyber Security
4	U25CS5MJP02	01	Practical of Information and Cyber Security
5	U25CS5MJ03	02	Science of Language Processing
II	**Minor Department Specific Course**		
1	U25CS5MI01	03	Statistical Methods
2	U25CS5MIP01	01	Practical Of Statistical Methods
III	**Electives (Any One)**		
1	U25CS5EL01 U25CS5EL02	03	Game Programming OR Linux Server Administration
2	U25CS5ELP01 U25CS5ELP02	01	Practical of Game Programming OR Practical of Linux Server Administration
IV	**VOCATIONAL COURSE (VC) & SKILL ENHANCEMENT COURSE (SEC)**		
	U26CS5VSC01	01	Mobile Application Development
	U26CS5VSCP01	01	Practical of Mobile Application Development
V	**ON JOB TRAINING/ FIELD PROJECT/RESEARCH PROJECT/COMMUNITY EXTENSION PROGRAMME**		
1	U26CS5FP01	02	Field Project- Project Work
TOTAL CREDITS		**22**	

MAJOR- Artificial Intelligence

COURSE CODE: U25CS5MJ01 **COURSE CREDIT: 03**

1 credit – 15 lectures **1 lecture is 60 minutes**

Course Objectives:

- Understand the foundations, history, and state of the art of AI.
- Learn about intelligent agents, their environments, and the structure of agents.
- Explore different problem-solving strategies, including uninformed and informed search techniques.
- Gain knowledge of knowledge representation and reasoning methods, and apply them to solve complex problems.
- Develop an understanding of artificial intelligence techniques, including classification, regression, and ensemble learning.

Course Outcomes:

After successful completion of this course, students would be able to

- Demonstrate knowledge of the foundations and key concepts in the field of AI.
- Analyze and design intelligent agents for specific environments.
- Apply problem-solving techniques and algorithms to find solutions to different types of problems.
- Construct knowledge representation models and use reasoning techniques to derive new knowledge.

Unit	Topics	No. of Lectures
I	**Introduction:** What is Artificial Intelligence? Foundations of AI, history, the state of art AI today. **Intelligent Agents:** agents and environment, good behavior, nature of environment, the structure of agents. **Formulating Problems:** Examples problems, toy problem, real problem, vacuum cleaner problem, 8 queens problem.	15
II	**Solving Problems by Searching:** Searching for solutions, uninformed search, informed search strategies, heuristic functions. **Beyond Classical Search:** local search algorithms, searching with non-deterministic action, searching with partial observations, online search agents and unknown environments.	15

III	**Adversarial Search:** Games, optimal decisions in games, alpha-beta pruning, stochastic games, partially observable games, state-of-the-aregame programs. **Logical Agents:** Knowledge base agents, The Wumpus world, logic, propositional logic, propositional theorem proving, effective propositional model checking, agents based on propositional logic.	15

Textbook(s):

1. Artificial Intelligence: Patrick Henry Winston: Addison-Wesley Publishing Company

2. Artificial Intelligence: Dr. Rajeshri Shinkar, Dr. Rajendra Patil, Ms. Mitali Shewale, University of Mumbai.

3. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010.

4. A First Course in Artificial Intelligence, Deepak Khmani, TMH, First edition,2017.

Additional Reference(s):

1. Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017.

2. Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017 3) The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

MAJOR- Practical of Artificial Intelligence

COURSE CODE: U25CS5MJP01 **COURSE CREDIT: 01**

1 credit – 2 lectures **1 lecture is 60 minutes**

List of Practicals	
1	Write a program to Implement the Depth First Search algorithm.
2	Write a program to Implement Breadth First Search algorithm,
3	Write a program to implement Iterative Depth First Search algorithm.
4	Write a program to implement Recursive Best-First Search.
5	Write a program to simulate 4-Queen/N-Queen problem.
5	Write a program to solve tower of Hanoi problem.
6	Write a program to implement alpha beta search.
7	Write a program to implement A* algorithm.
9	Write a program to implement AO* algorithm.
10	Write a program to solve traveling salesman problem using artificial intelligence techniques.
11	Write a program to shuffle Deck of cards.
12	Write a program to implement association rule mining algorithm.
13	Perform a demonstration or mini-project showcasing the capabilities of the AI tools.

Major - Information and Cyber Security

COURSE CODE : U25CS5MJ02 **COURSE CREDIT: 03**

1 Credit – 15 Lectures **1 Lecture is 60 minutes**

Course Objectives:

- Familiarize students with the fundamental principles, models, and mechanisms of computer and network security.
- Explore various encryption techniques, including symmetric and public-key cryptography, and understand their strengths, weaknesses, and real-world applications.
- Examine different authentication and key management methods to ensure secure communication and protect against unauthorized access.
- Understand the concepts and techniques of message authentication, digital signatures, and authentication protocols used in secure communication systems.
- Investigate network security measures, including IP security, web security, intrusion detection, malicious software detection, and firewall design principles.

Course Outcomes:

After successful completion of this course, students would be able to:

- Analyze and evaluate security trends, attacks, and mechanisms, and propose effective security solutions based on the OSI security architecture.
- Apply classical encryption techniques, such as substitution and transposition ciphers, to encrypt and decrypt messages and analyze their security implications.
- Implement public-key cryptography algorithms, including RSA, and demonstrate the ability to securely exchange keys and establish secure communication channels.
- Design and implement secure authentication mechanisms, including message authentication codes and digital signatures, to ensure data integrity and non-repudiation.
- Evaluate and implement various security measures, such as IP security, web security protocols (e.g., SSL/TLS), intrusion detection systems, and firewall configurations, to protect networks and systems from unauthorized access and attacks.

Unit	Syllabus	No. of Lectures
1	**Introduction:** Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms **Number Theory**: Modular arithmetic-Euclids algorithm-Finite fields-Polynomial Arithmetic – Prime numbers-Fermats and Eulers theorem-Testing for primality -The Chinese remainder theorem- Discrete logarithms. **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers	15

2	**Key Management:** Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange. **Message Authentication and Hash Functions:** Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC, Digital Signatures. **Authentication Applications:** Kerberos, X.509 Authentication, Public-Key Infrastructure.	15
3	**Introduction to Cyber Security and Cybercrime:** Cybercrime and information security, Cyber security and its types, Cybercriminals, Classifications of cybercrime. **Vulnerability and Cyber attack**:Vulnerability assessment and tools: Penetration testing Black box and white box, Cyber Threats, Viruses and Related Threats, Virus Countermeasures, worms, trojan, , DDOS, Phishing, SYN flood, Countermeasures. **Web Security:** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction **Electronic Mail Security:** Pretty Good Privacy, S/MIME **Firewalls:** Firewall Design Principles, Types of Firewalls.	15

Textbooks:

1. Cryptography and Network Security: Principles and Practice 7th edition, William Stallings, Pearson
2. Introduction to Computer Security 6th impression, 2005, Pearson
3. Cyber Security, Nina Godbole, SunitBelapure, Wiley India 1st Edition 2011

Additional References:

1. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill.

MAJOR- Practical of Information and Cyber Security

COURSE CODE : U25CS5MJ02 **COURSE CREDIT: 01**

1 Credit – 30 Lectures **1 Lecture is 60 minutes**

Sr. No.	List of Practical
1	Implementing Substitution Ciphers: Design and implement algorithms to encrypt and decrypt messages using classical substitution and transposition techniques.
2	Implementing Transposition Ciphers: Design and implement algorithms to encrypt and decrypt messages using classical substitution and transposition techniques
3	Message Authentication Codes: Implement algorithms to generate and verify message authentication codes (MACs) for ensuring data integrity and authenticity
4	Digital Signatures: Implement digital signature algorithms such as RSA-based signatures, and verify the integrity and authenticity of digitally signed messages
5	Key Exchange using Diffie-Hellman: Implement the Diffie-Hellman key exchange algorithm to securely exchange keys between two entities over an insecure network.
6	IP Security (IPsec) Configuration: Configure IPsec on network devices to provide secure communication and protect against unauthorized access and attacks.
7	Web Security with SSL/TLS: Configure and implement secure web communication using SSL/TLS protocols, including certificate management and secure session establishment
8	Intrusion Detection System: Set up and configure an intrusion detection system (IDS) to monitor network traffic

	and detect potential security breaches or malicious activities.
9	Malware Analysis and Detection: Analyze and identify malware samples using antivirus tools, analyze their behavior, and develop countermeasures to mitigate their impact.
10	Firewall Configuration and Rule-based Filtering: Configure and test firewall rules to control network traffic, filter packets based on specified criteria, and protect network resources from unauthorized access.
11	Port Scanning with NMap 1. Use NMap to perform an ACK scan to determine if a port is filtered, unfiltered, or open. 2. Perform SYN, FIN, NULL, and XMAS scans to identify open ports and their characteristics. Analyze the scan results to gather information about the target system's network services.
12	Network Traffic Capture Wireshark · Use Wireshark to capture network traffic on a specific network interface. · Analyze the captured packets to extract relevant information and identify potential security issues.
13	Network Traffic Capture and DoS Attack with Wireshark and Nemesy Denial of Service (DoS) Attack: · Use Nemesy to launch a DoS attack against a target system or network. · o Observe the impact of the attack on the target's availability and performance.

