Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Major paper- I)

Name of the paper: Wireless Networking

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Program Structure

Semester-III

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
GNKPSCSMJ1503	(Major) Paper-I Wireless Networking	60	60	4	2	6
GNKPSCSMJ2503	(Major) Paper-II Cyber Security and Risk Assessment	60	60	4	2	6
GNKPSCSEL1503	(Elective) Papers 1- Web3 Technologies	45	30	3	1	4
GNKPSCSEL2503	2- Fuzzy Systems					
GNKPSCSEL3503	3- Bioinformatics					
GNKPSCSRP503	Research paper writing + Research Project Proposal	--	--	--	--	4
Total		**165**	**150**	**11**	**05**	**20**

Semester-IV

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
GNKPSCSMJ1504	(Major) Paper-I Robotics	60	60	4	2	6
GNKPSCSMJ2504	(Major) Paper-II Deep Learning	60	60	4	2	6
GNKPSCSEL1504	(Elective) Papers 1- Trends in Cloud Computing	45	30	3	1	4

GNKPSCSEL2504	2- Simulation and Modeling					
GNKPSCSEL3504	3- GIS and Remote sensing					
GNKPSCSRP504	Research project Implementation	--	--	--	--	4
Total		**165**	**150**	**11**	**05**	**20**

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-III Paper-I
Course Title: Wireless Networking
Course Code:GNKPSCSMJ1503
Credits: 4

No of lectures (Hours): 60
Marks: 100 (75:25)
Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Gain a comprehensive understanding of fundamental concepts in wireless networking.
2	Explore the principles and functionalities of 4G and 5G technologies, including their operational mechanisms.
3	Acquire practical skills in implementing wireless architectures through hands-on activities and projects.
4	Develop a thorough knowledge of sensors and their operational principles, enabling practical application in various contexts.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Learners will comprehend advanced concepts in wireless technologies and stay abreast of recent trends in the field.	**PO1, PO2, PO3, PO8**	**PSO1,**	**R, U, An**
CO 2	Learners will demonstrate proficiency in practically implementing the wireless architecture.	**PO2, PO4, PO**	**PSO1**	**U, An, E, C**
CO 3	Learners will attain foundational knowledge aligned with industry standards.	**PO6, PO7**	**PS O1, PS O6**	**U, An, E**
CO 4	Learners will gain insight into wireless optical communication technologies.	**PO3, PO4, PO5, PO7**	**PS O1, PS O6**	**U, E, C**

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		**Basic Principles of Wireless Networking**	**15**	
	1.1	Introduction to Wireless Sensor Networks: Terminologies, Advantages, Challenges and Applications, Types of Wireless Sensor Networks.		**CO1** **CO3**
	1.2	Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks.		**CO2** **CO4**
	1.3	Wireless Communication Technologies: Mobile Ad-hoc Networks (MANETs).		**CO1** **CO4**
Unit 2		**Wireless Optical Communication(WOC)**	**15**	

	2.1	Optical Communication: Introduction to wireless optical communication (WOC), wireless optical channels,		**CO2 CO3**
	2.2	Atmospheric channel, underwater optical channel, atmospheric losses		**CO2 CO4**
	2.3	WOC and Applications: Weather condition influence, atmospheric turbulence effects i.e. scintillation, beam spreading, etc. wireless optical communication application areas, WOC challenges and applications.		**CO3 CO4**
Unit 3		**Fourth Generation Systems and New Wireless Technologies**	**15**	
	3.1	4G Vision: 4G Features and Challenges, Applications of 4G; 4G Technologies - LTE FDD vs TDD comparison		**CO1**

	3.2	Frame structure and its characteristics; smart antenna techniques; OFDM.		**CO2 CO3**
	3.3	Trends in Wireless Technology: MIMO Systems, Adaptive Modulation and Coding with Time-Slot Scheduler - Bell Labs Layered Space-Time (BLAST) System, Software-Defined Radio, Cognitive Radio		**CO3**
Unit 4		**Recent Trends in Wireless Networking (Skill Enhancement)**	**15**	
	4.1	5G Technology: Understand 5GPP & NGMN, 5G architecture and design objective		**CO1 CO4**

	4.2	5G spectrum requirements, ITU-R IMT-2020 vision for 5G, 5G RAN & Dynamic CRAN		**CO3**
	4.3	Architecture and applications: 5G Mobile Edge Computing & Fog computing, 5G Protocol Stack, 5G Ultra-dense networks, 5G Air interface, Applications		**CO2 CO4**

References:

1. Anurag Kumar, D.Manjunath, Joy kuri, ―Wireless Networking‖, third Edition, Elsevier 2018.

2. Jochen Schiller, ‖Mobile Communications‖, Second Edition, Pearson Education 2019.

3. Vijay Garg, ―Wireless Communications and networking‖, First Edition, Elsevier 2012.

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science
Practical Semester-III
Course Title: Practical Paper-I- Wireless Networking Course Code:GNKPSCSMJ1P503
Credits: 02
No of Practical (Hours): 60
Marks: 75

Course Objectives:

Sr. No.	Course objectives

The course aims at:	
1	Wireless Security: Understand and implement WEP encryption for wireless network security.
2	Distribution Layer Functions: Demonstrate configuration and operation of distribution layer devices.
3	Access Control: Configure and apply Access Control Lists (ACLs) for traffic control.
4	Firewall Planning: Design and implement network-based firewalls for enhanced security.
5	Auto Configuration: Utilize Auto Profiles ACU Utilities for automating wireless network setup

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Students can configure WEP encryption on wireless routers for secure communication.	PO1, PO2	PSO1	R, U, An
CO 2	Students can demonstrate the functions of distribution layer devices in a network hierarchy.	PO3, PO4	PSO1	U, E, C
CO 3	Students can configure and troubleshoot ACLs for controlling traffic flow.	PO4, PO5	PSO1	C, An Ap, E
CO 4	Students can plan and deploy network-based firewalls to protect network infrastructure.	PO5, PO6	PSO1	C, E, An, Ap
CO 5	Students can use Auto Profiles ACU Utilities for automated wireless network configuration.	PO7, PO8	PSO6	An, Ap

List of Experiments:

Note: Practical's can be implemented using GNS3, CISCO packet tracer 7.0 and above

1	Configuring WEP on a Wireless Router
2	Demonstrating Distribution Layer Functions
3	Placing ACLs

4	Planning Network-based Firewalls
5	Configure Auto Profiles ACU Utilities
6	Creating an Adhoc Network
7	Configuring Basic AP Settings
8	Configure Ethernet/Fast Ethernet Interface
9	Configure Radio Interfaces through the GUI
10	Configure Site-to-Site Wireless Link

References:

1. Wireless Networks: Security and Analysis by Seokjin Kang, et al.
2. CCNA Routing and Switching Portable Command Guide by Scott Empson.
3. Cisco Networking Essentials by Troy McMillan.
4. Network Security Essentials: Applications and Standards by William Stallings.
5. Interconnections: Bridges, Routers, Switches, and Internetworking Protocols by Radia Perlman.

Examination (Total Marks): 75 M
Experiment Marks: Experiment 1= 30 + Experiment 2= 30
Journal Marks: 05
Viva Marks: 05 + 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Major paper-II)

Name of the paper: Cyber Security and Risk Assessment

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-III Paper-II
Course Title: Cyber Security and Risk Assessment
Course Code:GNKPSCSMJ2503
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Learn about an advanced concept related to penetration testing
2	Understand ways to protect system and digital assets
3	Use of Kali Linux in performing penetration tests against networks, systems, and applications
4	selecting the most effective tools, to rapidly compromising network security to highlighting the techniques used to avoid detection

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs Addressed	Cognitive Levels addressed
CO 1	Develop skills to use kali Linux for penetration testing	**PO1, PO 2, PO3, PO8**	**PSO1,**	**R, U, An**

CO 2	Use open-source tools for Reconnaissance	**PO2, PO 4, PO5, PO9**	**PSO1**	**U, An, E, C**
CO 3	Perform vulnerability assessment using popular tools	**PO6, PO 7, PO10,**	**PS O1, PS O6**	**U, An, E**

CO 4	Learn about advanced ways to exploit web apps and cloud security	**PO3,PO4 , PO5, PO7**	**PS O1, PS O6**	**U, E, C**
CO 5	Apply techniques for privilege escalation and use exploitation tools.	**PO3,PO6 , PO7**	**PSO1, PSO6**	**U, An, E, C**

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		**Introduction to Penetration Testing and Reconnaissance**	**15**	
	1.1	**Goal-based penetration testing:** Introduction to Penetration Testing, Different types of threat actors, Conceptual overview of security testing, Common pitfalls of vulnerability assessments, penetration testing, and red team exercises, Objective-based penetration testing, The testing methodology Kali Linux & Red Team Tactics, Using CloudGoat and Faraday		**CO 1**
	1.2	**Open-source Intelligence and Reconnaissance:** Basic Principles of Reconnaissance, Scraping, Google Hacking Database, creating custom wordlist for cracking password		**CO 2**

	1.3	**Active Reconnaissance of External and Internal Networks:** Stealth scanning techniques, DNS reconnaissance, and route mapping, Employing comprehensive reconnaissance applications, Identifying the external network infrastructure, Mapping beyond the firewall, IDS/IPS identification, Enumerating hosts, port, operating system, and service discovery, Writing your port scanner using netcat, Large-scale scanning, Machine Learning for Reconnaissance		**CO 2**

Unit 2		**Vulnerabilities and Advanced Attacks**	**15**	
	2.1	**Vulnerability Assessment:** Local and online vulnerability databases, Vulnerability 8scanning with Nmap, Web application vulnerability scanners, Vulnerability scanners for mobile applications, OpenVAS network vulnerability scanner, Commercial vulnerability scanners, Specialized scanners, Threat modelling		**CO3**
	2.2	**Advanced Social Engineering and Physical Security:** Common Methodology, Physical attacks at a console, creating rough physical devices, Social Engineering Toolkit, Hiding executables and obfuscating the attacker's URL, Escalating an attack using DNS redirection, Launching Phishing attack		**CO 3**
	2.3	**Wireless and Bluetooth Attacks:** Wireless reconnaissance, Bypassing open SSID and MAC address authentication, attacking WPA and WPA2, Dos attacks against Wireless communication, Compromising enterprise implementations of WPA2, Evil Twin attack, using bettercap, WPA3, Bluetooth attacks		**CO 3**
Unit 3		**Web and Cloud Exploitations**	**15**	
	3.1	**Advanced Social Engineering and Physical Security** Common Methodology, Physical attacks at a console, creating rough physical devices, Social Engineering Toolkit, Hiding executables and obfuscating the attacker's URL, Escalating an attack using DNS redirection, Launching Phishing attack		**CO 4**

	3.2	**Wireless and Bluetooth Attacks:** Wireless reconnaissance, Bypassing open SSID and MAC address authentication, attacking WPA and WPA2, Dos attacks against Wireless communication, Compromising enterprise		**CO 5**
	3.3	**Exploiting Web-based applications:** Web app Hacking methodology, Reconnaissance of web apps, client- side proxies, application-specific attacks, Browser exploitation Framework **Cloud Security Exploitation:** Vulnerability scanning and application exploitation, Testing S3 bucket misconfiguration, exploiting security permission flaws, obfuscating Cloudtail logs **Bypassing Security Controls:** Bypassing Network Access Control and application-level controls, Bypassing antivirus, Bypassing Windows OS controls		**C0 5**
Unit 4		**Exploiting System Vulnerabilities**	**15**	
	4.1	**Metasploit Exploitation:** Metasploit framework, exploiting single and multiple targets using MSF, using the public exploit, developing windows exploit		**CO 1 & CO5**
	4.2	**Privilege Escalation:** Escalation methodology, escalating from domain user to system administrator, local system escalation, escalating from administrator to system, credential harvesting, and escalating attacks, escalating access right in active directory		**CO 4**
	4.3	**Embedded devices and RFID Hacking:** Firmware unpacking and updating, Introduction to RouterSploit Framework, UART, Cloning RFID using ChameleonMini		**C0 5**

TEXT BOOKS:

1. Mastering Kali Linux for Advanced Penetration Testing Fourth Edition, Vijay Kumar Velu, Packt, 2022
2. Learn Kali Linux 2019: Perform Powerful Penetration Testing Using Kali Linux, Metasploit, Nessus, Nmap, And Wireshark, Glen D. Singh, Packt, 2019

