Shiromani Gurudwara Parbandhak Committee's

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

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: TYBSc

Semester V and VI

(Name of Subject: Computer Science)

(As per NEP guidelines-DSC model)

With effect from Academic Year 2025 - 2026)

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

Program Structure

Semester- V

Course Name	Teaching Hours		Credits Assigned			Marks		
	Theory	Practical	Theory	Practical	Total	Theory	Practical	Total
Major-Paper-I Artificial Intelligence GNKUSCSMJ1105	45	30	3	1	4	75	25	100
Major-Paper-II Information and Network Security GNKUSCSMJ2105	45	30	3	1	4	75	25	100
Major- Paper- III Linux Server Administration GNKUSCSMJ3105	45	30	3	1	4	75	25	100
Elective Paper1 Cyber Forensics GNKUSCSEL1105 **Elective Paper2** **Architecting of IoT** **GNKUSCSEL2105**	45	30	3	1	4	75	25	100
Vocational Skill Course (VSC) Software Engineering & Testing GNKUSCSVSC105	--	60	--	2	2		50	50
OJT- On Job Training GNKUSCSOJT105	--	--	--	--	4	--	--	100
	180	180	12	6	22	300	150	550

*** Prerequisite courses to be done (Mandatory for all students)**

Data Structures

Android Application Development

Advanced Python Programming

Semester-VI

Course Name	Teaching Hours		Credits Assigned			Marks		
	Theory	**Practical**	**Theory**	**Practical**	**Total**	**Theory**	**Practical**	**Total**
Major Paper-I Data Science GNKUSCSMJ1106	45	30	3	1	4	75	25	100
Major Paper-II Cloud Computing GNKUSCSMJ2106	45	30	3	1	4	75	25	100
Major Paper- III Wireless and Sensor Networks GNKUSCSMJ3106	45	30	3	1	4	75	25	100
Elective Paper1 **Ethical Hacking** **GNKUSCSEL1106** Elective Paper2 Information Retrieval GNKUSCSEL2106	45	30	3	1	4	75	25	100
Minor Paper Computer Networks GNKUSCSMI1106	15	30	1	1	2	25	25	50
Co-curricular Course (CC) GNKUSCSCC106	--	--	--	--	2	--	--	50
Field project (FP) GNKUSCSFP106	–	--	--	--	2	--	--	50
	195	150	12	6	22	325	125	550

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

PROGRAMME OUTCOMES (PO)

BACHELOR OF SCIENCE (BSc)

PO1	**Foundational Understanding:** Develop a foundational understanding of core scientific principles and theories across various disciplines of science.
PO2	**Analytical Skills:** Develop analytical and problem-solving skills to critically analyse scientific problems and apply scientific methodologies.
PO3	**Global Perspective:** Gain a global perspective by understanding diverse scientific issues and incorporating ethical considerations in scientific practices.
PO4	**Research Awareness:** Gain awareness of research methodologies and techniques, preparing for future research endeavours.
PO5	**Holistic Development:** Experience holistic development by embracing values of humanism, empathy, and social responsibility in scientific pursuits.
PO6	**Communication Skills:** Enhance communication skills to effectively convey scientific concepts to diverse audiences
PO7	**Continuous Learning:** Develop a commitment to lifelong learning and staying updated with advancements in science.
PO8	**Ethical Practices:** Understand and adhere to ethical standards in scientific research and practice.

Department of Computer Science

Programme: BSC

Programme Specific Outcomes (PSOs) for BSc in Computer Science

Sr. No.	A student completing BSc in Computer Science will be able to:
PSO 1	Gain comprehensive understanding across various domains of information technology to facilitate advanced studies and research.
PSO 2	Cultivate analytical and problem-solving proficiencies essential for tackling real-world challenges within the field.
PSO 3	Master the art of communicating technical concepts and designs effectively to diverse audiences.
PSO 4	Foster collaborative teamwork skills, emphasizing constant communication and cooperation to develop innovative projects.
PSO 5	Apply contemporary tools and techniques proficiently to analyze system concepts and available data, enabling informed decision-making.
PSO 6	Demonstrate proficiency in reading and utilizing programming language documentation to develop, modify, and optimize systems for practical applications.
PSO 7	Develop adept technical writing skills tailored to effectively communicate information technology-related concepts.
PSO 8	Acquire expertise in database programming, encompassing design, implementation, and management of databases
PSO 9	Attain proficiency in developing predictive and clustering models, leveraging statistical and machine learning techniques for data analysis.Acquire skills in data visualization to present complex information in a clear and insightful manner.
PSO 10	Establish foundational knowledge in digital logic to understand fundamental principles underlying computer systems and architectures.