MAJOR- Science of Language Processing

COURSE CODE: U25CS5MJ03 **COURSE CREDIT: 02**

1 credit - 15 lectures **1 lecture - 60 minutes**

Course Objectives:

- To introduce fundamental concepts of linguistics with a focus on Sanskrit grammar and phonetics.
- To understand the role of Sanskrit in Natural Language Processing (NLP) and Artificial Intelligence.

Course Outcomes:

- Understand key components of language and linguistic structures.
- Evaluate the relevance of Sanskrit in modern NLP applications.

Sr. No	Syllabus	No. of lectures
01	Introduction to Linguistics and Sanskrit Language Processing: An ecosystem for Sanskrit language processing, Components of a language: Phonetics, morphology, syntax, semantics, pragmatics, Sanskrit as a structured language: Role in linguistic studies Pāṇini's Work and Computational Linguistics: Pāṇini's Aṣṭādhyāyī: Rules and structure, Computational aspects of Sanskrit grammar, Logic for sentence construction in Sanskrit, Importance of verbs in Sanskrit syntax	15
02	Phonetics and Vocabulary Patterns in Sanskrit: Sanskrit phonetics and pronunciation, Four stages of speech, Patterns in Sanskrit vocabulary and their linguistic significance Sanskrit in NLP and AI: Computational concepts in Aṣṭādhyāyī and their modern applications, Representation of Sanskrit grammar in digital language processing, Role of Sanskrit in Natural Language Processing (NLP) and AI-based language models, Applications in machine translation and speech recognition	15

Text Book(s):

1. Introduction to IKS: Concepts and Applications, B.Madhavan, PHI Publication

Additional Reference(s):

2. Natural Language Processing: A Paninian Perspective, Bharati, A., Sangal, R., Chaitanya, V. Prentice Hall India

MINOR- STATISTICAL METHODS

COURSE CODE: U25CS5MI01 **COURSE CREDIT:3**

1 credit 15 lectures **1 lecture is 60 minutes**

Course Objectives:

- This course is designed to introduce the concepts of estimation and testing of hypotheses.
- This course also deals with the concept of parametric tests for large and small samples. It also provides knowledge about non-parametric tests and its applications.
- This course will enable students to understand the concept of estimation, test of hypothesis and to apply appropriate estimation techniques and test of hypothesis.

Course Outcomes:

Upon completion of this course, students will be able to

- Demonstrate the concepts of point and interval estimation and use point estimators for estimating unknown parameters.
- Use sampling distributions in testing of hypotheses.
- Apply various parametric and nonparametric tests for one sample and two samples and interpret their results.

UNIT	TOPIC	NO OF LECTURES
I	**Concept of Population- Sample** Population, Concept of a random sample, parameter, statistic, estimator, unbiased estimator, bias, sampling distribution. standard error of an estimator. Central Limit Theorem for Independently and Identically Distributed Random Variables (Statement only). Sampling Distribution of sample mean, and sample proportion based on large samples. Confidence Interval for population mean and population proportion based on large samples. **Theory of Estimation Point Estimation**: Concept of Estimator and Estimate- properties of Point estimator – Unbiasedness- Consistency- Efficiency- relative efficiency- Minimum variance unbiased estimators- Sufficiency- Cramer Rao Inequality (Statement only)- Rao Blackwell Theorem (Statement only)- Neyman Factorization Theorem (Statement only)	15

	Tests of Significance I: **Concept of Statistical hypothesis**: Basics of testing of hypotheses, null and alternative, simple and composite hypotheses. Test of a statistical hypotheses. Critical Region, Probability of Type I and Type II errors, Level of Significance and power of the test, Neyman-Pearson lemma (Statement only).	
II	**Large sample tests:** Large sample tests (using central limit theorem, if necessary) For testing specified value of population mean For testing specified value in difference of two means For testing specified value of population proportion For testing specified value of difference of population proportion.	15
III	**Tests of Significance II:** Sampling distributions of Chi-square- t and F statistics: Small sample tests: Tests for single mean- equality of two means- single variance and equality of two variance- Tests of proportions based on t and F statistics. One way ANOVA- Mathematical model, test procedure, Examples, Two Way classification , Mathematical model, Test procedure for two way ANOVA, Application of ANOVA. Post hoc tests like Fisher's least significant difference and Duncan's multiple range test. Chi-square tests for independence of attributes and goodness of fit.	15

REFERENCES:

1. V. K. Rohatgi- Statistical Inference- Dover Publication- New York- 2013.
2. S. C. Gupta and V. K. Kapoor- Fundamentals of Mathematical Statistics-12th ed.- Sultan Chand & Sons- New Delhi- 2017.

ADDITIONAL REFERENCES:

1. R. E. Walpole, R. H. Myers and S. L. Myers- Probability and Statistics for Engineers and Scientists- 9th ed.- Pearson- New Delhi- 2017.
2. V. John- Using R for Introductory Statistics- 2nd ed.- CRC Press- Boca Raton- 2014.
3. M. Rajagopalan and P. Dhanavanthan- Statistical Inference-1st ed. - PHI Learning (P) Ltd.- New Delhi- 2012.
4. V. K. Rohatgi and E. Saleh- An Introduction to Probability and Statistics- 3rd ed.- John Wiley & Sons Inc- New Jersey- 2015.

MINOR- Practical of Statistical Methods

COURSE CODE: U25CS5MIP01 **COURSE CREDIT:1**

1 credit – 15 lectures **1 lecture is 60 minutes**

SNO	LIST OF PRACTICALS
1	Practicals to obtain Sampling distribution of various statistic.
2	Practicals to verify unbiasedness and consistency of estimator.
3	Practicals to verify efficiency of the estimator.
4	Practicals to test for single mean and equality of two means when variance is known under normality conditions
5	Practicals to perform both one sample and two sample t-test
6	Practical to perform equality of population variances F-test.
7	Practicals to test for single proportion and equality of two proportions.
8	Practicals to test for variance One Way ANOVA.
9	Practicals to test for variance Two Way ANOVA
10	Practicals to test for Fishers least significant Difference.
11	Practicals to test for Duncan's Multiple range test.
12	Practicals to test for chi square test of association.
13	Practicals to test for independence of attributes and goodness fit using Chi-Square test

MAJOR- ELECTIVE-Game Programming

COURSE CODE: U25CS5EL01 **COURSE CREDIT: 03**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objectives:

- Understand the fundamentals of game programming, 2D graphics, vectors.
- Implement 3d graphics techniques, including lighting, shading, and texturing, to create visually appealing game environments.
- Apply principles of game design and create engaging and immersive gaming experiences

Course Outcomes:

- Apply vector manipulation techniques and transformations to create and manipulate objects in 2D/3D space
- Implement advanced graphics techniques, including lighting, shading, and texturing, to create visually stunning game environments
- Implement AI principles to create advanced games

Unit	Syllabus	No. of lectures
	Game Programming Overview: Evolution of Video Game Programming, The Game Loop - Traditional Game Loop, Multithreaded Game Loops, Time and Games, Game	
1.	Objects, Types of Game Objects, Game Objects in the Game Loop **2D Graphics**: 2D Rendering Foundations- CRT Monitor Basics, Sprites, Sprite Sheets, Scrolling - Single-Axis Scrolling, Infinite Scrolling, Four-Way Scrolling, Tile Maps - Simple Tile Maps, Isometric Tile Maps **Linear Algebra for Games**: Vectors, Dot Product, Vector Reflection, Rotating a 2D Character, Coordinate Systems, Matrices,	15
2.	**3D Graphics:** Basics, Coordinate Spaces, Model Space, Lighting and Shading, Visibility, Quaternions, 3D Game Object Representation, World Transform **Input:** Input Devices- Digital Input, Analog Input, Event-Based Input Systems, Mobile Input - Touch Screens and Gestures **Sound:** Basic Sound- Source Data, Sound Cues, Listeners and Emitters, Falloff, Surround Sound, 3D Sound, Digital Signal Processing, Other Sound Topics	15
3.	**Physics:** Planes, Rays, and Line Segments, Collision Geometry- Bounding Sphere, Capsule, Convex Polygons, Collision Detection- Swept Sphere Intersection, Optimizing Collisions, Physics-Based Movement- Linear Mechanics Overview, Physics Middleware **Cameras:** Types of Cameras- First-person Camera, Cutscene Cameras, Perspective Projections- Field of View, Aspect Ratio, , Camera Implementations, Camera Support Algorithms **Artificial Intelligence:** "Real" AI versus Game AI, Pathfinding, State-Based Behaviors, Strategy and Planning	15