REFERENCE BOOKS:

1. Hands-on Penetration Testing for Web Applications: Run Web Security Testing on Modern Applications Using Nmap, Burp Suite and Wireshark, Richa Gupta, BPB, 2021
2. Advanced Penetration Testing, Wil Allsopp, Wiley, 2017

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science Practical Semester-III
Course Title: Practical Paper-II-Cyber Security and Risk
Assessment Course: MSc Computer Science Practical
Course Code: GNKPSCSMJ2P503
Credits: 02
No of Practical (Hours): 60
Marks: 75
Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand and configure Kali Linux
2	Learn about an advanced concept related to penetration testing
3	Understand ways to proect system and digital assets
4	Use of Kali Linux in performing penetration tests against networks, systems, and applications
5	selecting the most effective tools, to rapidly compromising network security to highlighting the techniques used to avoid detection

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addresse d	PSOs addresse d	Cognitive Levels addressed
CO 1	Students can configure Kali Linux	PO1, PO 2	PSO1	R, U, An
CO 2	Students can demonstrate passive reconnaissance.	PO3, PO 4	PSO1	U, E, C
CO 3	Students can configure SQL injections	PO4, PO 5	PSO1	C, An Ap, E
CO 4	Students can plan and deploy Wireless and Bluetooth attacks	PO5, PO 6, PO9	PSO1	C, E, An, Ap
CO 5	Students can use Metasploit Framework for exploitation	PO5, PO 6, PO10	PSO6	An, Ap

List of Experiments:

Note: The Practical to be performed preferably on Kali Linux

1	Exploring and building a verification lab for penetration testing (Kali Linux)
2	Use of open-source intelligence and passive reconnaissance
3	Practical on enumerating host, port, and service scanning
4	Practical on vulnerability scanning and assessment
5	Practical on use of Social Engineering Toolkit
6	Practical on Wireless and Bluetooth attacks
7	Practical on Exploiting Web-based applications
8	Practical on using Metasploit Framework for exploitation.
9	Practical on injecting Code in Data Driven Applications: SQL Injection

10	Wireless Network threats (sniff wifi hotspots, analyze strength, discover wireless access points)

TEXT BOOKS:

3. Mastering Kali Linux for Advanced Penetration Testing Fourth Edition, Vijay Kumar Velu, Packt, 2022
4. Learn Kali Linux 2019: Perform Powerful Penetration Testing Using Kali Linux, Metasploit, Nessus, Nmap, And Wireshark, Glen D. Singh, Packt, 2019

REFERENCE BOOKS:

1. Hands-on Penetration Testing for Web Applications: Run Web Security Testing on Modern Applications Using Nmap, Burp Suite and Wireshark, Richa Gupta, BPB, 2021

2. Advanced Penetration Testing, Wil Allsopp, Wiley, 2017

Examination (Total Marks): 75 M
Experiment Marks: Experiment 1= 30 + Experiment 2= 30
Journal Marks: 05
Viva Marks: 05 + 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Elective Paper-I)

Name of the paper: Web3 Technologies

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science
Semester-III
Elective Paper Course Title: Web3 Technologies
Course Code:GNKPSCSEL1503
Credits: 3
No of lectures (Hours): 45
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Explore the underlying principles of blockchain technology, including consensus mechanisms, cryptographic techniques, and distributed ledger systems.
2	Explore the process of tokenization and its applications in various industries such as real estate, art, and gaming.
3	Gain proficiency in writing smart contracts using Solidity (for Ethereum) or similar languages.
4	Understand the security considerations and best practices for smart contract development.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	To cover the technical aspects of cryptocurrencies, blockchain technologies, and distributed consensus.	PO1,PO2	PSO3	Ap,An
CO 2	Learn about different types of blockchains	PO1,PO2	PSO3	U,An
CO 3	To familiarize potential applications for Bitcoin- like cryptocurrencies	PO2,PO6	PSO3	
CO 4	To understand the meaning of terms such as “Web3,” “token,” “smart contract,”	PO1,PO2	PSO3	Ap,An,C

CO 5	Understand the concept of DApps and their difference from traditional web applications.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 6	Learn how to design, develop, and deploy DApps using platforms like Ethereum, EOS, or others.	PO1,PO2, PO6	PSO3	Ap,An,C

CO 7	Students will be able to design, develop, and deploy smart contracts using languages such as Solidity, and understand the implications of coding practices on security and functionality	PO1,PO2, P O8	PSO3	U,Ap, An,
CO 8	Students will be capable of implementing tokenization solutions using token standards	PO1,PO2, P O8	PSO3	U,Ap, An,
CO 9	To understand Basics of smart contracts, decentralized apps, and decentralized anonymous organizations (DAOs)	PO1,PO2, P O8	PSO3	Ap,An, C

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1			**15**	
	1.1	Blockchain: Growth of blockchain technology, Distributed systems, the history of blockchain and Bitcoin, Blockchain, Consensus, CAP theorem and blockchain,		**CO 1**
	1.2	Decentralization using blockchain,Methods of decentralization,Routes to decentralization, Blockchain and full ecosystem decentralization, The consensus problem, Analysis and design, Classification, Algorithms		**CO 2**
	1.3	Bitcoin: Overview, Cryptographic keys, Transactions, Blockchain Mining, Bitcoin network, Wallets, Bitcoin payments, Innovation in Bitcoin, Advanced protocols, Bitcoin investment, and buying and selling Bitcoin		**CO 3**
Unit 2			**15**	

	2.1	Smart Contracts: History, Definition Ricardian contracts, Smart contract templates, Oracles, Deploying smart contracts, The DAO		**CO 4**

	2.2	Ethereum: Overview, Ethereum network, Components of the Ethereum ecosystem, The Ethereum Virtual Machine (EVM), Smart contracts, Blocks and blockchain, Wallets and client software, Nodes and miners, APIs, tools, and DApps, Supporting protocols, Programming languages		**CO 5**
	2.3	Ethereum Development Environment: Overview, Test networks, Components of a private network, starting up the private network, mining on the private network, Remix IDE, MetaMask, Using MetaMask and Remix IDE to deploy a smart contract		**CO 6**
Unit 3			**15**	
	3.1	Solidity Programming (Skill Enhancement) Introduction to Solidity Programming: Layout of a Solidity Source File, Structure of a Contract, Types, Units, and Globally Available Variables, Input Parameters and Output Parameters		**CO 7**
	3.2	Control Structures, Function Calls, Creating Contracts via new, Order of Evaluation of Expressions, assignment, Scoping and Declarations, Error handling: Assert, Require, Revert and Exceptions		**CO 8**
	3.3	Smart Contracts: Solidity Programming – Contracts, Creating Contracts, Visibility and Getters, Function Modifiers, Constant State Variables, Functions, Inheritance, Abstract Contracts, Interfaces, Libraries.		**C0 9**

References:

1. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition 2020

2. Andreas M. Antonopoulos, Dr.Gavin wood "Mastering Ethereum" O"Reilly Media Inc, 2019

3. Ritesh Modi, "Solidity Programming Essentials: A Beginner"s Guide to Build Smart Contracts for Ethereum and BlockChain", Packt Publishing.

4. Josh Thompson, „Blockchain: The Blockchain for Beginnings, Guide to Blockchain Technology and Blockchain Programming", Create Space Independent Publishing Platform, First Edition - 2017.

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science
Practical Semester-III
Course Title: Elective Practical – Web3 Technologies
Course Code:GNKPSCSEL1P503
Credits: 01
No of Practical (Hours): 30
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Explore the underlying principles of blockchain technology, including consensus mechanisms, cryptographic techniques, and distributed ledger systems.
2	Explore the process of tokenization and its applications in various industries such as real estate, art, and gaming.
3	Gain proficiency in writing smart contracts using Solidity (for Ethereum) or similar languages.
4	Understand the security considerations and best practices for smart contract development.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	To cover the technical aspects of cryptocurrencies, blockchain technologies, and distributed consensus.	PO1,PO2	PSO3	Ap,An

CO 2	Learn about different types of blockchains	PO1,PO2	PSO3	U,An
CO 3	To familiarize potential applications for Bitcoin- like cryptocurrencies	PO2,PO6	PSO3	
CO 4	To understand the meaning of terms such as "Web3," "token," "smart contract,"	PO1,PO2	PSO3	Ap,An,C
CO 5	Understand the concept of DApps and their difference from traditional web applications.	PO1,PO2, PO6	PSO3	Ap,An,C

List of Experiments:

1	Install and understand Docker container, Node.js, Java and Hyperledger Fabric, Ethereum and perform necessary software installation on local machine/create instance on Cloud to run.
2	Create and deploy a block chain network using Hyperledger Fabric SDK for Java
3	Interact with a block chain network. Execute transactions and requests against a blockchain network by creating an app to test the network and its rules
4	Deploy an asset-transfer app using the block chain. Learn app development within a Hyperledger Fabric network
5	Use block chain to track fitness club rewards Build a web app that uses Hyperledger Fabric to track and trace member rewards
6	Car auction network: A Hello World example with Hyperledger Fabric Node SDK and IBM Block chain Starter Plan. Use Hyperledger Fabric to invoke chaincode while storing results and data in the starter plan
7	Develop an IoT asset tracking app using Block chain. Use an IoT asset tracking device to improve a supply chain by using Block chain, IoT devices, and Node-RED
8	Create a global finance block chain application with IBM Block chain Platform Extension for VS Code. Develop a Node.js smart contract and web app for a Global Finance with block chain use case
9	Develop a voting application using Hyperledger and Ethereum. Build a decentralized app that combines Ethereum's Web3 and Solidity smart contracts with Hyperledger hosting Fabric and Chaincode EVM
10	Create a block chain app for loyalty points with Hyperledger Fabric Ethereum Virtual Machine. Deploy Fabric locally with EVM and create a proxy for interacting with a smart contract through a Node.js web app

References:

1. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition 2020
2. Andreas M. Antonopoulos, Dr.Gavin wood "Mastering Ethereum" O"Reilly Media Inc, 2019
3. Ritesh Modi, "Solidity Programming Essentials: A Beginner"s Guide to Build Smart Contracts for Ethereum and BlockChain", Packt Publishing.
4. Josh Thompson, „Blockchain: The Blockchain for Beginnings, Guide to Blockchain Technology and Blockchain Programming", Create Space Independent Publishing Platform, First Edition - 2017.

Examination (Total Marks): 50 M
Experiment Marks: 40
Journal Marks: 05
Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Elective Paper - II)

Name of the paper: Bioinformatics

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-III Elective
Paper Course Title: Bioinformatics
Course Code:GNKPSCSEL2503
Credits: 3
No of lectures (Hours): 45
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Gain an understanding of the biological sequence structure deficit and its relevance to Genome Projects.
2	Develop proficiency in pattern recognition and prediction techniques used in bioinformatics.
3	Explore the role of chaperones in sequence analysis and protein folding.
4	Familiarize oneself with prominent information networks such as EMBnet and NCBI and their resources.
5	Learn to navigate protein and genome information resources, including primary and composite databases.
6	Master DNA sequence analysis techniques, including pair-wise and multiple sequence alignment.
7	Develop the ability to construct sequence search protocols and utilize analysis packages effectively.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Students will demonstrate a comprehensive understanding of the biological sequence structure deficit, Genome Projects, and the principles of pattern recognition and prediction in bioinformatics.	PO1,PO2	PSO3	Ap,An
CO 2	Students will be able to explain the role of chaperones in protein folding and stability, and how they contribute to sequence analysis.	PO1,PO2	PSO3	U,An
CO 3	Students will be proficient in navigating prominent information networks such as EMBnet and NCBI, utilizing their databases, tools, and services for bioinformatics research.	PO2,PO6	PSO3	
CO 4	Students will demonstrate proficiency in accessing and utilizing protein and genome information resources, including primary sequence databases, composite databases, and structure classification databases.	PO1,PO2	PSO3	Ap,An,C
CO 5	Students will develop practical skills in DNA sequence analysis, including pair-wise alignment techniques, multiple sequence alignment methods, secondary database searching, and the construction of sequence search protocols.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 6	Students will be proficient in using analysis packages commonly employed in DNA sequence analysis, enabling them to interpret and manipulate biological data effectively.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 7	Students will demonstrate critical thinking and problem-solving skills in the context of bioinformatics, applying their knowledge to address research questions and analyze complex biological data.	PO1,PO2, P O8	PSO3	U,Ap,An,
CO 8	Students will effectively communicate their findings and interpretations of bioinformatics analyses, both orally and in writing, to scientific and non-scientific audiences.	PO1,PO2, P O8	PSO3	U,Ap,An,

Unit		Title	No. of lectures	CO Mapping
Unit 1			**15**	
	1.1	**Introduction** The biological sequence structure deficit-Genome Projects-pattern recognition and prediction		**CO 1**
	1.2	The role of chaperones-sequence Analysis		**CO 2**
	1.3	**Information Networks** Review of information communication networks-the European molecular biology network-		**CO 3**
Unit 2			**15**	
	2.1	EMBnetNational Center for Biotechnology Information- NCBI- virtual tourism		**CO 4**
	2.2	**Protein Information resources** Biological Data Bases-Primary sequence Databases-Composite Protein sequence databases Secondary databases		**CO 5**
	2.3	Composite Protein pattern databases-structure classification databases-web addressee.		**CO 6**
Unit 3			**15**	
	3.1	**Genome Information resources** DNA Sequence Analysis, Pair-wise alignment Techniques		**CO 7**
	3.2	Multiple sequence alignment, Secondary database searching		**CO 8**
	3.3	Building a sequence search Protocol, Analysis packages		**C0 9**

References:

1. "Introduction to Bio – Informatics", by T.K. Attwood and D.J. Perry –smith, Longman, Essen, 1999
2. "Bio Informatics Computing", by Bryan Bergeron, Second Edition, Pearson Education, 2003.