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

Course: T.Y.B.Sc. CS
Semester-V: Major- I
Course Title: Artificial Intelligence
Course Code: GNKUSCSMJ1106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand The Foundations,history, and state of the art AI.
2	Learnabout intelligentagents,their environments,andthestructureofagents.
3	Explore Different Problem-solving strategies,including uninformed and informed search techniques.
4	Gain knowledge of knowledge representation and reasoning methods,and apply them to solve complex problems.
5	Develop An Understanding Of Machine Learning Techniques,including classification,regression,and ensemble learning.

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 knowledge of the foundations and key concepts in field of AI.	PO1	PSO1	U,Ap, An
CO 2	Analyze and design intelligent agents for specific environments.	PO1, PO2	PSO2	Ap,E
CO 3	Apply problem-solving techniques and algorithms to find solutions to different types of problems.	PO2	PSO2,PSO5	An, E, C
CO 4	Construct knowledge representation models and use reasoning techniques to derive knowledge.	PO1,PO2	PSO5	C
CO 5	Implement Machine-	PO7,PO8	PSO5,PSO9	E,C

	learning algorithms and evaluate their performance for classification and regression tasks.			

Unit		Title	No. of lectures	CO Mapping
Unit 1			**15**	
	1.1	**Introduction to AI and Intelligent Agents** **What Is AI:** Foundations, History and State of the Art of AI		**CO1**
	1.2	**Intelligent Agents:** Agents and Environments, Nature of Environments,Structureof Agents.		**CO2**
	1.3	**ProblemSolvingbysearching:**Problem SolvingAgents,UninformedSearchStrategies, Informed(Heuristic)Search Strategies		**CO3**
Unit 2			**15**	
	2.1	**Learning from Examples**: Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis,		**CO5**
	2.2	Theory of Learning, Regression and Classification with Linear Models		**CO2**
	2.3	Artificial Neural Networks, Nonparametric Models, Support Vector Machines, Ensemble Learning, Practical Machine Learning		**CO1**
Unit 3			**15**	
	3.1	Learning probabilistic models: Statistical Learning, Learning with Complete Data		**CO7**
	3.2	Learning with Hidden Variables: The EM Algorithm		**CO8**
	3.3	Reinforcement learning: Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Applications of Reinforcement Learning.		**CO6**

References:

1. Artificial Intelligence:A Modern Approach,Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010
2. Artificial Intelligence: Foundations of Computational Agents, David L Poole, Alan K. Mackworth, 2nd Edition, Cambridge University Press, 2017.
3. Artificial Intelligence, Kevin Knight and Elaine Rich,3rd Edition, 20173) TheElements of Statistical Learning, Trevor Hastie, Robert Tibshirani and JeromeFriedman, Springer, 2013

Total Marks: 75 Marks

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours
- Combined passing of 40% with minimum 20% in Internal Component.

Course: TY B.Sc. CS Practical
Semester-V: Major-I
Course Title: Artificial Intelligence
Course Code: GNKUSCSMJ1P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand The Foundations,history, and state of the art AI.
2	Learnabout intelligentagents,their environments,andthestructureofagents.
3	Explore Different Problem-solving strategies,including uninformed and informed search techniques.
4	Gain knowledge of knowledge representation and reasoning methods,and apply them to solve complex problems.
5	Develop An Understanding Of Machine Learning Techniques,including classification,regression,and ensemble learning.