References:

1. "Game Programming Algorithms and Techniques", Sanjay Madhav, Addison-Wesley
2. Mathematics for Computer Graphics, John Vince, Springer-Verlag London, 5th Edition,2017

Additional References:

1. Mathematics for 3D Game Programming and Computer Graphic, Eric Lengyel, Delmar
2. Computer Graphics, C Version, Donald Hern and Pauline Baker, Pearson Education, 2nd Edition, 1997

MAJOR ELECTIVE- Practical of Game Programming

COURSE CODE: U25CS5ELP01 **COURSE CREDIT: 01**

1 credit - 30 lectures **1 lecture is 60 minutes**

Sr. No.	List of Practical
1	Setup DirectX 11, Window Framework and Initialize Direct3D Device.
2	Loading models into DirectX 11 and rendering
3	Learn Basic Game Designing Techniques with pygame
4	Develop Snake Game using pygame
5	Create 2D Target Shooting Game using pygame
6	Creating 2D Infinite Scrolling Background using pygame
7	Creating Camera Shake Effect in Unity
8	Design and Animate Game Character in Unity
9	Creating Snowfall Particle effect in Unity
10	Creating a movable character in Unity
11	Create Jump Mechanic in Unity
12	Implement Basic Collision & UI in Unity
13	Implement Simple Enemy AI in Unity

MAJOR ELECTIVE: Linux Server Administration

COURSE CODE: U25CS5EL02 **COURSE CREDIT: 03**

1 credit - 15 lectures **1 lecture is 60 min**

Course Objective:

- Develop a solid understanding of Linux server administration principles and concepts.
- Acquire practical skills in managing users, groups, and file systems in a Linux environment.
- Learn how to configure and secure network services such as DNS, FTP, Apache web server, SMTP, POP, IMAP and SSH.

Course Outcomes:

- Demonstrate proficiency in managing software packages and repositories in Linux.
- Configure and administer user accounts, groups, and permissions in a Linux system.
- Implement network services such as DNS, FTP, and web servers, ensuring proper security measures.
- Design and manage advanced network services including NFS, Samba, and LDAP for efficient file sharing and user authentication.

Unit	Syllabus	No. of lectures
01	Introduction: Technical Summary of Linux Distributions, Managing Software Single-Host Administration: Managing Users and Groups, Booting and shutting down processes. File Systems, Core System Services, Process of configuring, compiling, Linux Kernel Networking and Security: TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security	15
02	Internet Services: Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server, Simple Mail Transfer Protocol (SMPT), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP), Secure Shell (SSH), Network authentication system (Kerberos), Domain Name Service (DNS), Security	15
03	Network File System (NFS), Samba, Distributed File Systems (DFS), Network Information Service (NIS), Lightweight Directory Access Protocol (LDAP), Dynamic Host configuration Protocol (DHCP), MySQL, LAMP Applications, File Services, Email Services, Chat applications, Virtual Private Networking.	15

References:

1. Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016
2. Ubuntu Server Guide, Ubuntu Documentation Team, 2016
3. Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016

MAJOR ELECTIVE- Practical of Linux Server Administration

COURSE CODE: U25CS5ELP02 **COURSE CREDIT: 01**

~~1 credit - 30 lectures~~ ~~1 lecture is 60 minutes~~

Sr. No.	List of Practical
1	Install DHCP Server in Ubuntu 16.04
2	Initial settings: Add a User, Network Settings, Change to static IP address, Disable IPv6 if not needed, Configure Service, display the list of services which are running.
3	Stop and turn OFF auto-start setting for a service if you don't need it, Sudo Settings
4	Configure NP Server (NTPd), Install and configure NTPd, Configure NTP Client (Ubuntu)
5	Configure NP Server (NTPd), Install and configure NTPd, Configure NTP Client (Windows)
6	SSH Server : Password Authentication Configure SSH server to manage a server from the remote computer, SSH Client : (Ubuntu)
7	SSH Server : Password Authentication Configure SSH server to manage a server from the remote computer, SSH Client : (Windows)
8	Install DNS server BIND, Configure DNS server which resolves domain name or IP address, Install BIND 9, Configure BIND, Limit ranges You allow to access if needed
9	Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS server to share directories on your NFS, Configure NFS Client. (Ubuntu and Windows Client OS)
10	Configure LDDAP Server, Configure LDAP Server in order to share users' accounts in your local networks, Add LDAP User Accounts In the networks. Install phpLDAPadmin to operate LDAP server via Web browser.
11	Configure NIS Server in order to share users; accounts in your local networks, Configure NIS Client to bind NIS Server.
12	Install MySQL to configure database server, Install phpMyAdmin to operate MySQL on web browser from Clients.
13	Install Samba to share folders or files between Windows and Linux

VSC- MOBILE APPLICATION DEVELOPMENT

COURSE CODE: U26CS5VSC01 **COURSE CREDIT: 01**

1 credit - 15 lectures **1 lecture is 60 minutes**

COURSE OBJECTIVES

1) To provide the comprehensive insight into developing applications running on smart mobile devices and demonstrate programming skills for managing task on mobile.
2) To provide systematic approach for studying definition, methods and its applications for Mobile-App development.

COURSE OUTCOMES

1) Understand the requirements of Mobile programming.environment.
2) Learn about basic methods, tools and techniques for developing Apps
3) Explore and practice App development on Android Platform
4) Develop working prototypes of working systems for various uses in daily lives.

Unit No.	SYLLABUS	No of Lectures
I	**Basic Introduction** What is Android? - Obtaining the required tools, Programming Languages - Java and Kotlin basics- variables, Data types, simple programme. **Creating first android app**, understanding the components of screen, adapting display orientation, action bar, Activities and Intents, Activity **Lifecycle and Saving State**, Basic Views: TextView, Button, ImageButton, EditText, CheckBox, ToggleButton, RadioButton, and RadioGroup Views, ProgressBar View, AutoCompleteTextView, TimePicker View, DatePicker View, ListView View, Spinner View.	**15**

Textbooks:

1) "Beginning Android 4 Application Development", Wei-Meng Lee, March 2012, WROX.

Additional Reference(s):

2) https://developers.google.com/training/courses/android-fundamentals
https://www.gitbook.com/book/google-developer-training/android-developer-fundamentals- course-practicals/details

VSC- Practical of MOBILE APPLICATION DEVELOPMENT

COURSE CODE : U26CS5VSCP01 **COURSE CREDIT: 01**

1 credit - 15 lectures **1 lecture is 60 minutes**

S No	List Of Practicals
01	Install Android Studio and Run Hello World Program
02	Create an android app with Interactive User Interface using Layouts.
03	Create an android app that demonstrates working with TextView Elements.
04	Create an android app that demonstrates Activity Lifecycle and Instance State.
05	Create an android app that demonstrates the use of Radio Buttons, Checkboxes, Notification, and Date Pickers
06	Create an android app that demonstrates the use of an Options Menu
07	Create an android app that demonstrate Screen Navigation Using the App Bar and Tabs.
08	Create an android app that demonstrates the use of Keyboards, Alerts
09	Create an android app that demonstrates the use of Input Controls.
10	Create an android app to Connect to the Internet and use BroadcastReceiver.
11	Create an android app to show Notifications
12	Create an android app to Alarm manager.
13	Installing SQLITE app for database storage.

Field Work- Project Work

COURSE CODE: U26CS5FP01 **COURSE CREDIT: 02**

1 credit - 30 lectures

1 lecture - 60 minutes

Course Objectives:

- To enable students to practically apply interdisciplinary knowledge and software development life cycle (SDLC) methodologies in analyzing, designing, implementing, testing, and deploying solutions to real-world problems.
- To develop professional competencies such as teamwork, project management, ethical practices, technical documentation, and effective communication required to function efficiently in a global IT environment.