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.

- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science
Practical Semester-III
Course Title: Elective Practical – Bioinformatics
Course Code:GNKPSCSEL2P503
Credits: 01
No of Practical (Hours): 30
Marks: 50

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Understand the fundamental principles of DNA sequence analysis.
2	Learn sequence alignment algorithms.
3	Master Multiple Sequence Alignment (MSA).
4	Develop proficiency in building sequence similarity search protocols.
5	Utilize scientific computing packages for biological data analysis.

Course Outcomes (COs):

Sr. No.	**On completing the course, the student will be able to:**	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Students will gain knowledge about DNA sequences, their structure, and how to manipulate them programmatically using Python libraries like Biopython.	PO1,PO2	PSO3	Ap,An
CO 2	Students will learn and apply algorithms such as Smith-Waterman or Needleman-Wunsch for pairwise sequence alignment, understanding the principles of dynamic programming and how they relate to biological sequence analysis.	PO1,PO2	PSO3	U,An
CO 3	Students will gain proficiency in using Biopython's modules for MSA algorithms like ClustalW or Muscle, enabling them to align multiple sequences to identify conserved regions and evolutionary relationships.	PO2,PO6	P O3 S	U, An , C

CO 4	Students will learn to leverage popular packages like NumPy, SciPy, and pandas for statistical analysis, data visualization, and potentially machine learning tasks tailored to biological datasets, enhancing their skills in computational biology.	PO1,PO2	PSO3	Ap,An,C
CO 5	Students will understand the principles behind tools like BLAST and learn how to utilize them to search biological databases effectively, enabling them to identify sequences of interest and retrieve relevant information efficiently.	PO1,PO2, PO6	PSO3	Ap,An,C

List of Experiments:

1	Develop a Python program for DNA sequence analysis utilizing libraries such as Biopython. This program should include functionalities for reading, writing, and analyzing DNA sequences. Additionally, implement pair-wise sequence alignment techniques using algorithms like Smith-Waterman or Needleman-Wunsch to identify similarities between sequences
2	Write a Python program using Biopython to perform Multiple Sequence Alignment (MSA) of a set of DNA or protein sequences. Utilize Biopython's modules for MSA algorithms such as ClustalW or Muscle. Multiple Sequence Alignment enables the identification of conserved regions and reveals evolutionary relationships among the sequences.
3	Develop a Python program to build sequence similarity search protocols using Biopython or custom scripts. Researchers can utilize tools like BLAST to perform searches against databases such as NCBI's nr database. This program should facilitate the setup and execution of sequence similarity searches, enabling researchers to analyze and compare sequences effectively
4	Develop a Python program that leverages popular scientific computing packages like NumPy, SciPy, and pandas for comprehensive analysis of biological data. The program should include functionalities for statistical analysis, data visualization, and potentially machine learning tasks tailored to biological datasets.
5	write a python code that can use Biopython, a widely used Python package for biological computation, to interact with NCBI's Entrez databases.
6	write a python program to implement a Python script utilizing Biopython's modules to parse PDB files and extract relevant data from the Protein Data Bank (PDB), facilitating the analysis and

	manipulation of 3D structural information of proteins and nucleic acids stored within the PDB repository.
7	Develop a Python program that utilizes tools such as BLAST (Basic Local Alignment Search Tool) to conduct sequence searches within biological databases, enabling users to identify sequences of interest and retrieve relevant information.
8	write a python program which Use scoring matrices such as BLOSUM or PAM for determining the similarity between aligned sequences
9	Write a python program to Utilize tools like Clustal Omega, MAFFT, or MUSCLE for multiple sequence alignment.
10	write a python program to Implement a step-by-step protocol including sequence retrieval, alignment, and analysis.

References:

1."Introduction to Bio – Informatics", by T.K. Attwood and D.J. Perry –smith, Longman, Essen, 1999

2."Bio Informatics Computing", by Bryan Bergeron, Second Edition, Pearson Education, 2003.

Examination (Total Marks): 50 M

Experiment Marks: 40

Journal Marks: 05

Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Elective Paper - III)

Name of the paper: Fuzzy Systems

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-III
Elective Paper Course Title: Fuzzy Systems
Course Code:GNKPSCSEL3503
Credits: 3
No of lectures (Hours): 45
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Students will gain a solid understanding of the principles and concepts underlying fuzzy logic, including imprecision, uncertainty, and fuzzy sets.
2	Students will become familiar with various fuzzy logic operators and their roles in modelling and controlling complex systems with uncertain inputs.
3	Students will learn about fuzzy logic controllers (FLCs) and how to design and implement them for various control tasks, including decision-making and system regulation.
4	Students will develop proficiency in applying fuzzy reasoning techniques to model complex relationships and make decisions in uncertain environments.
5	Students will understand how to apply fuzzy logic principles to pattern recognition tasks and clustering techniques, enabling them to extract useful information from noisy or imprecise data.
6	Students will explore the diverse applications of fuzzy logic in fields such as robotics, natural language processing, finance, and engineering.
7	Students will gain skills in identifying and validating fuzzy systems, ensuring their effectiveness in representing real-world phenomena

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addresse

				d
CO 1	Students will gain a thorough understanding of different types of imprecision such as inexactness, ambiguity, undecidability, fuzziness, and certainty, and their significance in various domains.	PO1,PO2	PSO3	Ap,An

CO 2	Students will be able to distinguish between fuzzy sets and crisp sets and understand their applications in modeling real-world systems.	PO1,PO2	PSO3	U,An
CO 3	Students will learn about fuzzy logic operators and how they are applied in fuzzy logic controllers (FLCs) to control complex systems with uncertain inputs. Students will develop skills in fuzzy decision-making processes and clustering techniques, enabling them to handle uncertain and imprecise data effectively.	PO2,PO6	PSO3	
CO 4	Students will be able to apply fuzzy logic principles to pattern recognition tasks and time series analysis, allowing them to extract meaningful information from noisy or uncertain data.	PO1,PO2	PSO3	Ap,An,C
CO 5	Students will learn about fuzzy relations and various reasoning techniques used in fuzzy systems, enhancing their ability to model complex relationships and make informed decisions.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 6	Students will gain expertise in modeling linguistic variables and defining linguistic terms, which are crucial for representing human-like reasoning in fuzzy systems.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 7	Students will be able to formulate fuzzy propositions and apply compositional rules of inference to draw conclusions in uncertain environments.	PO1,PO2, P O8	PSO3	U,Ap,An,
CO 8	Students will learn various defuzzification techniques and be able to choose appropriate methods to convert fuzzy outputs into crisp values for decision-making.	PO1,PO2, P O8	PSO3	U,Ap,An,

Unit		Title	No. of lectures	CO Mapping
Unit 1			**15**	
	1.1	Different faces of imprecision – inexactness, ambiguity, un decidability, Fuzziness and certainty, Fuzzy sets and crisp sets. Fuzzy Logic Operators, Fuzzy Logic Controllers (FLCs), Fuzzy Control Systems, Fuzzy Decision Making, Fuzzy Clustering, Fuzzy Pattern Recognition, Fuzzy Time Series Analysis, Fuzzy Neural Networks, Fuzzy Text Mining.		**CO 1**
	1.2	Intersection of Fuzzy sets, Union of Fuzzy sets - the complement of Fuzzy sets-Fuzzy reasoning, Fuzzy Set.		**CO 2**
	1.3	Operations Beyond Intersection and Union, Extension Principle, Fuzzy Relations, Fuzzy Reasoning Techniques, Fuzzy Sets in Machine Learning.		**CO 3**
Unit 2			**15**	
	2.1	Linguistic Variable Modelling, Linguistic Variable Definition, Linguistic Variable Types, Linguistic Term Definitions		**CO 4**
	2.2	Fuzzy Propositions and Fuzzy Logic Connectives: Fuzzy Propositions, Fuzzy Logic Connectives Fuzzy Compositional Rules of Inference: Compositionality in Fuzzy Logic, Compositionality Operators Methods of Decomposition: Decomposition Methods in Fuzzy Systems, Decomposition Algorithms.		**CO 5**
	2.3	Defuzzification Methods: Defuzzification Techniques, Comparative Analysis of Defuzzification Methods Fuzzy Logic Applications Revisited: Fuzzy Logic in Natural Language Processing, Fuzzy Logic in Robotics		**CO 6**
Unit 3			**15**	
	3.1	Fuzzy System Identification: Introduction to System Identification:, Fuzzy System Identification Fuzzy Model Validation and Performance Evaluation: Model Validation Techniques, Performance Metrics for		**CO 7**

		Fuzzy Models.		
	3.2	Adaptive and Online Learning in Fuzzy Systems: Adaptive Fuzzy Systems, Incremental Learning Methods.		**CO 8**
	3.3	Fuzzy Estimation and Filtering: Fuzzy Kalman Filtering, Fuzzy Observer Design		**C0 9**

References :

1. "An Introduction to Fuzzy Control", Driankov D., Hellendoorn H. & Reinfrank M., Norosa Publishing House
2. "Fuzzy Systems Design Principles", Berkan R.C., and Trubatch S.L., IEEE Press,
3. "Fuzzy Logic with Engineering Applications", Thimothy J. Ross, McGraw Hill
4. "Introduction to Applied Fuzzy Electronics", Ahmad Ibrahim, PHI.
5. "Fuzzy Logic: A Practical Approach" by Subir Kumar Sarkar and Sabnam Sengupta
6. "Fuzzy Logic and NeuroFuzzy Applications Explained" by B.M. Harish Kumar and V. Raj Kumar
7. "Fuzzy Systems Engineering: Theory and Practice" by Chander Mohan and Rajneesh Sharma

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science
Practical Semester-III
Course Title: Elective Practical – Fuzzy Systems
Course Code:GNKPSCSEL3P503
Credits: 01
No of Practical (Hours): 30
Marks: 50

Course Objectives:

Sr.	Course objectives

No.	
The course aims at:	
1	Understand the fundamental principles of Fuzzy Logic Controllers (FLC) and their real-world applications in various systems.
2	Gain proficiency in implementing fuzzy decision-making systems tailored for autonomous vehicles, considering factors such as navigation, obstacle avoidance, and adaptive control.
3	Apply Fuzzy C-Means (FCM) clustering techniques to effectively segment customers based on their preferences, behavior, or other relevant characteristics for marketing and business strategies.
4	Develop the ability to implement basic compositionality operators (AND, OR, NOT) within fuzzy logic systems to model complex decision-making processes accurately.
5	Evaluate and compare different decomposition algorithms to determine their suitability for breaking down complex problems into manageable subproblems within fuzzy logic contexts.Implement and critically analyze defuzzification methods in fuzzy inference systems to interpret fuzzy outputs into crisp values for decision-making.