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 knowledge of the foundations and key concepts in field of AI.	PO1	PSO1	U,Ap, An
CO 2	Analyze and design intelligent agents for specific environments.	PO1, PO2	PSO2	Ap,E
CO 3	Apply problem-solving techniques and algorithms to find solutions to different types of problems.	PO2	PSO2,PSO5	An, E, C

CO 4	Construct knowledge representation models and use reasoning techniques to derive knowledge.	PO1,PO2	PSO5	C
CO 5	Implement Machine-learning algorithms and evaluate their performance for classification and regression tasks.	PO7,PO8	PSO5,PSO9	E,C

List of Experiments:

1. Implement Breadth first search algorithm for Romanian map problem.
2. Implement Iterative deep depth first search for Romanian map problem.
3. Implement A* search algorithm for Romanian map problem.
4. Implement recursive best-first search algorithm for Romanian map problem.
5. Implement a decision tree learning algorithm for the restaurant waiting problem.
6. Implement feed forward back propagation neural network learning algorithm for the restaurant waiting problem.
7. Implement Adaboost ensemble learning algorithm for the restaurant waiting problem.
8. Implement Naive Bayes' learning algorithm for the restaurant waiting problem.
9. Implement passive reinforcement learning algorithm based on adaptive dynamic programming (ADP) for the 3 by 4 world problem.
10. Implement a passive reinforcement learning algorithm based on temporal differences (TD) for 3 by 4 world problem.

References:

1. Artificial Intelligence:A Modern Approach,Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010
2. Artificial Intelligence: Foundations of Computational Agents, David L Poole, Alan K. Mackworth, 2nd Edition, Cambridge University Press, 2017.
3. Artificial Intelligence, Kevin Knight and Elaine Rich,3rd Edition, 20173) TheElements of Statistical Learning, Trevor Hastie, Robert Tibshirani and JeromeFriedman, Springer, 2013

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-V: Major II
Course Title: Information & Network Security
Course Code:GNKUSCSMJ2106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Introduce Fundamental Security Principles: Provide students with a strong foundation in the core principles, models, and mechanisms of computer and network security.
2	Explore Cryptography Techniques: Equip students with knowledge of encryption methods, including symmetric and public-key cryptography, and help them understand their real-world applications, strengths, and limitations.
3	Understand Authentication and Key Management: Teach students how to implement various authentication and key management techniques to ensure secure communication and protect against unauthorized access.
4	Examine Secure Communication Protocols: Explore the concepts of message authentication, digital signatures, and authentication protocols to ensure the integrity and authenticity of communication systems.

5	Analyze Network Security Measures: Investigate security measures for protecting networks, including IP security, web security, intrusion detection, malware detection, and the design of firewalls.

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 Security Architectures and Attacks: Comprehend the fundamentals of security trends, the OSI security architecture, and the various types of security attacks, services, and mechanisms.	PO1, PO2, PO7	PSO 1, PSO 2, PSO 5, PSO 6	R,U,An
CO 2	Apply Classical Encryption Techniques: Utilize symmetric cipher models, substitution and transposition techniques, and understand block cipher principles to ensure data confidentiality and integrity.	PO1, PO7	PSO 3, PSO 5, PSO 6	Ap, U, An
CO 3	Implement Symmetric and Asymmetric Cryptographic Algorithms: Apply symmetric key algorithms such as DES and AES, and implement public-key cryptographic systems, including RSA and Diffie-Hellman key exchange.	PO1, PO7	PSO 3, PSO 5, PSO 6	Ap,U,An

CO 4	Understand and Apply Message Authentication and Hash Functions: Implement message authentication codes (MACs), hash functions, and understand their security roles in ensuring data authenticity, including HMAC and SHA.	PO1, PO2, PO7	PSO 3, PSO 5, PSO 6	Ap, U, An
CO 5	Implement Digital Signatures and Authentication Protocols: Understand and apply digital signature standards, including DSS, and implement authentication protocols like Kerberos and X.509 for secure communication.	PO1, PO7	PSO 3, PSO 5,	Ap, U, An
CO 6	Secure Email and Web Communication: Implement security protocols for email (PGP, S/MIME) and web security (SSL/TLS, SET) to protect sensitive information in electronic communications.	PO1, PO7	PSO 2, PSO 3, PSO 5,	Ap, U, An
CO 7	Counter Malicious Software Threats: Identify various malicious software (viruses, DDOS) and apply countermeasures to protect systems from these threats.	PO1, PO7	PSO 2, PSO 3, PSO 5,	Ap, U, An