Course Outcomes:

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

- design and deliver a functioning, real-life application or solution by applying SDLC processes and integrating concepts from multiple domains of computer science and artificial intelligence.
- demonstrate the ability to work collaboratively, manage project timelines and resources, produce professional documentation, and present outcomes in alignment with industry standards and ethical practices.

Project Types:

a) Developing a solution for a real-life problem: In this case, the project focuses on addressing an existing requirement for a computer-based solution that has practical applications. The project should successfully implement the different stages of the system development life cycle. Examples: Secure Online Banking System, Machine Learning-based Disease Diagnosis System, Cloud-based Document Management System.

b) **Innovative Product Development:** These projects involve exploring and developing a computer-based solution with a unique and innovative utility. Examples: Cybersecurity Monitoring and Threat Detection System, Machine Learning-powered Predictive Maintenance System for Industrial Equipment, IoT-based Smart Energy Management System.

c) **Research-Level Project:** These projects involve conducting research and development to explore advanced technologies and solve complex problems. Examples: Deep Learning-based Image Recognition System for Medical Imaging, Cloud Computing Infrastructure Optimization for Big Data Processing, Data Science-driven Predictive Analytics for Sales Forecasting. The methodology and reporting of such projects may vary based on the project supervisor's guidance.

Tools & Technologies:

In the project work, students are granted complete freedom to select platforms, tools, and programming languages without any imposed restrictions. This approach encourages creativity, flexibility, and exploration of various technologies. By prioritizing open-source technologies, students can leverage a vast array of resources and community support. Commonly employed tools include IDEs, version control systems (e.g., Git), programming languages (e.g., Python, Java), databases (e.g., MySQL), and web frameworks (e.g., Django, Ruby on Rails). The evaluation process focuses on the project's content and implementation rather than the specific tools chosen, ensuring a fair assessment of the students' skills and problem-solving abilities.

Project Guide:

Assigning a project guide to each project or group is a mandatory requirement to ensure the successful completion of the project work. The guide plays a crucial role as a mentor and technical expert, providing invaluable support and guidance to students. They are expected to facilitate effective communication and teamwork, review project proposals, assign schedules, and monitor progress on a regular basis. Additionally, guides are expected to offer timely feedback, provide guidance on project planning and implementation strategies, evaluate the quality of work, and promote professionalism and ethical conduct. Their expertise and involvement are essential in helping students navigate challenges, make informed decisions, and achieve their project goals effectively.

Project Team Size: 1 – 2 members

Project Proposal: The project proposal is a mandatory document that serves as a foundation for the project. It helps students define their project idea, receive early evaluation and feedback, establish clear communication with the project guide, and take ownership of the project's successful execution. A formal proposal ensures systematic and professional project planning, fostering critical thinking, effective communication, and project management skills. The proposal provides a roadmap and increases the chances of a successful outcome. Before initiating a project, it is mandatory to submit a project proposal for approval. **The original duly approved project proposal should be attached to the final project report.** The project proposal for UG computer science projects should include the following contents:

- Title
- Introduction

- Objectives
- Scope
- Methodology
- Tools and Technologies
- Timeline
- Resources
- Expected Outcomes
- References

Project Report:

The Certified Copy of Hard Bound Project Report must adhere to the following guidelines:

- No of Copies: Team Size + 1 (College / Department Copy)
- The project report should include the following
    - Title Page *(Sample attached in Appendix)*
    - Certificate *(Sample attached in Appendix)*
    - Declaration *(Sample attached in Appendix)*
    - Acknowledgement
    - Table of Contents
    - Original Copy of approved Project Proposal
    - Self-attested copy of Plagiarism Report from any open source tool.
    - Chapters / Sections depending upon the type of project
    - List of Tables and/or List of Figures
    - References (IEEE / Springer format)
    - Glossary
    - Appendices (Survey datasheets / Questionnaires, ect)
- Use of LaTeX for documentation purposes should be preferred.
- The text of the report should be set in 12 pt, Times New Roman font, and single-spaced.
- Chapter headings should be centered, written in 20 pt, Times New Roman font, bold, and in all caps.
- These guidelines ensure a standardized format for the project report, promoting clarity and readability.

Evaluation:

The evaluation of the project will include a viva voce, which will assess the project based on the following parameters:

- **Documentation – 10 Marks:** The completeness, accuracy, and professionalism of the project documentation, including the project report and supporting materials, will be considered.
- **Quality of the Project – 10 Marks:** The overall quality of the project, including its design, implementation, and user experience, will be evaluated.
- Working of the Project – 20 Marks: The functionality and performance of the project will be assessed to determine how well it meets the specified requirements and objectives.
- **Project Presentation & Viva – 10 Marks:** The clarity, organization, and effectiveness of the project presentation will be evaluated. The viva voce session will provide an opportunity for the student to demonstrate their knowledge and understanding of the project, as well as to answer questions and engage in a discussion with the evaluators.

SAMPLE TITLE PAGE FORMAT

A PROJECT REPORT

on

<PROJECT NAME>

Submitted by

Mr. XYZ

in partial fulfillment for the award of the degree

of

BACHELOR OF SCIENCE

in

COMPUTER SCIENCE

under the guidance of

<Guide Name>

Department of Computer Science

<<College Logo>>

<<College Name>>

(Sem V / VI)

(202- – 202-)

SAMPLE CERTIFICATE FORMAT

<<College Logo>>

<<College Name>>,

<<College Address>>

Department of Computer Science

CERTIFICATE

This is to certify that Mr./Ms. _____ of **T.Y.B.Sc. (Sem V/VI)** class has satisfactorily completed the Project _____, to be submitted in the partial fulfillment for the award of **Bachelor of Science** in **Computer Science** during the academic year **202- – 202-**.

Date of Submission:

Project Guide	**Head / Incharge,** **Department Computer Science**
College Seal	**Signature of Examiner**

SAMPLE DECLARATION FORMAT

DECLARATION

I, _____, hereby declare that the project entitled "_____" submitted in the partial fulfilment for the award of **Bachelor of Science** in **Computer Science** during the academic year **202- – 202-** is my original work and the project has not formed the basis for the award of any degree, associateship, fellowship or any other similar titles.

Signature of the Student:

Place:

Date:

NEP Credit Structure for 2026 - 27

Semester	Major	Minor	Elective (Any One)	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum Cr/ Sem.
VI	Machine Learning **(3+1P Credits)** Wireless Sensor Networks **(3+1P Credits)** Remote Sensing (2 Credit)	Fuzzy Computational Logic **(4 credits)**	Information Retrieval (OR) IoT Technologies **(3+1P credits)**		—	On Job Training **(4 Credits)**	22
Total	**10**	**2**	**4**	**2**		**4**	**22**

Semester VI			
Serial No.	**Course Code**	**Credits**	**Course Name**
I	**Major Department Specific Course (DSC)**		
1	U25CS6MJ01	03	Machine Learning
2	U25CS6MJP01	01	Practical of Machine Learning
3	U25CS6MJ02	03	Wireless Sensor Networks
4	U25CS6MJP02	01	Practical of Wireless Sensor Networks
5	U25CS6MJ03	02	Remote Sensing
II	**Minor Department Specific Course**		
1	U26CS6MI01	03	Fuzzy Computational Logic
1	U26CS6MIP01	01	Practical of Fuzzy Computational Logic
III	**Electives (Any Two)**		
1	U25CS6EL01 U25CS6EL02	03	Information Retrieval OR IoT Technologies
2	U25CS6ELP01 U25CS6ELP02	01	Practical of Information Retrieval OR Practical of IoT Technologies
VI	**ON JOB TRAINING/ FIELD PROJECT/RESEARCH PROJECT/COMMUNITY EXTENSION PROGRAMME**		
1	U25CS6OJT01	04	On Job Training
TOTAL CREDITS		**22**	

MAJOR - MACHINE LEARNING

COURSE CODE: U25CS6MJ01 **COURSE CREDIT – 3 credit**

1 credit – 15 lectures **1 lecture is 60 minutes**

Course Objectives:

· Understand the foundations and scope of Machine learning, including its applications and comparison to related fields like Business Intelligence and Artificial Intelligence.
· Develop skills in data preprocessing, including cleaning, transforming, selecting, and merging data, to ensure data quality and suitability for analysis.
· Gain knowledge of machine learning algorithms and techniques, such as regression, classification, clustering, and ensemble learning, to build predictive models and make data-driven decisions.
· Learn how to evaluate and select models using appropriate evaluation metrics and cross-validation techniques to ensure reliable and robust model performance.
· Develop proficiency in data visualization techniques and tools to effectively communicate insights and tell compelling stories using data.