6	Apply fuzzy logic concepts to enhance autonomy and decision-making capabilities in robotic systems, considering tasks such as path planning, object recognition, and dynamic environment interaction.
7	Compare the process and outcomes of fuzzy system identification with traditional techniques, understanding the strengths and limitations of each approach in modeling complex systems
8	Describe and apply relevant performance metrics for evaluating the accuracy, efficiency, and effectiveness of fuzzy models in various applications. Compare the principles and applications of traditional Kalman filtering with fuzzy Kalman filtering, exploring their respective advantages and disadvantages in dealing with uncertainty and noise in dynamic systems.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understand the principles and applications of Fuzzy Logic Controllers (FLC) in real-world systems.	PO1,PO2	PSO3	Ap,An
CO 2	Implement fuzzy decision-making systems for autonomous vehicles.	PO1,PO2	PSO3	U,An
CO 3	Apply Fuzzy C-Means (FCM) clustering for customer segmentation.	PO2,PO6	PSO3	Ap,An,C
CO 4	Implement basic compositionality operators (AND, OR, NOT) for fuzzy logic.	PO1,PO2	PSO3	Ap,An,C
CO 5	Compare and contrast different decomposition algorithms.	PO1,PO2, PO6	PSO3	Ap,An,C

CO 6	Implement and compare defuzzification methods in a fuzzy inference system.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 7	Apply fuzzy logic for enhancing autonomy and decision-making in robotic systems.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 8	Compare fuzzy system identification with traditional techniques.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 9	Describe performance metrics for evaluating fuzzy models.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 10	Compare traditional Kalman filtering with fuzzy Kalman filtering.	PO1,PO2, PO6	PSO3	Ap,An,C

List of Experiments:

1	Write a Python program demonstrating how Fuzzy Logic Controllers (FLC) can be used to control the temperature of a room
2	Write a Python program outlining a basic fuzzy decision-making system for a self-driving car to determine when to change lanes on a highway
3	Write a Python program implementing a Fuzzy C-Means (FCM) algorithm for customer segmentation based on their purchasing behaviour.
4	Write a Python program demonstrating the implementation of basic compositionality operators (AND, OR, and NOT).
5	Write a python Python program that compares and contrasts different decomposition algorithms.
6	Write a Python program to implement and compare different defuzzification methods (centroid, mean of maximum, and weighted average) using a simple fuzzy inference system.
7	Write a Python program that demonstrates how fuzzy logic can be used to enhance the autonomy and decision-making capabilities of robotic systems.
8	Write a python program to compare and contrast fuzzy system identification with traditional system identification techniques like least squares estimation or neural network-based approaches
9	Write a Python program that describes commonly used performance metrics for evaluating fuzzy models.

10	Write a Python program that compares the performance of traditional Kalman filtering and fuzzy Kalman filtering.

References:

1. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross
2. “Pattern Recognition and Machine Learning" by Christopher M. Bishop.
3. Fuzzy Sets, Fuzzy Logic, and Fuzzy Systems" by George J. Klir and Bo Yuan
4. "Numerical Recipes: The Art of Scientific Computing" by William H. Press et al.

Examination (Total Marks): 50 M
Experiment Marks: 40
Journal Marks: 05
Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester III

(Elective Paper - III)

Name of the paper: Research Paper Writing and Research Project Proposal

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-III
Course Title: Research Paper Writing
Course Code:GNKPSCSRP503
Credits: 2
No of lectures (Hours): 30
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course *aims at:*	
1	Understanding Research Paper Structure: To familiarize students with the structure and components of a research paper in computer science, enabling them to identify and understand the purpose of each section.
2	Literature Review Skills: To develop students' ability to conduct thorough literature reviews, critically evaluate existing research, and identify gaps in the literature that can form the basis for their own research.
3	Research Methodology Proficiency: To provide students with the knowledge and skills necessary to design and conduct research studies in computer science, including selecting appropriate methodologies, designing experiments, and addressing ethical considerations.
4	Data Analysis and Presentation: To equip students with the skills to analyze research data using appropriate techniques and present their findings effectively using tables, charts, graphs, and other visualization methods.
5	Critical Thinking and Analytical Skills: To foster students' critical thinking skills, enabling them to evaluate research findings, identify strengths and weaknesses, and propose meaningful interpretations and conclusions.

6	Effective Academic Writing: To enhance students' academic writing skills, including grammar, punctuation, clarity, and coherence, enabling them to communicate their ideas and arguments effectively in academic prose.
7	Publication and Presentation Skills: To familiarize students with the academic publishing process, including selecting suitable venues for publication, writing abstracts and manuscripts, and presenting research findings at conferences.
8	Peer Review and Feedback: To engage students in peer review activities, providing them with opportunities to receive constructive feedback on their work, develop their ability to provide feedback to others, and refine their research papers based on peer input.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Students will demonstrate an understanding of the structure and components of a research paper in the field of computer science, including the introduction, literature review, methodology, results, discussion, and conclusion sections.	PO1,PO2	PSO3	Ap,An
CO 2	Students will be able to conduct comprehensive literature reviews using academic databases and search engines, critically evaluate the credibility and relevance of sources, and synthesize existing literature to identify research gaps.	PO2,PO3	PSO3	U,An
CO 3	Students will acquire proficiency in research methodology techniques specific to computer science, including experimental design, data collection, ethical considerations, and writing the methodology section of a research paper.	PO3,PO5	PSO3	Ap,An,C
CO 4	Students will develop skills in data analysis techniques relevant to computer science research, including statistical analysis and visualization methods, and effectively present research findings using tables, charts, and graphs.	PO2,PO5, PO6	PSO3	Ap,An,C
CO 5	Students will cultivate critical thinking and analytical skills necessary for evaluating research findings, identifying limitations, proposing future research directions, and engaging in scholarly discourse.	PO6,PO7, PO8	PSO3	Ap,An,C

CO 6	Students will enhance their academic writing skills, including writing style, grammar, punctuation, and sentence structure, and learn to effectively communicate their ideas and arguments in clear, concise, and coherent academic prose.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 7	Students will gain knowledge of the academic publishing process, including selecting appropriate journals and conferences for submission, writing abstracts and manuscripts, and presenting research findings effectively at academic conferences.	PO7, PO8	PSO3	Ap,An,C
CO 8	Students will engage in peer review activities to provide constructive feedback on their classmates' research papers, learn from their peers' perspectives, and refine their own research papers based on peer feedback.	PO5, PO8	PSO3	Ap,An,C

Week wise schedule	**Title**	**No. of lectures**	**CO Mapping**
Week 1	**Introduction to Research Paper Writing and selection of Research Project Topic** Overview of academic writing in computer science Understanding the purpose and significance of research papers. Types of research papers and their structures Identifying research topics and formulating research questions.	4	**CO 1**
Week 2	**Literature Review** Searching for relevant literature using academic databases and search engines Evaluating the credibility and relevance of sources Synthesizing literature and identifying research gaps Proper citation and referencing techniques	4	**CO 2**
Week 3	**Research Methodology** Introduction to research methodologies in computer science. Designing experiments and collecting data Ethical considerations in research. Writing the methodology section of a research paper.	4	**CO 3**
Week 4	**Data Analysis and Results** Techniques for data analysis in computer science research Presenting data using tables, charts, and graphs Interpreting results and drawing conclusions Writing the results section of a research paper.	4	**CO 4**

Week 5	**Discussion and Conclusion** Analyzing and discussing research findings. Addressing limitations and future research directions. Writing the discussion and conclusion sections of a research paper. Strategies for effective argumentation and persuasion.	4	**CO 5**
Week 6	**Academic Writing Skills** Writing style and tone in academic writing. Grammar, punctuation, and sentence structure. Editing and revising drafts. Peer review and feedback.	4	**CO 6**
Week 7	**Publishing and Presentation** Understanding the academic publishing process. Selecting appropriate journals and conferences for submission. Writing abstracts and preparing manuscripts. Presentation skills for academic conferences.	4	**CO 7**
Week 8	**Final Research Paper Presentation and Research Project Proposal Presentation.** Finalizing research paper drafts. Presenting research findings to the class. Peer feedback and evaluation.	2	**CO 8**

Examination:

- **Internal Examination 25 Marks): Per week discussion with internal guide + Research Paper Documentation.**
- **End Semester Research Paper Viva examination (25 Marks): A learner will be evaluated based on innovation in research done, uniqueness and Analysis of work.**
- **Combined passing of 40% with minimum 20% in both Components.**

Course: MSc Computer Science Practical

Semester-III

Course Title: Research Project Proposal Code:GNKPSCSRP504

Credits: 02

No of Practical (Hours): 30

Marks: 50

Sr. No.	Course objectives
The course *aims at:*	
1.	Understand the principles and guidelines for conducting research paper writing and research project proposal development.
2.	Select a topic related to their specialization for Semester IV, demonstrating alignment with their academic and career goals.
3.	Apply knowledge gained from elective courses in Semester II and III to inform their research topic selection and proposal development.

4.	Devote a minimum of 2 to 3 months to studying, researching, and documenting their chosen topic, preparing them for implementation in Semester IV.
5.	Develop a comprehensive research project proposal documentation that adheres to the provided guidelines and includes essential components such as title, introduction, related works, objectives, and methodology.
6.	Compile and analyze relevant literature and research papers, integrating them into the proposal to demonstrate a thorough understanding of the chosen topic.
7.	Clearly articulate the objectives of the proposed research project, outlining its intended outcomes and contributions to the field of study.
8.	Describe in detail the methodology and procedures to be employed in solving the research problem, including the use of appropriate techniques, tools, software, and data.
9.	Produce a well-organized and coherent report of approximately 20 pages, meeting the specified requirements and standards set by the course instructors and the department.
10.	Present the signed project proposal documentation during the viva as part of the University examination process.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Demonstrate proficiency in selecting and refining a research topic relevant to their specialization, demonstrating their understanding of academic and professional interests.	PO1,PO2	PSO3	Ap,An
CO 2	Utilize knowledge and concepts acquired from previous elective courses to inform and support their research project proposal development.	PO2,PO3	PSO3	U,An
CO 3	Apply critical thinking and analytical skills to review and evaluate existing literature and research papers, identifying gaps and opportunities for further investigation.	PO3,PO5	PSO3	Ap,An,C
CO 4	Formulate clear and concise research objectives that align with the identified problem or research question, providing a rationale for the proposed study.	PO2,PO5, PO6	PSO3	Ap,An,C

CO 5	Design a robust research methodology, outlining the steps and procedures to be followed in conducting the proposed research project.	PO6,PO7, PO8	PSO3	Ap,An,C
CO 6	Effectively communicate the proposed research plan through a well-structured and comprehensive project proposal documentation, adhering to formatting and content requirements.	PO1,PO2, PO6	PSO3	Ap,An,C
CO 7	Engage in academic writing practices, including proper citation and referencing of sources, to maintain integrity and scholarly rigor in the research proposal.	PO7, PO8	PSO3	Ap,An,C
CO 8	Present the signed project proposal documentation confidently during the viva, defending the research plan and addressing any questions or feedback from examiners.	PO5, PO8	PSO3	Ap,An,C
CO9	Develop skills in time management and project planning by allocating adequate time and resources for the preparation and completion of the research project proposal.	PO4, PO7	PSO4	U, Ap, An, C
C010	Gain a foundational understanding of the research process and ethical considerations involved in conducting academic research, preparing them for future research endeavors.	PO3, PO5, PO8	PO6	U, C , Ap, E

Guidelines for Research Project Proposal in Semester - III

• Students should take a topic related to the specialization he or she is planning to take in Semester IV.

• Should have studied the related topics in the elective he or she has chosen in semester-II and semester-III

• A student is expected to devote at least 2 to 3 months of study as part of topic selection and It's documentation.

The student should be comfortable to implement the proposal in the semester – IV.

Course code:	Research Project Proposal
1.	**Selection of Research Project Topic** Introduction to the research process, including topic selection, literature review, data collection, analysis, and reporting.
2.	**Importance of Research Topic Selection:** Understanding the significance of selecting a research topic relevant to the student's specialization and academic goals. **Criteria for Topic Selection:** Criteria for evaluating and selecting research topics, such as relevance, feasibility, novelty, and ethical considerations.