Unit		**Title**	**No. of ectures**	**CO Mapping**
Unit 1			**15**	
	1.1	Introduction: Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms		**CO1**

	1.2	Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles,		**CO2**
	1.3	Symmetric Key Algorithm: The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers		**CO3**
Unit 2			**15**	
	2.1	Public-Key Cryptography and Key Management: Principles of Public-Key Cryptosystems, The RSA Algorithm, Key Management, Diffie- Hellman Key Exchange		**CO3**
	2.2	Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC		**CO4**
	2.3	Digital Signatures and Authentication Applications : Digital Signatures, Digital Signature Standard, Kerberos, X.509 Authentication, Public-Key Infrastructure		**CO5**
Unit 3			**15**	
	3.1	Electronic Mail Security: Pretty Good Privacy, S/MIME Intrusion: Intruders, Intrusion Techniques, Intrusion Detection		**CO6**
	3.2	Web Security: Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction		**CO6**
	3.3	Malicious Software: Viruses and Related Threats, Virus Countermeasures, DDOS Firewalls: Firewall Design Principles, Types of Firewalls		**CO7**

Textbook(s):

1. Cryptography and Network Security: Principles and Practice 7th edition, William Stallings, Pearson

Additional Reference(s):

1. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

2. Atul Kahate, “Cryptography and Network Security”, Tata McGraw-Hill.4

3. https://crypto.interactive-maths.com/

4. https://www.cryptool.org/en/cto/

5. https://www.geeksforgeeks.org/basics-of-cryptographic-algorithms/

Total Marks: 75 Marks

- **Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)**

- **End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours**

- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: T.Y.B.Sc. CS Practical
Semester-V: Major II
Course Title: Information & Network Security
Course Code: GNKUSCSMJ2P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

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 Security Architectures and Attacks: Comprehend the fundamentals of security trends, the OSI security architecture, and the various types of security attacks, services, and mechanisms.	PO1, PO2, PO7	PSO 1,PSO 2, PSO 5,PSO 6	R,U,An
CO 2	Apply Classical Encryption Techniques: Utilize symmetric cipher models, substitution and transposition techniques, and understand block cipher principles to ensure data confidentiality and integrity.	PO1, PO7	PSO 3,PSO 5, PSO 6	Ap, U, An

CO 3	Implement Symmetric and Asymmetric Cryptographic Algorithms: Apply symmetric key algorithms such as DES and AES, and implement public-key cryptographic systems, including RSA and Diffie-Hellman key exchange.	PO1, PO7	PSO 3,PSO 5, PSO 6	Ap,U,An
CO 4	Understand and Apply Message Authentication and Hash Functions: Implement message authentication codes (MACs), hash functions, and understand their security roles in ensuring data authenticity, including HMAC and SHA.	PO1, PO2, PO7	PSO 3,PSO 5, PSO 6	Ap, U, An
CO 5	Implement Digital Signatures and Authentication Protocols: Understand and apply digital signature standards, including DSS, and implement authentication protocols like Kerberos and X.509 for secure communication.	PO1, PO7	PSO 3,PSO 5,	Ap, U, An
CO 6	Secure Email and Web Communication: Implement security protocols for email (PGP, S/MIME) and web security (SSL/TLS, SET) to protect sensitive information in electronic communications.	PO1, PO7	PSO 2,PSO 3, PSO 5,	Ap, U, An
CO 7	Counter Malicious Software Threats: Identify various malicious software (viruses, DDOS) and apply countermeasures to protect systems from these threats.	PO1, PO7	PSO 2,PSO 3, PSO 5	Ap, U, An

References:

1. Cryptography and Network Security: Principles and Practice 7th edition, William Stallings, Pearson

2. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

3. Atul Kahate, “Cryptography and Network Security”, Tata McGraw-Hill.4

4. https://crypto.interactive-maths.com/

5. https://www.cryptool.org/en/cto/

6. https://www.geeksforgeeks.org/basics-of-cryptographic-algorithms/

List of Experiments:

Sr. No	Title
1.	Write programs to implement the following Substitution Cipher Techniques: - Caesar Cipher - Monoalphabetic Cipher
2.	Write programs to implement the following Substitution Cipher Techniques: - Vernam Cipher - Rail Fence Cipher
3.	Write program to encrypt and decrypt strings using - DES Algorithm - AES Algorithm
4.	Write a program to implement an RSA algorithm to perform encryption. Decryption of a given string.
5.	Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.
6.	Write a program to implement the MD5 algorithm to compute the message digest.
7.	Write a program to calculate HMAC-SHA1 Signature.