Course Outcomes:

After successful completion of this course, students would be able to
· Apply data preprocessing techniques to clean and transform raw data, handle missing values and outliers, and merge datasets.
· Implement machine-learning algorithms to perform tasks such as regression, classification, clustering, and ensemble learning.
· Evaluate and compare different machine learning models using appropriate evaluation metrics and cross-validation techniques.
· Create informative and visually appealing data visualizations to communicate insights and patterns in data.
· Understand the principles and practices of data management, including data governance, data quality assurance, and data privacy considerations.

Unit	Topics	No of Lectures
I	**Introduction to Machine Learning:** What is Machine Learning? Definition and importance of Machine Learning, Challenges of Machine Learning **Data Preprocessing:** **Data cleaning:** handling missing values, outliers, duplicates, **Data transformation:** scaling, normalization, encoding categorical variables, **Feature selection:** selecting relevant features/columns, Data merging: combining multiple datasets, **Data Mining (DM):** Data Lakes.	15

II	**Supervised Learning:** **Supervised Learning:** Classification and Regression, Support Vector Machines (SVM), Decision tree, **Ensemble Learning:** Boosting and Bagging, K-Nearest Neighbors (K-NN), Gradient Descent, Bias/Variance Tradeoff, underfitting and overfitting. **Artificial Neural Networks (ANN):** Architecture of ANN, Merits and Demerits of ANN.	**15**
III	**Unsupervised Learning:** Introduction to unsupervised learning, **Clustering:** K-means, Principal Component Analysis (PCA),Hierarchical Clustering, Association rule mining (Apriori algorithm), **Model Evaluation Metrics:** Accuracy, precision, recall, F1-score, Area Under the Curve (AUC), Evaluating models for imbalanced datasets.	**15**

Textbook(s):

1. Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly, First Edition.
2. Introduction to Machine Learning with Python - A Guide for Data Scientists by Andreas C. Muller & Sarah Guide O'reilly 20

Additional Reference(s):

1. Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015
2. Hands-On Programming with R, Garrett Grolemund,1st Edition, 2014
3. Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013

MAJOR – Practical of Machine Learning

COURSE CODE: U25CS6MJP01 **COURSE CREDIT – 1**
1 credit – 15 lectures **1 lecture is 60 minutes**

Course Code	Course Title	Credits	Lectures/Week
	Data Science Practical	1	2

List of Practicals	
1	Data Frames and Basic Data Pre-processing · Read data from CSV and JSON files into a data frame. · Perform basic data pre-processing tasks such as handling missing values and outliers.
2	· Manipulate and transform data using functions like filtering, sorting, and grouping.
3	· IIlustrate various Machine Learning Libraries
4	Feature Scaling and Dummification · Apply feature-scaling techniques like standardization and normalization to numerical features. · Perform feature dummification to convert categorical variables into numerical representations.
5	Hypothesis Testing · Formulate null and alternative hypotheses for a given problem. · Conduct a hypothesis test using appropriate statistical tests (e.g., t-test, chisquare test). . Interpret the results and draw conclusions based on the test outcomes.
6	ANOVA (Analysis of Variance) · Perform one-way ANOVA to compare means across multiple groups. · Conduct post-hoc tests to identify significant differences between group means.
7	Regression and Its Types · Implement simple linear regression using a dataset. · Explore and interpret the regression model coefficients and goodness-of-fit measures. · Extend the analysis to multiple linear regression and assess the impact of additional predictors.

8	Logistic Regression · Build a logistic regression model to predict a binary outcome. · Evaluate the model's performance using classification metrics (e.g., accuracy, precision, recall).
9	Decision Tree · Construct a decision tree model and interpret the decision rules for classification.
10	K-Means Clustering · Apply the K-Means algorithm to group similar data points into clusters. · Determine the optimal number of clusters using elbow method or silhouette analysis. · Visualize the clustering results and analyze the cluster characteristics.
11	Principal Component Analysis (PCA) · Perform PCA on a dataset to reduce dimensionality. · Evaluate the explained variance and select the appropriate number of principal components. · Visualize the data in the reduced-dimensional space.
12	Data Visualization Illustrate various Data Visualization Techniques.
13	Data Visualization and Storytelling · Create meaningful visualizations using data visualization tools · Combine multiple visualizations to tell a compelling data story. · Present the findings and insights in a clear and concise manner.

MAJOR- Wireless Sensor Networks

COURSE CODE: U25CS6MJ02 **COURSE CREDIT:03**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objectives:

- Provide students with a comprehensive understanding of Wireless Sensor Networks (WSNs), including their, advantages, and challenges.
- Familiarize students with basic network architecture, physical layer
- Introduce students to the key technologies and protocols used in WSNs, such as medium access control (MAC) protocols, link layer protocols

Course Outcomes:

- Understand the fundamental concepts of Wireless Sensor Networks (WSNs) and apply this knowledge to analyze and design WSN solutions.
- Demonstrate knowledge of wireless sensor network architecture, physical layer
- Evaluate medium access control protocols and link layer in WSNs, and make informed decisions to ensure efficient and reliable communication.

Unit	Syllabus	No. of lectures
1.	**Introduction:** The vision of Ambient Intelligence, Application examples, Types of applications, Challenges for WSNs - Characteristic requirements, Required mechanisms, Why are sensor networks different? - Mobile ad hoc networks and wireless sensor networks, Fieldbuses and wireless sensor networks, Enabling technologies for wireless sensor networks **Single-node architecture:** Hardware components - Sensor node hardware overview, Controller, Memory, Communication device, Sensors and actuators, Power supply of sensor nodes, Energy consumption of sensor nodes - Operation states with different power consumption, Microcontroller energy consumption, Memory, Radio transceivers, Relationship between computation and communication, Power consumption of sensor and actuators	15
2.	**Network architecture:** Sensor network scenarios - Types of sources and sinks, Single-hop versus multihop networks, Multiple sinks and sources, Three types of mobility, Optimization goals and figures of merit - Quality of service, Energy efficiency, Scalability, Robustness, Design principles for WSNs - Distributed organization, In-network processing, Adaptive fidelity and accuracy, Data centricity, Exploit location information, Exploit activity patterns, Exploit heterogeneity, Component-based protocol stacks and cross-layer optimization **Physical layer:** Physical layer and transceiver design considerations in WSNs - Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations	15
3.	**MAC protocols:** Fundamentals of (wireless) MAC protocols - Requirements and design constraints for wireless MAC protocols, Important classes of	15

	MAC protocols, MAC protocols for wireless sensor networks, S-MAC **Link-layer protocols:** Fundamentals: tasks and requirements, Error control - Causes and characteristics of transmission errors, ARQ techniques, FEC techniques, Hybrid schemes, Power control, Further mechanisms to combat errors	

References:

1. Wireless Sensor Networks Technology, Protocols, and Applications ,Kazem Sohraby, Daniel Minoli and TaiebZnati, John Wiley & Sons, 2017

2. Protocols and Architectures for Wireless Sensor Network, Holger Kerl, Andreas Willig, John Wiley and Sons, 2015

Additional References:

1. Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011
2. Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

MAJOR- Practical of Wireless Sensor Networks

COURSE CODE: U25CS6MJP02 **COURSE CREDIT: 01**

1 credit - 30 lectures **1 lecture is 60 minutes**

Sr. No.	List of Practical
1	Understanding the Sensor Node Hardware : Sensors, Nodes, Base Station, Graphical User Interface
2	Exploring and understanding Operating systems and execution environments in WSN: *TinyOS and nesC*
3	Study of Some sensor nodes: The "Mica Mote" family, EYES nodes, BTnodes, Scatterweb
4	Create and simulate a simple adhoc network
5	Create a basic MANET implementation simulation for Packet animation and Packet Trace
6	Implement a Wireless sensor network simulation.
7	Simulate single-hop networks
8	Simulate multi-hop networks
9	Compare different modulation techniques for energy efficiency
10	Create MAC protocol simulation implementation for wireless sensor Network.
11	Simulate and evaluate ARQ (Automatic Repeat reQuest).
12	Simulate and evaluate FEC (Forward Error Correction).
13	Implement S-MAC in a simulated WSN