3.	**Literature Review** **Resources for Topic Exploration:** Introduction to resources for exploring research topics, including academic journals, databases, conferences, and consultations with faculty mentors.
4.	**Strategies for Identifying Research Gaps:** Techniques for identifying gaps in existing literature and formulating research questions or hypotheses to address them.
5.	**Ethics in Research Topic Selection:** Discussion of ethical considerations in selecting research topics, including sensitivity to cultural, social, and ethical issues.
6.	**Developing a Research Proposal:** Overview of the components of a research proposal, including title, introduction, literature review, objectives, methodology, and expected outcomes.
7.	**Presentation and Evaluation of Research Proposals:** Guidelines for preparing and presenting research proposals, including formatting, citation style, and criteria for evaluation. Peer Review and Feedback: Opportunities for peer review and feedback on research proposals to enhance the quality and rigor of the proposed research projects.
8.	**Revision and Refinement:** Importance of revising and refining research proposals based on feedback from peers, faculty, and other stakeholders.
9.	**Timeline and Milestones:** Establishing a timeline and milestones for completing the research proposal, including deadlines for topic selection, literature review, and proposal submission.
10.	**Final Research Project Proposal Presentation.** Finalizing research project proposal drafts. Peer feedback and evaluation.

Guidelines for Documentation of Research Project Proposal in Semester –III

Student is expected to make a project proposal documentation which should contain the following:

- Title: A suitable title giving the idea about what work is proposed.
- Introduction: An introduction to the topic of around 3-5 pages, giving proper back ground of the topic discussed.
- Related works: A detailed survey of the relevant works done by others in the domain. Student is expected to refer at least 5 research papers in addition to text books and web-links in the relevant topic. It may be around 7 to 10 pages.
- Objective: A detailed objective of the proposal is needed. It may be of 1 to 2 pages.
- Methodology: A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software and data to be used. It shall be of around 3 to 5 pages.

The report may be of around 20 pages, which needs to be signed by the teacher in charge and

head of the Department. Students should submit the signed project proposal documentation at the time of viva as part of the final examination.

Examination:

- **Internal Examination 25 Marks): Per week discussion with internal guide + Documentation.**
- **End Semester Research Project Proposal Viva examination (25 Marks): A learner will be evaluated based on innovation in research project topic, uniqueness and literature review.**
- **Combined passing of 40% with minimum 20% in both Components.**

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

(Major paper- I)

Name of the paper: Robotics

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-IV Paper-I
Course Title: Robotics (Online Mode)
Course Code:GNKPSCSMJ1504
Credits: 4

No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Leverage the features of the Raspberry Pi OS
2	Discover how to configure a Raspberry Pi to build an AI-enabled robot
3	Interface motors and sensors with a Raspberry Pi
4	Code robot to develop engaging and intelligent robot behaviour
5	Explore AI behavior such as speech recognition and visual processing

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs Addressed	Cognitive Levels addressed
CO 1	Knowledge about the fundamentals of Robotics and its applications	**PO1, PO6**	**PSO3**	**An U, Ap, C , E**
CO 2	Ability to use Raspberry Pi for programming Robotics	**PO2, PO5, PO6**	**PSO3**	**An , Ap, C, E**
CO 3	Ability to apply robotics in speech and vision problems	**PO2, PO3, PO8**	**PSO3**	**U, An, Ap, E, C**

Unit		Title	No. of lectures	CO Mapping
Unit 1		Introduction to Robotics	**15**	
	1.1	Introduction to Robotics: What is a robot? Examples of Advanced and impressive robots, Robots in the home, Robots in industry		**CO1**
	1.2	Robotics in Action: Exploring Robot Building Blocks - Code and Electronics Technical requirements,		**CO1**
	1.3	Introducing the Raspberry Pi - Starting with Raspbian Technical requirements, Raspberry Pi controller on a robot.		**CO1**
Unit 2		Building Robot Basics	**15**	
	2.1	Technical requirements: Robot chassis kit with wheels and motors, a motor controller		**CO2**

	2.2	Powering the robot, Test fitting the robot, Assembling the base.		**CO2**
	2.3	Robot Programming: Programming technique, adding line sensors to our robot, creating line- sensing behavior, and Programming RGB Strips in robot.		**CO2**
Unit 3		Servo Motors	**15**	
	3.1	Use and control of servo motors, pan, and tilt mechanism. Distance sensors, Introduction to distance sensors and their usage		**CO3**
	3.2	Connecting distance sensors to robot and their testing. Creating a smart object avoidance behaviour.		**CO3**
	3.3	Creating a menu to select different robot behaviours, Distance and speed measuring sensors—encoders and odometry.		**CO3**
Unit 4		Robot Vision and Voice Communication (Skill Enhancement)	**15**	
	4.1	Robotics setup: Setting up a Raspberry Pi Camera on the robot (software and hardware),		**CO3**
	4.2	Check the robot vision on a phone or laptop, Mask images with RGB strips		**CO3**
	4.3	Robotics for Vision and Voice Applications: Colours, masking, and filtering – chasing coloured objects, Detecting faces with Haar cascades, Finding objects in an image, Voice Communication with a robot		**CO3**

References:

2. Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb

3. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019

4. D. K. Pratihar, FUNDAMENTALS OF ROBOTICS. Narosa Publication, 2016.

5. Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015.

Examination:

- **Internal Examination (25 Marks): 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.**
- **End Semester theory examination (75 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins**
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Computer Science
Practical Semester-IV
Course Title: Practical Paper-I- Robotics
Course Code:GNKPSCSMJ1P504
Credits: 02
No of Practical (Hours): 60
Marks: 75

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Enable students to configure Raspberry Pi headless setup for network access via WiFi and SSH.
2	Teach students to transfer files between PC and Raspberry Pi using SFTP for seamless communication.
3	Empower students to write Python code to control motors and develop basic robotic functionalities.
4	Instruct students in integrating sensors with Raspberry Pi, testing them, and developing behaviors such as line-following and obstacle avoidance.

5	Introduce students to computer vision concepts and guide them in implementing face detection using Haar cascades.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Learner can successfully set up Raspberry Pi for headless operation and access it remotely via WiFi and SSH.	PO1, PO2,	PSO2	U, Ap, E
CO 2	Learner can effectively manage files between their PC and Raspberry Pi using SFTP for seamless communication.	PO2, PO6	PSO3	Ap, An, E
CO 3	Learner can write Python code to control motors, allowing them to initiate basic robotic movements and operations.	PO3, PO6	PSO3	C, U, Ap
CO 4	Learner can integrate sensors with Raspberi, develop behavior scripts, and test functionalities such as line-following and obstacle avoidance.	PO5, PO7,	PSO3	An, E, C
CO 5	Learner can implement face detection using Haar cascades, demonstrating their understanding of computer vision principles and applications in robotics.	PO3, PO5, PO8	PSO3	C, E, An, Ap

List of Experiments:

1.	Making a Raspberry Pi headless, and reaching it from the network using WiFi and SSH.
2.	Using SFTP upload files from PC.
3.	Write Python code to test motors.
4.	Write a script to follow a predetermined path.
5.	Develop Python code for testing the sensors.

6.	Add the sensors to the Robot object and develop the line-following behavior code.
7.	Using the light strip develop and debug the line follower robot.
8.	Add pan and tilt service to the robot object and test it.
9.	Create an obstacle avoidance behavior for robot and test it.
10.	Detect faces with Haar cascades.

References:

1. Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019
2. D. K. Pratihar, FUNDAMENTALS OF ROBOTICS. Narosa Publication, 2016.
3. Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015.

Examination (Total Marks): 75 M
Experiment Marks: Experiment 1= 30 + Experiment 2= 30
Journal Marks: 05
Viva Marks: 05 + 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

(Major paper- II)

Name of the paper: Advanced Deep Learning

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-IV Paper- II
Course Title: Advanced Deep Learning
Course Code:GNKPSCSMJ2504
Credits: 4

No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Understand the theoretical foundations and practical applications of neural networks and deep learning in various domains.
2	Identify and proficiently utilize relevant tools and libraries such as TensorFlow, PyTorch, and Keras for deep learning tasks.
3	Demonstrate a comprehensive understanding of neural networks and deep learning principles through practical implementation and experimentation.
4	Explore and manipulate the key parameters of neural networks, including but not limited to learning rate, batch size, activation functions, and layer architecture.
5	Recognize and analyze emerging applications of deep learning such as autonomous vehicles, medical image analysis, and natural language processing.
6	Implement various neural network architectures, including feedforward networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative adversarial networks (GANs).

7	Develop skills in implementing regularization techniques (e.g., dropout, L1/L2 regularization) and optimization algorithms (e.g., stochastic gradient descent, Adam) to improve neural network performance and prevent overfitting.
8	Master the implementation of advanced network architectures such as CNNs for image processing, RNNs for sequence modeling, and GANs for generative tasks.
9	Apply deep learning techniques to solve advanced real-world problems, including but not limited to object identification, speech recognition, and natural language understanding.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understand the context and use of neural networks and deep learning	PO1,PO2, P O4,PO6	PSO4	U,Ap,An
CO 2	Understand the tools and libraries for deep learning	PO1,PO2, P O6	PS O1, PS O2, PS O6	U,Ap,An
CO 3	Have a working knowledge of neural networks and deep learning	PO1,PO2.	PSO4.	U,Ap
CO 4	Explore the parameters for neural networks	PO1,PO2, P O3	PSO4.	U,Ap

CO 5	Identify emerging applications of deep learning	PO1,PO3, P O6	PSO4.	U,Ap
CO 6	Knowledge of implementing neural network architectures for deep learning.	PO1,PO2	PSO4	U,Ap
CO 7	Skill to implement regularization and optimization of neural network	PO1,PO2	PSO4	U,Ap,E
CO 8	Ability to implement advanced networks like CNN, RNN and GAN	PO1,PO2, P O6	PSO4	U,Ap
CO 9	Implement deep learning for advanced applications like object identification, speech, and language	PO1,PO2, P O3,PO6	PSO4	U,Ap

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		**Neural Network for Deep Learning**	**15**	
	1.1	Optimization and Neural Network: Review of Neural Network fundamentals, the problem of Learning, Implementing single Neuron- Linear and Logistic Regression.		**CO 1**
	1.2	Deep Learning: Fundamentals, Deep Learning Applications, Popular open-source libraries for deep learning		**CO 2**
	1.3	Deep Learning: Fundamentals, Deep Learning Applications, Popular open-source libraries for deep learning		**CO 3**

Unit 2		**Convolutional and Recurrent Networks for Deep Learning**	**15**	
	2.1	Regularization: Complex Network and Overfitting, Regularization and related concepts, Hyperparameter tuning		**CO 4**
	2.2	Convolutional Neural Networks:Kernels and Filters,Building Blocks of CNN, Inception Network, Transfer Learning		**CO 5**
	2.3	Recurrent Neural Network: Notation and Idea of recurrent neural networks, RNN Topologies, backpropagation through time, vanishing and exploding gradients		**CO 6**
Unit 3		**Advanced Concepts for Deep Learning**	**15**	
	3.1	Autoencoders: Introduction, Network Design, Regularization in Autoencoders, Denoising autoencoders, Feed-Forward Autoencoders, spare and Contractive autoencoders		**CO 7**
	3.2	Unsupervised Feature Learning: Hopfield networks and Boltzmann machines, restricted Boltzmann machine, Deep belief networks		**CO 8**
	3.3	Generative Adversarial Networks (GANs):Introduction, training algorithms, Conditional GANs, applications, Deep convolutional generative adversarial networks		**C0 9**
Unit 4		**Deep Learning Application**	**15**	

	4.1	Deep Learning for AI Games: AI Game Playing, Reinforcement learning, Maximizing future rewards, Q-learning, The deep Q- network as a Q-function, Balancing exploration with exploitation, Experience replay, or the value of experience		**CO 10**
	4.2	Deep Learning for Object Localization and classification: Intersect Over Union (IoU), Sliding Window Approach, Region-Based CNN (R-CNN)		**CO 11**
	4.3	Deep Learning for Language Modelling and Speech Recognition		**C0 12**

References:

1. Python Deep Learning, Valentino Zocca, Packt Publication, 2017

2. Applied Deep Learning, with TensorFlow 2, Umberto Michelucci, Apress, 2022

3. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017

4. Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018

5. Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017

6. Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017

Examination:

- Internal Examination (25 Marks): 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- End Semester theory examination (75 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- Combined passing of 40% with minimum 20% in Internal Component.

Course: MSc Computer Science
Practical Semester-IV
Course Title: Practical Paper-II -Advanced Deep Learning
Course Code:GNKPSCSMJ2P504

Credits: 02

No of Practical (Hours): 60
Marks: 75
Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand Neural Network Fundamentals:Explain the basic concepts of neural networks, including neurons, activation functions, layers, and feed-forward architecture.
2	Explore Optimization Techniques:Evaluate and compare different optimization algorithms used in training neural networks, such as gradient descent variants, and understand their impact on convergence and performance.
3	Apply Regularization Techniques:Implement regularization methods like L1/L2 regularization, dropout, and batch normalization to mitigate overfitting in neural network models.
4	Master Image Classification:Develop proficiency in applying deep learning techniques for image classification tasks, using datasets like CIFAR-10 and MNIST, with the ability to build and train feed-forward and convolutional neural network models.
5	Utilize Transfer Learning:Understand the principles of transfer learning and apply pre-trained models to new tasks, particularly in classifying datasets like cats versus dogs, demonstrating proficiency in adapting pre-existing models to new domains.
6	Experiment with Generative Models:Gain familiarity with generative adversarial networks (GANs) and their application in generating synthetic data, such as digits, demonstrating the ability to train and evaluate GAN architectures.
7	Explore Sequential Data Processing:Understand the architecture of recurrent neural networks (RNNs) and advanced models like LSTM, applying them to sequential data tasks such as rain prediction and sentiment analysis.
8	Develop Object Detection Skills:Acquire skills in object detection techniques, both traditional methods and using pre-trained models, enabling students to detect objects within images or video streams effectively.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understanding of Feed-forward Neural Networks: Students will be able to comprehend the architecture and functioning of feed-forward neural networks, including concepts such as activation functions, forward propagation, and backpropagation.	**P01,PO2**	**PS04**	**U,Ap**
CO 2	Familiarity with Optimization Techniques: Students will gain practical experience with various optimization techniques used in training neural networks, such as stochastic gradient descent (SGD), Adam, RMSprop, etc., and understand how they affect model convergence and performance	**P01,PO2**	**PS04**	**U,Ap,An**
CO 3	Knowledge of Regularization Techniques: Students will learn about regularization methods such as L1/L2 regularization, dropout, and batch normalization to prevent overfitting in neural networks, and be able to implement them effectively.	**P01,PO2**	**PS04**	**U,Ap,An**

CO 4	Deep Learning for Image Classification: Students will gain proficiency in using deep learning techniques for image classification tasks, demonstrated through implementing models like feed-forward networks for CIFAR-10 and convolutional neural networks (CNNs) for MNIST digit recognition.	**P01,PO2**	**PS04**	**U,Ap.**
CO 5	Transfer Learning: Students will understand the concept of transfer learning and its application in leveraging pre-trained models to solve tasks on new datasets, illustrated through the classification of the cats versus dogs dataset using transfer learning techniques.	**P01,PO2**	**PS04**	**U,Ap.**
CO 6	Generative Adversarial Networks (GANs): Students will be introduced to GANs and their application in generating synthetic data, such as synthetic digits, demonstrating understanding of adversarial training and generator-discriminator architectures.	**P01,PO2**	**PS04**	**U,Ap.**
CO 7	Recurrent Neural Networks (RNNs): Students will learn about sequential data processing using RNNs, including basic RNN architectures and advanced models like Long Short-Term Memory (LSTM), applied to tasks like rain prediction and sentiment analysis.	**P01,PO2**	**PS04**	**U,Ap.**

CO 8	Object Detection: Students will develop skills in object detection techniques using both traditional methods and pre-trained models, enabling them to detect objects within images or video streams.	**P01,PO2**	**PS04**	**U,Ap,An.**

List of Experiments:

Note: Following practical can be performed using python.

1	Implement Feed-forward Neural Network and train the network with different optimizers and compare the results.
2	Write a Program to implement regularization to prevent the model from overfitting.
3	Implement deep learning for recognizing classes for datasets like CIFAR-10 images for previously unseen images and assign them to one of the 10 classes.
4	Implement deep learning for the Prediction of the autoencoder from the test data (e.g. MNIST data set)
5	Implement Convolutional Neural Network for Digit Recognition on the MNIST Dataset
6	Write a program to implement Transfer Learning on the suitable dataset (e.g. classify the cats versus dogs dataset from Kaggle).
7	Write a program for the Implementation of a Generative Adversarial Network for generating synthetic shapes (like digits)
8	Write a program to implement a simple form of a recurrent neural network. a. E.g. (4-to-1 RNN) to show that the quantity of rain on a certain day also depends on the values of the previous day b. LSTM for sentiment analysis on datasets like UMICH SI650 for similar.
9	Write a program for object detection from the image/video.
10	Write a program for object detection using pre-trained models to use object detection.

References:

1. Python Deep Learning, Valentino Zocca, Packt Publication, 2017
2. Applied Deep Learning, with TensorFlow 2, Umberto Michelucci, Apress, 2022
3. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017
4. Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018
5. Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017
6. Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017

Examination (Total Marks): 75 M
Experiment Marks: Experiment 1= 30 + Experiment 2= 30
Journal Marks: 05
Viva Marks: 05 + 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

(Elective paper- I)

Name of the paper: Trends in Cloud Computing

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science
Semester-IV Paper-Elective-1
Course Title: Trends in Cloud Computing
Course Code:GNKPSCSEL1504
Credits: 3
No of lectures (Hours): 60 Marks: 100
(75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand the principles of Cloud Computing
2	Apply the appropriate Cloud Services to various scenarios.
3	Deploy, manage and operate applications Cloud Platforms.
4	Develop skills for implementing cloud solutions for various scenarios.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Learners will comprehend concepts in cloud technologies and stay abreast of recent trends in the field.	**PO1, PO 2, PO 3, PO8**	**PSO5**	**R, An, E**

CO 2	Design, develop & deploy real-world applications in the cloud computing platforms	**PO2, PO4, PO5, PO10**	**PSO5**	**U, An E**
CO 3	Describe the standardization process of the cloud platform and various API's used in Cloud Computing	**PO6, PO7, PO10,**	**PSO5**	**C, U, An**
CO 4	Describe the methods for managing the data in the cloud	**PO3, PO4, PO5, PO7**	**PSO5**	**C, U, E**
CO5	Analyze and use of an appropriate framework and APIs for the task	**PO6, PO7, PO10,**	**PSO5**	**C, Ap, An**

Unit		Title	No. of lectures	CO Mapping
Unit 1		Basic Concepts & Techniques for Cloud Application Development	15	
	1.1	**Fundamentals of Cloud Application Development:** Business case for implementing cloud application, Requirements collection for cloud application development, Cloud service models and deployment models		CO 1
	1.2	Open challenges in Cloud Computing: Cloud interoperability and standards, scalability and fault tolerance, security, trust, and privacy		CO 2
	1.3	**Application Development framework:** Accessing the clouds: Web application vs Cloud Application, Frameworks: Model View Controller (MVC). Cloud		CO2 & CO 3

		platforms in Industry – Google AppEngine, Microsoft Azure, Openshift, CloudFoundry		
Unit 2		**Cloud Service Delivery Environment and API**	15	
	2.1	**Sessions and API:** Storing objects in the Cloud, Session management, Working with third party APIs: Overview of interconnectivity in Cloud ecosystems. Facebook API, Twitter API, Google API.		CO2 & CO 3
	2.2	**Architecting for the Cloud:** Best practices in architecture cloud applications in AWS cloud, Amazon Simple Queue Service (SQS), RabbitMQ		CO2 & CO 4
	2.3	**Managing the data in the Cloud:** Securing data in the cloud, ACL, OAuth, OpenID, XACML, securing data for transport in the cloud, scalability of applications and cloud services.		CO 4
Unit 3		**DevOps Azure & GCP Essentials**	15	
	3.1	**Basics of DevOps:** Introduction to DevOps, Continuous Deployment: Containerization with Docker, Orchestration (Kubernetes and Terraform), Automating Infrastructure on Cloud, Application Deployment and Orchestration using ECS, ECR & EKS, Application Deployment using Beanstalk, Configuration Management using OpsWorks		CO2 ,CO3 & CO4

	3.2	**Azure essentials:** Azure Compute and Storage, Azure Database and Networking, Monitoring and Managing Azure Solutions, GCP Compute and Storage, GCP Networking and Security, Google App Engine (PaaS)		CO2 ,CO3 & CO4
	3.3	**Cloud applications**: Amazon Simple Notification Service (Amazon SNS), multi-player online game hosting on cloud resources, building content delivery networks using clouds		C03

TEXTBOOKS:

1. Kevin L. Jackson. Scott Goessling, Architecting Cloud Computing Solutions,Packt Publishing 2018
2. Shailendra Singh, Cloud Computing: Focuses on the Latest Developments in Cloud Computing, Oxford University Press; First edition, June 2018

REFERENCE BOOKS:

1. JJ GEEWAX, Google Cloud Platform in Action, Manning Publications Co, 2018
2. Haishi Bai, Dan Stolts, Santiago Fernández Muñoz, Exam Ref 70-535 Architecting Microsoft Azure Solutions, Pearson Education, 2018
3. Dr. Kumar Saurabh, Cloud Computing, 4ed: Architecting Next-Gen Transformation Paradigms, Wiley, 2017

Examination:

- Internal Examination (25 Marks): 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.

- End Semester theory examination (75 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- Combined passing of 40% with minimum 20% in Internal Component.

Course: MSc Computer Science
Practical Semester-IV
Course Title: Practical Paper-Elective-1 Trends in Cloud Computing
Course Code:GNKPSCSEL1P504
Credits: 02

No of Practical (Hours): 60
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To develop and deploy services for cloud
2	To understand Kubernetes and deploy applications on Azure Kubernetes Service
3	To understand DevOps for Azure
4	To follow the DevOps practices for software development
5	To build APIs for Azure and AWS

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Creating and using Web application using MVC Framework	**PO1, PO2,**	**PSO5**	**R, An, E**
CO 2	Build and deploy services to Azure Kubernetes service.	**PO3, PO6**	**PSO5**	**U, An E**
CO 3	Understand and build the DevOps way.	**PO4, PO5**	**PSO5**	**C, U, An**
CO 4	Thoroughly build the applications in the DevOps way.	**PO6, PO8**	**PSO5**	**C, U, E**
CO 5	Build the APIs for Microsoft Azure and AWS.	**PO6,PO 7**	**PSO5**	**C, Ap, An**

List of Experiments:

Note: Learners are expected to create free accounts with various Cloud Computing providers and try to explore different technologies.

1	Using the software like / API / Tools JDK 1.7/1.8, Eclipse IDE, Dropbox API, Apache tomcat server 7.0/8.0,Google AppEngine API, Servlets, Struts, Spring framework design and develop Web applications using MVC Framework
2	Installing and configuring the required platform for Google App Engine
3	Studying the features of the GAE PaaS model.
4	Creating and running Web applications (Guest book, MVC) on localhost and deploying the same in Google App Engine
5	Developing an ASP.NET based web application on the Azure platform
6	Creating an application in Dropbox to store data securely. Develop a source code using Dropbox API for updating and retrieving files.