MAJOR- Remote Sensing

COURSE CODE: U25CS6MJ03 **COURSE CREDIT: 02**

1 credit - 15 lectures **1 lecture - 60 minutes**

Course Objectives:

- To provide a comprehensive understanding of the principles and applications of remote sensing.
- To introduce the fundamental concepts of Geographic Information Systems (GIS)

Course Outcomes:

- Understand basic of remote sensing
- Learn techniques used in GIS applications

Sr. No	Syllabus	No. of lectures
01	**Overview of Remote sensing**: Definition of Remote sensing Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction of EM Radiation with atmosphere, and target, Atmospheric Widows, imaging spectrometry, Spectral signature of various land cove features **Platform and Sensors**: Platforms: Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana) **Sensors**: Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors, GPS- Coordinate and time systems, Satellite orbital motions, GPS observables, Estimation procedures	15
02	**GIS:** Introduction to GIS, Understand the difference between GIS and information system in general, GIS components and function of GIS: hardware software requirement of GIS, data types and spatial data models, idea of conceptual, logical and physical models, RDBMS, data base normalization Representation of real world via vector and raster representation model. Applications in land use and land cover analyses, Raster data structure, Vector data structures for geographical entities. GIS Operation Layers and Operations.	15

Text Book(s):

3. Applied Remote Sensing, C.P. Lo, Longman, Scientific and Technical Publishers
4. Remote Sensing in hydrology, Engman, E.T. Gurney, R.J.

Additional Reference(s):

1. Remote Sensing in water management in command areas, Govardhan, V.
2. Satellite oceanography, An introduction for oceanographers and Remote Sensing Scientists, I.R. Robinson, Ellis Horwood series marine sciences.

MINOR- Fuzzy Computational Logic

COURSE CODE: U26CS6MI01 **COURSE CREDIT: 03**

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

- To understand basic concepts of modeling in systems using fuzzy sets
- To understand fuzzy sets and operations
- To understand role of fuzzy systems in applications of semantic interpreters, control systems and reasoning systems.

Course Outcomes:

- Understand basic knowledge of the fuzzy sets.
- Understand basic knowledge of the fuzzy operations.
- Understand the fundamental concepts of Fuzzy logic

Unit	Syllabus	No. of lectures
1.	**From Classical (Crisp) Sets to Fuzzy Set**: Introduction, Crisp Sets: An Overview, Fuzzy Sets: Basic Types, Fuzzy Sets: Basic Concepts, Characteristics and Significance of the Paradigm Shift **Fuzzy Sets Versus Crisp Sets**: Additional Properties of a-Cuts Representations of Fuzzy Sets Extension Principle for Fuzzy Sets	15
2.	**Operations On Fuzzy Sets**: Types of Operations, Fuzzy Complements, Fuzzy Intersections: t-Norms, Fuzzy Unions: t-Conorms, Combinations of Operations, Aggregation Operations **Fuzzy Arithmetic**: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations	15
3.	**Possibility Theory**: Fuzzy Measures, Evidence Theory, Possibility Theory, Fuzzy Sets and Possibility Theory, Possibility Theory versus Probability Theory **Fuzzy Logic**: Classical Logic: An Overview, Multivalued Logics, Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges, Inference from Conditional Fuzzy Propositions, Inference from Conditional and Qualified Propositions, Inference from Quantified Propositions	15

References:

1. George J.Klir and Bu Yuan, Fuzzy sets and Fuzzy logic Theory and applications , Prentice Hall of India, New Delhi.
2. Didier Bubois and Henri Prade , "Fuzzy sets and systems" , Academic Press

Additional References:

1. James Buckley, Esfandiar Eslami, "An Introduction to Fuzzy logic and Fuzzy sets" (Springer)
2. H.J.Zimmernman , "Fuzzy set theory and application" (Allied Publication in Association with KLUWER)

Minor- Practical of Fuzzy Computational Logic

COURSE CODE : U26CS6MIP01 **COURSE CREDIT: 01**

1 credit - 30 lectures

1 lecture is 60 minutes

Sr. No.	List of Practical
1	Compare crisp and fuzzy sets
2	Implement different types of membership functions (triangular, trapezoidal, Gaussian) and visualize them
3	Implement fuzzy set operations using t-norms and t-conorms
4	Apply extension principle for function transformations on fuzzy sets.
5	Compute α-cuts of fuzzy sets and measure distance between fuzzy sets.
6	Implement fuzzy relations and their composition using max-min composition
7	Fuzzy Number Arithmetic (Addition, Multiplication, Division)
8	Implement fuzzy arithmetic using interval arithmetic.
9	Implement and compare different defuzzification techniques.
10	Solve fuzzy equations using different methods.
11	Solve fuzzy inequalities and find max/min of fuzzy functions.
12	Solve fuzzy linear equations using fuzzy matrix operations.
13	Implement aggregation operations to combine fuzzy sets.

MAJOR ELECTIVE- Information Retrieval

COURSE CODE: U25CS6EL01 **COURSE CREDIT: 03**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objectives:

- To understand the fundamental principles and components of information retrieval systems.
- To explore various techniques for document indexing, storage, and retrieval.
- To analyze and compare different retrieval models and understand their strengths and limitations.
- To gain practical experience in implementing and evaluating information retrieval systems.
- To explore advanced topics in information retrieval, such as web information retrieval and machine learning techniques.

Course Outcomes:

After successful completion of this course, students would be able to

· Explain the key components and principles of information retrieval systems.
· Apply indexing, storage, and retrieval techniques to efficiently retrieve relevant documents.
· Compare and contrast different retrieval models and select appropriate models for specific search scenarios.
· Develop practical skills in implementing and evaluating information retrieval systems.
· Demonstrate an understanding of advanced topics in information retrieval, including web search and machine learning techniques.

Sr. No	Syllabus	No. of lectures
01	Introduction to Information Retrieval (IR) systems: Definition and goals of information retrieval, Components of an IR system, Challenges and applications of IR Document Indexing, Storage, and Compression: Inverted index construction and compression techniques, Document representation and term weighting, Storage and retrieval of indexed documents, Retrieval Models: Boolean model: Boolean operators, query processing, Vector space model: TF-IDF, cosine similarity, query-document matching, Probabilistic model: Bayesian retrieval, relevance feedback Spelling Correction in IR Systems: Challenges of spelling errors in queries and documents, Edit distance and string similarity measures, Techniques for spelling correction. Performance Evaluation: Evaluation metrics: precision, recall, F-measure, average precision, Test collections and relevance judgments, Experimental design and significance testing.	15

02	Text Categorization and Filtering: Text classification algorithms: Naive Bayes, Support Vector Machines, Feature selection and dimensionality reduction, Applications of text categorization and filtering Text Clustering for Information Retrieval: Clustering techniques: Kmeans, hierarchical clustering, Evaluation of clustering results, Clustering for query expansion and result grouping Image Information Retrieval: What is image retrieval? Applications of image retrieval (e.g., medical imaging, e-commerce, forensics, multimedia search), Challenges in image retrieval (e.g., semantic gap, variations in lighting, viewpoint), Different types of image retrieval systems: CBIR, TBIR, Semantic-based image retrieval (SBIR). Web Information Retrieval: Web search architecture and challenges, Crawling and indexing web pages, Link analysis and PageRank algorithm Learning to Rank: Algorithms and Techniques, Supervised learning for ranking: RankSVM, RankBoost, Pairwise and listwise learning to rank approaches Evaluation metrics for learning to rank	15
03	Link Analysis and its Role in IR Systems: Web graph representation and link analysis algorithms, HITS and PageRank algorithms, Applications of link analysis in IR systems Crawling and Near-Duplicate Page Detection: Web page crawling techniques: breadth-first, depth-first, focused crawling, Near-duplicate page detection algorithms, Handling dynamic web content during crawling Advanced Topics in IR: Text Summarization: extractive and abstractive methods, Question Answering: approaches for finding precise answers, Recommender Systems: collaborative filtering, content-based filtering Cross-Lingual and Multilingual Retrieval: Challenges and techniques for cross-lingual retrieval, Machine translation for IR, Multilingual document representations and query translation, Evaluation Techniques for IR Systems User-based evaluation: user studies, surveys, Test collections and benchmarking, Online evaluation methods: A/B testing, interleaving experiments	15

References:

Textbooks:

1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, —Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books
2. C. Manning, P. Raghavan, and H. Schütze, —Introduction to Information Retrieval, Cambridge University Press

Additional References:

1. Ricci, F, Rokach, L. Shapira, B. Kantor, —Recommender Systems Handbookl, First Edition.
2. Bruce Croft, Donald Metzler, and Trevor Strohman, Search Engines: Information Retrieval in Practice, Pearson Education.
3. Stefan Buttcher, Charlie Clarke, Gordon Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press.