7	Installing Cloud Foundry in localhost and exploring CF commands.
8	Cloud application development using IBM Bluemix Cloud.
9	Installing and Configuring Dockers in localhost and running multiple images on a Docker Platform.
10	Configuring and deploying VMs/Dockers using Chef/Puppet Automation tool

Mooc Course
Course Name: AWS Academy Cloud Foundations (ACF) **Link:** **https://www.awsacademy.com/servlet/servlet.FileDownload?file=0151K000003qL84QAE**

Examination (Total Marks): 50 M
Experiment Marks: 40
Journal Marks: 05
Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

(Elective paper- II)

Name of the paper: Simulation and Modeling

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science Semester-IV Elective
Paper Course Title: Simulation and Modeling
Course Code:GNKPSCSEL2504
Credits: 3

No of lectures (Hours): 45
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand the fundamentals of simulation modeling and its importance in various domains.
2	Develop skills in conceptual modeling, including defining and communicating conceptual models effectively.
3	Learn data collection and analysis techniques essential for accurate simulation modeling.
4	Gain proficiency in model verification and validation to ensure the reliability of simulation results.
5	Explore different types of simulation modeling methods, including system dynamics, discrete event modeling, and agent-based modeling.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Students will be able to articulate the significance of simulation modeling and its applicability in diverse fields.	**PO1, PO2**	**PSO4**	**R, U, An**
CO 2	Students will be capable of constructing and communicating conceptual models to represent real-world systems accurately.	**PO3, PO4**	**PSO4**	**C, E, An**
CO 3	Students will demonstrate proficiency in collecting and analyzing data required for simulation modeling, effectively managing variability and uncertainty.	**PO3, PO6**	**PSO4**	**An, Ap, E**
CO 4	Students will apply techniques for model verification and validation, ensuring the credibility and reliability of simulation results.	**PO3, PO4, PO5**	**PSO4**	**Ap, E**
CO 5	Students will develop practical skills in various simulation modeling methods, including system dynamics, discrete event modeling, and agent-based modeling, and utilize them to solve real- world problems effectively.	**PO6, PO7, PO8**	**PSO4**	**U, C, E**

Unit		Title	No. of lectures	CO Mapping
Unit 1		**Introduction**	**15**	
	1.1	Introduction to Simulation, Need of Simulation, Time to simulate, Inside simulation software: Modeling the progress of Time, Modeling Variability		**CO 1**
	1.2	Conceptual Modeling: Introduction to Conceptual modeling, Defining conceptual model, Requirements of the conceptual model		**CO 2**
	1.3	Communicating the conceptual model, Developing the Conceptual Model: Introduction, A framework for conceptual modeling, methods of model simplification.		**CO 3**
Unit 2		Model Verification and Validation	**15**	
	2.1	Data Collection and Analysis: Introduction, Data requirements, Obtaining data, Representing unpredictable variability, Selecting statistical distributions. Obtaining Accurate Results: Introduction		**CO 4**

	2.2	The nature of simulation models and simulation output, Issues in obtaining accurate simulation results, example model, dealing with initialization bias: warm- up and initial conditions, Selecting the number of replications and run- length. Searching the Solution Space: Introduction, The nature of simulation experimentation, Analysis of results from a single scenario, Comparing alternatives		**CO 5**
	2.3	Search experimentation, and Sensitive analysis. Verification, Validation and Confidence: Introduction, Defining Verification and Validation, The difficulties of verification and validation, Methods of verification and validation, Independent verification and validation.		**CO 2**
Unit 3		Modeling and simulation modeling	**15**	
	3.1	Types of models, Analytical vs Simulation modeling, Application of simulation modeling, Level of abstraction, Simulation Modeling. Methods, System Dynamics, Discrete Event Modeling, Agent Based modeling: Introduction to Agent, Agent-based modeling, Time in agent based models		**CO 3**
	3.2	Space in agent based models, Discrete space, Continuous space movement in continuous space, Communication between agents, Dynamic creation and destruction of agents, Statics on agent population, Condition triggered		**CO 1, CO 3**

		events and transition in agents.		
	3.3	Building agents based models: The problem statement, Phases of modeling, Assumptions, 3 D animation. Dynamics Systems: Stock and flow diagrams, examples of stock and flow diagrams. Multi-method modeling: Architecture, Technical aspects of combining modeling methods, Examples.		**C0 4, CO 5**

References:

1. Simulation: The Practice of Model Development and Use by Stewart Robinson, John Wiley and Sons, Ltd, 2004.

2. The Big Book of Simulation Modeling: Multi Method Modeling by Andrei Borshchev, 2013.

3. Agent Based Modeling and Simulation, Taylor S, 2014.

4. Simulation Modeling Handbook: A Practical Approach, Christopher A. Chung, 2003.

5. Object Oriented Simulation: A Modeling and Programming Perspective, Garrido, José M, 2009.

6. Simulation, Modeling and Analysis, Averill M Law and W. David Kelton, "Tata McGraw Hill, Third Edition, 2003.

7. Process Control: Modeling, Design and Simulation, Wayne Bequette W, Prentice Hall of India, 2003.

Examination:

- Internal Examination (25 Marks): 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- End Semester theory examination (75 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- Combined passing of 40% with minimum 20% in Internal Component.

Course: MSc Computer Science
Practical Semester-IV
Course Title: Practical Paper-Elective- Simulation and modeling
Course Code:GNKPSCSEL2P504
Credits: 02

No of Practical (Hours): 60
Marks: 50
Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Design and develop agent-based models to simulate real-world scenarios, focusing on creating agent populations, defining agent behaviors, and visualizing model outputs.
2	Enhance agent-based models by incorporating additional features such as word-of-mouth effects, product discards, and delivery times, applicable to scenarios like restaurants.
3	Extend agent-based models further to include complexities like agent impatience, parameter variations, and comparative analysis, suitable for market models.
4	Learn to design and develop system dynamic models using stock and flow diagrams, visualization plots, parameter variations, and calibration techniques, applied to scenarios like the spread of contagious diseases.

5	Develop discrete-event models to simulate processes, including resource allocation, 3D animation, and modeling delivery processes, relevant to scenarios such as manufacturing and shipping in a company.
6	Implement time-slice simulations for specific scenarios like airport models, to understand passenger movements and interactions within the airport environment.
7	Verify and validate simulation models, using techniques such as model calibration, sensitivity analysis, and comparison with empirical data, applicable to scenarios like bank operations or manufacturing processes.
8	Apply simulation modeling techniques to create defense models, focusing on simulating aircraft behavior for various defense applications.

Course Outcomes (COs):

Sr. No.	**On completing the course, the student will be able to:**	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Students will be able to design and develop agent-based models for various real-world scenarios, demonstrating proficiency in creating agent populations, defining behaviors, and visualizing outputs.	**PO1, PO2,**	**PSO4**	**R, An, E**
CO 2	Students will enhance their agent-based models by incorporating additional features and complexities, improving the accuracy and realism of simulations.	**PO3, PO6**	**PSO4**	**U, An E**

CO 3	Students will gain experience in extending agent-based models to address more complex scenarios, enabling them to analyze and compare different simulation runs effectively.	**PO4, PO5**	**PSO4**	**C, U, An**
CO 4	Students will demonstrate proficiency in designing and developing system dynamic models, including the creation of stock and flow diagrams and parameter variations, for understanding dynamic systems.	**PO6, PO8**	**PSO4**	**C, U, E**
CO 5	Students will develop discrete-event models for simulating processes in various domains, showcasing skills in resource allocation, 3D animation, and process modeling.	**PO6, PO7**	**PSO4**	**C, Ap, An**
CO 6	Students will acquire the ability to implement time-slice simulations for specific scenarios, allowing them to analyze and optimize system performance within constrained time frames.	**PO4, PO6**	**PSO4**	**R, U,An, E**
CO 7	Students will learn to verify and validate simulation models, ensuring the accuracy and reliability of the simulation results for practical applications.	**PO6, PO7, PO8**	**PSO4**	**C, U, E, Ap**
CO 8	Students will apply simulation modeling techniques to create defense models, contributing to the understanding and	**PO6, PO8**	**PSO4**	**Ap, C, E**

	analysis of complex defense systems and scenarios.			

List of Experiments : -

	Simulation and modelling
1	Design and develop agent based model by a) Creating the agent population b) Defining the agent behavior c) Add a chart to visualize the model output. [Use a case scenario like grocery store, telephone call center etc for the purpose].
2	Design and develop agent based model by a) Creating the agent population b) Defining the agent behavior c) Adding a chart to visualize the model output d) Adding word of mouth effect e) Considering product discards f) Considering delivery time [Use a case scenario like restaurant].
3	From practical 2 continue design and develop agent based model by a) Adding word of mouth effect b) Considering product discards c) Considering delivery time [Use a case scenario like restaurant].
4	Design and develop agent based model by a) Creating the agent population b) Defining the agent behavior c) Adding a chart to visualize the model output d) Adding word of mouth effect [Use a scenario like market model]
5	From practical 2 continue design and develop agent based model by a) Considering product discards b) Consider delivery time c) Simulating agent impatience d) Comparing model runs with different parameter values

10	Design and develop System Dynamic model by a) Creating a stock and flow diagram b) Adding a plot to visualize dynamics c) Parameter Variation d) Calibration [Use a case scenario like spread of contagious disease for the purpose]

6	Design and develop a discrete-event model that will simulate process by: a) Creating a simple model b) Adding resources c) Creating 3D animation d) Modeling delivery [Use a case situation like a company's manufacturing and shipping].
7	Design and develop time-slice simulation for a scenario like airport model to design how passengers move within a small airport that hosts two airlines, each with their own gate. Passengers arrive at the airport, check in, pass the security checkpoint and then go to the waiting area. After boarding starts, each airline's representatives check their passengers' tickets before they allow them to board.
8	Verify and validate a model developed like bank model or manufacturing model
9	Create defense model to stimulate aircraft behaviour

References:

1. Agent Based Modeling and Simulation, Taylor S, 2014.

2. Simulation Modeling Handbook: A Practical Approach, Christopher A. Chung, 2003.
3. Object Oriented Simulation: A Modeling and Programming Perspective, Garrido, José M, 2009.
4. Simulation, Modeling and Analysis, Averill M Law and W. David Kelton, "Tata McGraw Hill, Third Edition, 2003.

Examination (Total Marks): 50 M
Experiment Marks: 40
Journal Marks: 05
Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

(Elective paper- III)

Name of the paper: GIS and Remote Sensing

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Computer Science

Course: MSc-II Computer Science
Semester-IV Elective Paper
Course Title: GIS and Remote Sensing
Course Code:GNKPSCSEL3504
Credits: 3

No of lectures (Hours): 45
Marks: 100 (75:25)
Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Foundational Knowledge: Objective: Introduce students to the fundamental concepts, theories, and techniques of GIS and Remote Sensing.
2	Practical Skills Development: Objective: Equip students with practical skills in data acquisition, processing, analysis, and visualization using GIS and Remote Sensing software.
3	Advanced Applications: Objective: Familiarize students with advanced topics and applications of GIS and Remote Sensing, including spatial analysis, modelling, and environmental management.
4	Problem-Solving and Critical Thinking: Objective: Develop students' ability to apply GIS and Remote Sensing tools and methodologies to solve real-world spatial problems and challenges.
5	Interdisciplinary Perspective: Objective: Foster interdisciplinary perspectives by exploring the diverse applications of GIS and Remote Sensing in fields such as urban planning, disaster management, and environmental science.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Students will demonstrate an understanding of the fundamental principles and theories underlying GIS and Remote Sensing technologies.	PO1, PO2	PSO5	R, U
CO 2	Students will be proficient in acquiring, preprocessing, analyzing, and visualizing spatial data using GIS and Remote Sensing software.	PO3, PO5	PSO5	R, U, C, An
CO 3	Students will develop advanced skills in spatial analysis, modeling, and environmental management, enabling them to address complex spatial problems effectively.	PO4, PO6	PSO5	C, Ap, E
CO 4	Students will exhibit the ability to critically evaluate and apply GIS and Remote Sensing techniques to real-world scenarios, demonstrating problem-solving skills.	PO7, PO8	PSO5	An, E, Ap, C
CO 5	Students will gain interdisciplinary perspectives and appreciate the diverse applications of GIS and Remote Sensing across various domains, enhancing their readiness for diverse career opportunities.	PO4, PO7, PO8	PSO5	U, An Ap, E, C

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		Fundamentals of GIS and Remote Sensing	15	

	1.1	Introduction to GIS and Remote Sensing - Overview of Geographic Information Systems (GIS) and Remote Sensing Applications and significance in various fields		CO 1
	1.2	Spatial Data Acquisition and Processing -Sources of spatial data: satellite imagery, aerial photography, LiDAR, etc. Data preprocessing techniques: georeferencing, mosaicking, and image enhancement		CO 2
	1.3	Spatial Analysis and Modeling – Spatial analysis techniques: buffer analysis, overlay analysis, spatial interpolation Introduction to spatial modeling and simulation		CO 3
Unit 2		Advanced Topics in GIS and Remote Sensing	15	
	2.1	Remote Sensing Principles and Image Interpretation- Basic principles of remote sensing: electromagnetic spectrum, sensors, and platforms Image interpretation techniques: visual interpretation, digital image processing		CO 4
	2.2	Spatial Data Visualization and Cartography- Principles of cartography and map design Visualization techniques for spatial data presentation		CO 5
	2.3	G-IS Applications in Environmental Management- Environmental modeling and impact assessment using GIS Case studies in environmental management		CO 2

Unit 3		Spatial Data Analysis and Applications	15	
	3.1	Spatial Database Management Systems (DBMS)- Overview of spatial database concepts and systems Spatial data querying and analysis		CO 3
	3.2	GIS and Remote Sensing in Urban Planning- Applications of GIS and remote sensing in urban planning and management Urban growth modeling and land-use planning		CO 1, CO 3
	3.3	GIS in Disaster Management- Role of GIS in disaster risk assessment, mitigation, and response Case studies in disaster management		C0 4, CO 5

References:

1. "Geographic Information Systems and Science" by Paul A. Longley, et al.
2. "Remote Sensing and Image Interpretation" by Thomas Lillesand, et al.
3. "GIS Fundamentals: A First Text on Geographic Information Systems" by Paul Bolstad.
4. "Introduction to Geographic Information Systems" by Kang-tsung Chang.
5. "Principles of Geographic Information Systems" by John A. Bernhardsen.