MAJOR ELECTIVE- Practical of Information Retrieval

COURSE CODE: U25CS6ELP01 **COURSE CREDIT: 01**

1 credit - 2 lectures **1 lecture is 60 minutes**

SNo.	List of Practicals
1	Document Indexing and Retrieval · Implement an inverted index construction algorithm. · Build a simple document retrieval system using the constructed index.
2	Retrieval Models · Implement the Boolean retrieval model and process queries. · Implement the vector space model with TF-IDF weighting and cosine similarity.
3	Spelling Correction in IR Systems · Develop a spelling correction module using edit distance algorithms. · Integrate the spelling correction module into an information retrieval system.
4	Evaluation Metrics for IR Systems · Calculate precision, recall, and F-measure for a given set of retrieval results. · Use an evaluation toolkit to measure average precision and other evaluation metrics.
5	Text Categorization · Implement a text classification algorithm (e.g., Naive Bayes or Support Vector Machines). · Train the classifier on a labelled dataset and evaluate its performance.
6	Clustering for Information Retrieval · Implement a clustering algorithm (e.g., K-means or hierarchical clustering). · Apply the clustering algorithm to a set of documents and evaluate the clustering results.
7	Web Crawling and Indexing · Develop a web crawler to fetch and index web pages. · Handle challenges such as robots.txt, dynamic content, and crawling delays.
8	Link Analysis and PageRank · Implement the PageRank algorithm to rank web pages based on link analysis.
9	Apply the PageRank algorithm to a small web graph and analyze the results.
10	Learning to Rank · Implement a learning to rank algorithm (e.g., RankSVM or RankBoost).
11	Train the ranking model using labelled data and evaluate its effectiveness.
12	Advanced Topics in Information Retrieval · Implement a text summarization algorithm (e.g., extractive or abstractive).
13	· Build a question-answering system using techniques such as information extraction.

MAJOR ELECTIVE- IoT Technologies

COURSE CODE : U25CS6EL02 **COURSE CREDIT: 03**

1 Credit – 15 Lectures **1 Lecture is 60 minutes**

Course Objectives:

- Introduce concepts of SoC and IoT
- Introduce various types of IoT platforms
- Interfacing various types of devices using different protocols with IoT
- Understand practical applications of IoT in real life world

Course Outcomes:

After successful completion of this course, students would be able to

- understand SoC and IoT
- Use different types of IoT Platforms and interfaces
- Understand and implement an idea of various types of applications built using IoT

Unit	Syllabus	No. of Lectures
1	**Fundamentals of IoT:** Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M. **System on Chip:** What is System on chip? Structure of System on Chip. SoC Elements: FPGA, GPU, APU, Compute Units. **Different types of IoT/SoC Platforms:** Introduction to Raspberry Pi, Arduino & NodeMCU, Introduction to SoC-ARM Architecture, atmega328 architecture	15
2	**Interfacing with IoT Platforms:** Basic hardware components like LED, Button, Camera, 8X8 LED Grid, Motor etc and interfacing them for input/output with IoT devices using PWM, UART, GPIO, I2C, SPI **Using Sensor & Actuators**: Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor, Level Sensors, Ultrasonic sensors, Interfacing of Actuators, Interfacing of Relay Switch and Servo Motor.**IoT and Protocols IoT Security:** HTTP, UPnP, CoAP, MQTT, XMPP, Privacy and Security Issues in IoT.	15
3	**IoT & Web:** Web server for IoT, Sending/Receiving data between web server & IoT device, Cloud for IoT, Node RED, M2M vs IoT Communication Protocols, Basics of WSNs, WSN architecture and types. **IoT Applications:** Modern IoT case studies / applications used in the areas of transportation, agriculture, health care etc **Edge Computing:** Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M.	15

Textbooks:

1. Introduction to IoT Paperback by Sudip Misra , Anandarup Mukherjee , Arijit Roy , Cambridge Press, 2022

2. Jain, Prof. Satish, Singh, Shashi, "Internet of Things and its Applications", 1st Edition, BPB, 2020.
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley, India, 2019
4. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020

Additional References:

1. Internet of Things by Vinayak Shinde, SYBGEN Learning India Pvt. Ltd, 2020
2. Internet of things, Dr. Kamlesh Lakhwani, Dr. Hemant kumar Gianey, Josef Kofi Wireko, Kamalkant Hiran, BPB Publication, 2020
3. Arduino, Raspberry Pi, NodeMCU Simple projects in easy way by Anbazhagan k and Ambika Parameswari k, 2019.
4. IoT based Projects: Realization with Raspberry Pi, NodeMCU Paperback – February 2020, by Rajesh Singh Anita Gehlot, 2020
5. Mastering the Raspberry Pi, Warren Gay, Apress, 2014

MAJOR ELECTIVE- Practical of IoT Technologies

COURSE CODE : U25CS6ELP02 **COURSE CREDIT: 01**
1 Credit – 30 Lectures **1 Lecture is 60 minutes**
All practical can be implemented using any free and open-source simulators.

Sr. No	List of Practical
1	Preparing Raspberry Pi: Hardware preparation and Installation
2	Interfacing the RGB LED with the Arduino
3	Demonstrate Arduino Uno and its pins interfacing with IDE.
4	GPIO: Light the LED with Python with/without a button using either Uno/Raspberry Pi.
5	GPIO: LED Grid Module: Program the 8X8 Grid with Different Formulas
6	Stepper Motor Control: PWM to manage stepper motor speed using Uno/Raspberry Pi
7	Node RED: Connect LED to Internet of Things
8	Detection of the light using photo resistor
9	Interfacing of the Active Buzzer with Arduino.
10	Practical 8 Interfacing of the Relay with Arduino.
11	Interfacing of temperature sensor LM35 with Arduino
12	Trigger a set of led GPIO on any IoT platform via any related web server
13	Interface with any sensor and send its value over the internet to the server using any suitable protocol

Programme Name: BSC COMPUTER SCIENCE UG Programs (Semester VI)	Credit ---04 Marks---100 Course name-- On Job Training Course Code – U25CS6OJT01

Introduction:

- On Job training (OJT) is an important component of the UG program that provides students with a unique opportunity to bridge the gap between theoretical knowledge gained in the classroom and practical application in a real-world environment. This training aims to equip students with both technical and non-technical skills that are essential for success in the industry.
- On Job training (OJT) aims to equip students with both technical and non-technical skills that are essential for success in the industry.
- By participating in OJT, students are able to apply the concepts and theories learned during their coursework to real-world scenarios. They gain hands-on experience, problem-solving skills, and a deeper understanding of how the industry operates.
- From an organizational perspective, hosting OJT programs allows companies to gain insights into the curriculum and content of UG Program. They can provide valuable feedback on the relevance of the coursework and industry requirements, enabling academic institutions to continually improve the program's alignment with industry needs. This collaboration between academia and industry fosters a mutually beneficial relationship, ensuring that graduates are well-prepared for the job market.

Enhancing practical Skills through OJT:

- The On the Job Training (OJT) program spans 4-6 weeks, requiring a minimum of 80-100 hours of physical presence at the organization.
- Students are expected to find their own OJT placements, although the institution provides support and guidance in securing positions with reputable organizations.
- OJT must be conducted outside the home institution to expose students to real-world work environments.
- OJT covers any subject within the syllabus, allowing students to align their experience with their academic interests.

- OJT bridges the gap between theoretical knowledge and practical application, preparing students for successful careers in Information technology and computer science.

Interning organization: Students have the flexibility to pursue their OJT in various types of organizations, including but not limited to:

- Software Development Firms: Gain practical experience in software development and programming.
- Hardware/Manufacturing Firms: Learn about hardware design, manufacturing processes, and quality assurance.
- Civic Departments: Engage with local civic departments such as ward offices, post offices, police stations, or panchayats to understand their functioning and contribute to their activities.
- Research Centre's/University Departments/Colleges: Contribute as research assistants or in similar roles for research projects or initiatives, fostering collaboration between academia and industry.

OJT mentors: To enhance the learning experience and ensure the quality of the MSc program, each student participating in the OJT will be assigned two mentors: a faculty mentor from the institution and an industry mentor from the organization where the student is interning.

Industry Mentor Role: The industry mentor plays a crucial role in guiding the student during the internship. They ensure that the internee fulfills the requirements of the organization and successfully meets the demands of the assigned project. Through their expertise and experience, industry mentors provide valuable insights into real-world practices and industry expectations.

Faculty Mentor Role: The faculty mentor serves as the overall coordinator of the OJT program. They oversee the entire internship process and evaluate the quality of the OJT in a consistent manner across all students. The faculty mentor ensures that the OJT aligns with the program's objectives and provides valuable learning opportunities. They also facilitate communication between the institution, industry mentor, and student to ensure a fruitful OJT experience. By having both an industry mentor and a faculty mentor, students benefit from a comprehensive guidance system that combines industry expertise and academic support

Submission of documentation for OJT

The student will make two documents as part of the OJT

1. Online diary: This ensures that the student updates daily activity, which could be accessed by both the mentors. Daily entry can be of 3-4 sentences giving a very brief account of the learning/activities/interaction taken place.
2. OJT report: A student is expected to make a report based on the OJT he or she has done in an organization. It should contain the following:

It should contain the following:

1. Certificate: A certificate from the organization where the OJT was done.
2. Title: A suitable title giving the idea about what work the student has performed during the OJT.
3. Description of the organization: A small description of the organization where the student has interned
4. Description of the activities done by the section where the intern has worked: A description of the section or cell of the organization where the intern worked. This should give an idea about the type of activity a new employee is expected to do in that section of the organization.
5. Description of work allotted and done by the intern: A detailed description of the work allotted, and actual work performed by the intern during the OJT period. It shall be the condensed and structured version of the daily report mentioned in the online diary.
6. Self-assessment: A self-assessment by the intern on what he or she has learned during the OJT period. It shall contain both technical as well as interpersonal skills learned in the process.

Interaction between mentors: To ensure the smooth conduct of the OJT a meet-up involving the intern, industry mentor, and the faculty mentor will be scheduled as a mid-term review. The meeting can preferably be online to save time and resources. The meeting ensures the synergy between all stakeholders of the OJT. A typical meeting can be of around 15 minutes where at the initial stage the intern brief about the work and interaction goes for about 10 minutes. This can be followed by the interaction of the mentors in the absence of the intern. This ensures that issues between the intern and the organization, if any, are resolved amicably.

OJT workload for the faculty: Every student is provided with a faculty member as a mentor. So, a faculty mentor will have a few students under him/her. A faculty mentor is the overall in charge of the OJT of the student. He/she constantly monitors the progress of the OJT by regularly overseeing the diary, interacting with the industry mentor, and guiding on the report writing etc. Considering the time and effort involved, a faculty mentor who is in-charge of 20 students shall be provided by a workload of 3 hours.

Appendix-I

Maintain the weekly online diary for each week in the following format.

	Day	Date	Name of the Topic/Module Completed	Remarks
1st WEEK	MONDAY			
	TUESDAY			
	WEDNESDAY			
	THRUSDAY			
	FRIDAY			
	SATURDAY			

Signature of the Faculty mentor: _____

Seal of the University/College

Appendix-II

(Proforma for the certificate for internship in official letter head)

This is to certify that Mr./Ms. ___ of _____ College/Institution worked as an intern as part of his/her BSc Course in Computer Science of the University of Mumbai. The particulars of internship are given below:

Internship Starting date:_____

Internship ending date:_____

Actual number of days worked:_____

Tentative number of hours worked:_____ Hours

Broad area of work:_____

A small description of work done by the intern during the period:_____

Signature:_____

Appendix-III

(Proforma for the Evaluation of the intern by the industry mentor /to whom the intern was reporting in the organization)

Professional Evaluation of intern

Name of intern: _____

College/Institution: _____

[Note: Give a score in the 1 to 5 scale by putting √ in the respective cells]

No	Particular	Excellent	Very Good	Good	Moderate	Satisfactory
1	Attendance & Punctuality					
2	Ability to work in a team					
3	Written and oral communication skills					
4	Problem solving skills					
5	Ability to grasp new concepts					
6	Technical skill in terms of technology, programming etc					
7	Ability to complete the task					
8	Quality of overall work done					

Comments:

_____

Signature: _____

Name :

_____

Designation:

Contact details:

Email :

Evaluation

1. Presentation of the project
2. Black Book evaluation

SCHEME OF EXAMINATION

I. FOR MAJOR PAPERS WITH 4 CREDITS

The scheme of examination shall be divided into two parts:

- Internal assessment 40% i.e. 40 marks
- **Semester end examination 60% i.e. 60 marks**

(A) Internal Assessment 40 marks

Description	Marks
Internal Test of 20 Marks (Online/Offline) Q.1 Multiple choice Questions - 20 Marks	20
Presentation / Case studies / Poster Making / Quiz / Role Play / Subject Specific Activities	15
Attendance and Class Behavior	05
Total	40

(B) Semester end examination 60 marks

PAPER PATTERN

Duration : 2 hours			
Total Marks: 60			
All questions are compulsory			
Question	Based on	Options	Marks
1	Unit 1	A & B OR P & Q	15
2	Unit 2	A & B OR P & Q	15
3	Unit 3	A & B OR P & Q	15
4	Unit 1,2,3	A & B OR P & Q	15
Total			60

Note:
1. Q.1, 2, 3 and 4 - 15 marks questions may be divided into sub questions if required.

Passing criteria: Minimum 40% in Internal (16 out of 40) and 40% (24 out of 60) in semester end examination.

SCHEME OF PRACTICAL EXAMINATION
I. FOR MAJOR PAPERS WITH 4 CREDITS

The scheme of examination shall be

- Practical assessment carries 50 Marks : 40 marks + 05 marks (journal)+ 05 marks(viva)
- Minimum 75 % practical are required to be completed and written in the journal.

(Certified Journal is compulsory for appearing at the time of Practical Exam)

(A) Practical Assessment 50 marks

Description	Marks
Q.1. Two questions of practical's (20 + 20 OR 30+10)	40
Journal	05
Viva	05
Total	50

Passing criteria: Minimum 40% i.e. 20 out of 50 Marks

II. MAJOR/MINOR - (2 credit)

The scheme of examination shall be divided into two parts:

- Practical assessment 40% i.e. 20 marks
- Semester end examination 60% i.e. 30 marks

Practical Assessment 20 marks

Description	Marks
One question of 10 marks practical	10
Journal	5
Viva	5
Total	20

Semester end examination 30 marks PAPER PATTERN

Duration: 1 hours	
Total Marks: 30	
Description	**Marks**
Q.1 10 marks OR 10 marks	10
Q.2 10 marks OR 10 marks	10
Q.3 10 marks OR 10 marks	10

Note:
1. Q.1, 2, 3 may be divided into sub questions if required.
2. Q.3 May include theory (short notes) /Case Study in one of the options.

Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in semester end examination.

III FOR MAJOR PAPERS WITH 2 CREDITS

The scheme of examination shall be divided into two parts:

- Internal assessment 40% i.e. 20 marks
- Semester end examination 60% i.e. 30 marks

(A) Internal Assessment 20 marks

	Description	Marks
Internal Test	One Internal test (Online/Offline) Q.1 Multiple choice Questions	10
Assignment	Assignment relevant to course followed by presentation	10
	Total	20

(B) Semester end examination 30 marks PAPER PATTERN

Duration : 1 hours	
Total Marks: 30	
Q.1 10 marks OR 10 marks	10
Q.2 10 marks OR 10 marks	10
Q.3 10 marks OR 10 marks	10
Total	30
Note: 1. Q.1, 2, 3 - 10 marks questions may be divided into sub questions if required.	

Passing criteria: Minimum 40% in Internal (8 out of 20) and 40% (12 out of 30) in semester end examination

IV VOCATIONAL COURSE (VSC)

The scheme of examination shall be divided into two parts:

- Practical assessment 40% i.e. 20 marks
- Semester end examination 60% 30 marks

Practical Assessment 20 marks

Description	Marks
One question of 10 marks practical	10
Journal	5
Viva	5
Total	20

B) **Semester end examination 30 marks PAPER PATTERN**

Description	Marks
Q.1 10 marks OR 10 marks	10
Q.2 10 marks OR 10 marks	10
Q.3 10 marks OR 10 marks	10
Total	30
Note:Q.1, 2, 3 may be divided into sub questions if required. Q.3 May include theory (short notes) /Case Study in one of the options.Passing criteria: Minimum 40% in Internal (8 out of 20) and 40% (12 out of 30) in semester end examination	

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