Examination:

- Internal Examination (25 Marks): 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- End Semester theory examination (75 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- Combined passing of 40% with minimum 20% in Internal Component**.**

Course: MSc Computer Science
Practical Semester-IV
Course Title: Practical Paper-Elective- GIS and Remote Sensing
Course Code:GNKPSCSEL3P504
Credits: 02

No of Practical (Hours): 60
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Introduce students to GIS software interface and basic functionalities.
2	Provide hands-on experience in acquiring and preprocessing spatial data using GIS software.
3	Apply spatial analysis techniques using GIS software.
4	Provide hands-on experience in interpreting and classifying remote sensing images.
5	Teach students cartographic design principles and map production using GIS software.
6	Engage students in group projects focused on environmental modeling and impact assessment using GIS.
7	Provide hands-on experience in querying and analyzing spatial data using spatial Database Management Systems (DBMS).
8	Engage students in group projects focusing on urban planning and management using GIS and remote sensing.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Students will be able to navigate through GIS software interface, Students will gain familiarity with basic GIS tools and operations	**PO1**	**PSO5**	**R, An, E**
CO 2	Students will be proficient in acquiring spatial data from various sources.	**PO1, PO2**	**PSO5**	**R, U, An, C**
CO 3	Students will understand and apply spatial analysis methods such as buffer analysis, overlay analysis, and spatial interpolation.	**PO2, PO8**	**PSO5**	**An, U, Ap**
CO 4	Students will be able to classify land cover types and features accurately using remote sensing data.	**PO2, PO3**	**PSO5**	**C, E**
CO 5	Students will be able to design thematic maps that effectively communicate spatial information.	**PO3, PO6**	**PSO5**	**C, E, An**
CO 6	Students will produce comprehensive reports or presentations outlining environmental modeling methodologies and findings.	**PO4, PO5, PO8**	**PSO5**	**U, An, Ap,**
CO 7	Students will understand spatial database concepts and SQL queries for spatial data analysis.	**PO2, PO7**	**PSO5**	**U, Ap, E**
CO 8	Students will propose and implement solutions to urban planning challenges using GIS and remote sensing techniques.	**PO1, PO3, PO5, PO6**	**PSO5, PSO6**	**C, E**

List of Experiments:

Note: The practical's can be performed in ArcGIS, QGIS, GRASS GIS, etc. OR any other related software.

1	Introduction to GIS Software Familiarization with GIS software interface and basic functionalities.
2	Data Acquisition and Preprocessing Hands-on experience in acquiring and preprocessing spatial data using GIS software
3	Spatial Analysis Techniques Application of spatial analysis techniques using GIS software
4	Image Interpretation and Classification Hands-on experience in interpreting and classifying remote sensing images
5	Cartographic Design and Map Production Designing and producing thematic maps using GIS software
6	Environmental Modeling Projects Group projects on environmental modeling and impact assessment using GIS
7	Spatial Database Querying Hands-on experience in querying and analyzing spatial data using spatial DBMS
8	Urban Planning Projects Group projects on urban planning and management using GIS and remote sensing
9	Disaster Response Planning Developing disaster response plans and strategies using GIS-based spatial analysis and modeling. Simulating disaster scenarios and evaluating response strategies to enhance preparedness and resilience.
10	Case Studies in Disaster Management Analyzing real-world disaster events and emergency response efforts using GIS data and spatial analysis. Examining the role of GIS in disaster management through case studies from various regions and contexts.

References:

1) Geographic Information Science and Systems by Paul A. Longley, et al
2) Remote Sensing and Image Interpretation by Thomas Lillesand, et al
3) GIS Tutorial for ArcGIS Pro by Wilpen L. Gorr and Kristen S. Kurland
4) GIS Fundamentals: A First Text on Geographic Information Systems by Paul Bolstad
5) Remote Sensing and GIS for Ecologists: Using Open Source Software by Martin Wegmann
6) GIS for Urban and Regional Planning by Holloway and Shankar
7) Introduction to Spatial Econometrics by James LeSage and R. Kelley Paceta.
8) Cartography: Thematic Map Design by Borden D. Dent, et al.
9) PostGIS in Action" by Regina O. Obe and Leo S. Hsu
10) GIS and Environmental Modeling: Progress and Research Issues by Michael F. Goodchild, et al.

Examination (Total Marks): 50 M

Experiment Marks: 40

Journal Marks: 05

Viva Marks: 05

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Syllabus

Course: MSc-II Computer Science

Semester IV

Name of the paper: Research Project Implementation

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Course: MSc-II Computer Science
Semester-IV
Course Title: Research Project Implementation (RP)
Course Code:GNKPSCSRP504
Credits: 4
No of lectures (Hours): 120
Marks: 100

Course Code	Course Title	Credits
	Research Project Implementation	**04**
	Guidelines for Research Project Implementation ● A student is expected to devote at least 3 to 4 months of effort to the implementation. ● Students should submit a detailed project implementation report at the time of viva.	
	Guidelines for Documentation of Research Project Implementation A student should submit a project implementation report with the following details: ● **Title:** Title of the project. ● **Objective:** A detailed objective of the proposal is needed. ● **Related works:** A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 15 recent (last five years) research papers in addition to textbooks and web links in the relevant topic. ● **Methodology:** A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software, and data to be used. ● **Implementation details:** A description of how the project has been implemented. ● **Experimental setup and results:** A detailed explanation of how experiments were conducted, what software was used,	

	and the results obtained. Details like screenshots, tables, and graphs can come here. ● **Analysis of the results:** A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this. ● **Conclusion:** A conclusion of the project performed in terms of its outcome ● **Future enhancement:** A small description of what enhancement can be done when more time and resources are available ● **Program code:** The program code may be given as an appendix. The project documentation needs to be signed by the teacher in charge and head of the Department. Student should also attach the certified copy of the internal evaluation report (Appendix I) at the time of Project evaluation and viva as part of the University examination.	

Examination:

- **Internal Examination 50 Marks): Per week discussion with internal guide + Documentation.**
- **End Semester Project Viva examination (50 Marks): A learner will be evaluated based on innovation in research, implementation uniqueness and working of project.**
- **Combined passing of 40% with minimum 20% in both Components.**

Appendix-I

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

WEEK No	Day	Date	Name of the Topic/Module Completed	Remarks
	MONDAY			
	TUESDAY			
	WEDNESDAY			
	THRUSDAY			
	FRIDAY			
	SATURDAY			

Signature of the Faculty mentor: _____

Seal of the
University/College

___xxxx___

Course Outcomes

Bloom's Taxonomy categorizes educational objectives into six cognitive levels, listed from the simplest to the most complex.

The course outcomes (CO) are mapped to the revised Bloom's Taxonomy using the following Cognitive levels along with abbreviations: **Remembering-R, Understanding-U, Applying-Ap, Analyzing-An, Evaluating-E, Creating-C.**

R-Remembering: This level involves recalling facts, terms, basic concepts, and answers without necessarily understanding the meaning or implications.

U-Understanding: Understanding involves explaining ideas or concepts and interpreting them in one's own words to demonstrate comprehension.

Ap-Applying: Applying knowledge involves using acquired knowledge in new situations or applying it in different ways.

An-Analyzing: Analyzing involves breaking down information into parts to understand its organizational structure, recognizing patterns, and identifying relationships between components.

E-Evaluating: Evaluating involves making judgments based on criteria and standards, assessing the value of theories, presentations, or materials.

C-Creating: Creating involves putting elements together to form a coherent or functional whole, reorganizing elements into a new pattern or structure.

Use the following action verbs for Blooms taxonomy levels to prepare Course outcomes:

No	Levels	Action verbs
1	**Remember**	Choose, Describe, Define, Label List, Locate, Match, Memorize, Name, Omit, Recite, Select, State, Count, Draw, Outline, Point, Quote, Recall, Recognize, Repeat, Reproduce, Recall, Arrange, Duplicate, Tabulate.
2	**Understand**	Restate, Discuss, Clarify, Locate, Recognise, Classify, Translate, Explain, Express, Review, Interpret, Select, Summarise, Contrast, Predict, Associate, Estimate, Extend
3	**Apply**	Demonstrate, Schedule, Operate, Dramatize, Apply, Employ, Use, Practise, Illustrate, Choose, Solve, Write, Calculate, Complete, Show, Examine, Modify, Relate, Classify, Experiment.
4	**Analyse**	Distinguish, Differentiate, Investigate, Categorise, Appraise, Inspect, Test, Debate, Compare, Contrast, Question
5	**Evaluate**	Judge, Score, Select, Evaluate, Choose, Rate, Assess, Compare, Estimate, Value, Measure, Discriminate, Argue, Defend, Support, Conclude, Summarize, Appraise, Revise.
6	**Create**	Compose, Assemble, Organise, Plan, Collect, Propose, Construct, Design, Create, Formulate, Arrange, Devise, Modify, Derive, Develop, Integrate, Rearrange, Substitute, Invent, Generalise.

PROGRAMME OUTCOMES

(PO) MASTERS IN SCIENCE

(MSc)

The undergraduate and postgraduate Programmes in Sciences will instil in the students a scientific temper and impart a holistic education through the following outcomes:

PO1	**Advanced Understanding: Attain an advanced understanding of specialized scientific areas and theories, building upon undergraduate knowledge.**
PO2	**Advanced Analytical Skills: Develop advanced analytical and problem-solving skills for complex scientific issues.**
PO3	**Research Proficiency: Acquire proficiency in scientific research, contributing significantly to the advancement of knowledge.**
PO4	**Leadership Skills: Develop leadership skills to lead scientific initiatives and contribute to the scientific community.**
PO5	**Interdisciplinary Collaboration: Collaborate effectively with interdisciplinary teams for comprehensive scientific solutions.**
PO6	**Innovation and Creativity: Foster innovation and creativity in scientific research and practice.**
PO7	**Professionalism: Demonstrate professionalism and excellence in all scientific endeavours.**
PO8	**Quality Improvement: Embrace self-evaluation and continuous improvement for achieving excellence in scientific pursuits.**

Programme: MSc Computer Science

Programme Specific Outcomes (PSOs) for MSc in Computer Science

Sr. No.	A student completing MSc in Computer Science will be able to:
PSO 1	Proficiency in Networking and Security ● Demonstrate a comprehensive understanding of wireless networking principles and protocols, along with the ability to design, implement, and troubleshoot wireless network infrastructures. ● Possess advanced knowledge and skills in cyber security, including risk assessment techniques, threat analysis, security policies, and incident response mechanisms.
PSO 2	Expertise in Emerging Technologies ● Acquire specialized knowledge in advanced computing, particularly focusing on Web3 technologies, decentralized applications, blockchain, and smart contracts. ● Understand and apply concepts of fuzzy systems to solve complex real-world problems, including pattern recognition, decision making, and control systems.
PSO 3	Proficiency in Computational Biology and Robotics ● Apply computational techniques to analyze biological data, predict molecular structures, and understand biological processes through bioinformatics and computational biology methodologies. ● Design, develop, and deploy robotic systems with proficiency in robot kinematics, dynamics, control algorithms, and sensor integration.
PSO 4	Mastery in Deep Learning and Data Analysis ● Gain expertise in deep learning methodologies, including neural network architectures, optimization algorithms, and applications in computer vision, natural language processing, and speech recognition. ● Analyze and interpret data using advanced data analysis techniques, including simulation, modeling, and machine learning algorithms.
PSO 5	Specialization in Cloud Computing and Geographic Information Systems (GIS)

	● Understand the latest trends and advancements in cloud computing, including virtualization, containerization, serverless computing, and hybrid cloud architectures. ● Apply GIS and remote sensing techniques to analyze spatial data, perform geospatial analysis, and develop applications for environmental monitoring, urban planning, and disaster management.
PSO 6	Research and Innovation ● Conduct independent research projects, exploring current trends and challenges in computer science domains such as robotics, deep learning, cloud computing, and cyber security. ● Demonstrate the ability to formulate research problems, conduct literature reviews, design experiments, collect and analyze data, and present findings effectively through research papers, reports, and presentations.