8.	Configure Windows Firewall to block: i. A port ii. A Program iii. A website
9.	Malware Analysis and Detection: Analyze and identify malware samples using antivirus tools, analyze their behavior, and develop countermeasures to mitigate their impact.
10.	Firewall Configuration and Rule-based Filtering: Configure and test firewall rules to control network traffic, filter packets based on specified criteria, and protect network resources from unauthorized access.

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

Course: T.Y.B.Sc. CS
Semester-V: Major III
Course Title: Linux Server Administration
Course Code: GNKUSCSMJ3106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Develop a solid understanding of Linux server administration principles and concepts.
2	Acquire practical skills in managing users, groups, and file systems in a Linux environment.
3	Learn how to configure and secure network services such as DNS, FTP, Apache web server, SMTP, POP, IMAP, and SSH.
4	Gain knowledge of advanced network administration topics including NFS, Samba, DFS, NIS, LDAP, DHCP, MySQL, LAMP applications, file services, email services, chat applications, andVPN.

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 managing software packages and repositories in Linux.	**PO1, PO2, PO5**	**PSO1, PSO2**	**Ap**

CO 2	Configure and administer user accounts, groups, and permissions in a Linux system.	**PO1, PO2, PO3**	**PSO1, PSO2**	**Ap,An**
CO 3	Implement network services such as DNS, FTP, and web servers, ensuring proper security measures.	**PO1, PO2, PO5, PO6**	**PSO2, PSO3**	**Ap,An**
CO 4	Design and manage advanced network services including NFS, Samba, and LDAPfor efficient file sharing and user authentication.	**PO1, PO2, PO4, PO5**	**PSO2, PSO3**	**An,E**
CO 5	Apply troubleshooting techniques to identify and resolve common issues in Linux server administration	**PO1, PO2, PO3, PO4, PO7, PO10**	**PSO2, PSO3**	**Ap,E**

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1			15	
	1.1	Introduction: Technical Summary of Linux Distributions, Managing Software .		CO1
	1.2	Single-Host Administration: Managing Users and Groups, Booting and shutting down processes. File Systems, Core System Services, Process of configuring, compiling, Linux Kernel.		CO2,CO5
	1.3	Networking and Security: TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security		CO3,CO5
Unit 2			15	

	2.1	Internet Services: Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server.		CO3
	2.2	Simple Mail Transfer Protocol (SMPT), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP).		CO3
	2.3	Secure Shell (SSH), Network authentication system (Kerberos), Domain Name Service (DNS), Security.		CO3, CO5
Unit 3			15	
	3.1	Internet Services: Network File System (NFS), Samba, Distributed File Systems (DFS), Network Information Service (NIS).		CO4
	3.2	Lightweight Directory Access Protocol (LDAP), Dynamic Host configuration Protocol (DHCP)		CO4
	3.3	MySQL, LAMP Applications, File Services, Email Services, Chat applications, Virtual Private Networking.		CO3, CO4, CO5

References:

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

Total Marks: 75 Marks

- **Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)**

- **End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours**

- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: TY B.Sc. CS Practical
Semester-V: Major -III
Course Title: Linux Server Administration
Course Code: GNKUSCSMJ3P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Develop a solid understanding of Linux server administration principles and concepts.
2	Acquire practical skills in managing users, groups, and file systems in a Linux environment.
3	Learn how to configure and secure network services such as DNS, FTP, Apache web server, SMTP, POP, IMAP, and SSH.
4	Gain knowledge of advanced network administration topics including NFS, Samba, DFS, NIS, LDAP, DHCP, MySQL, LAMP applications, file services, email services, chat applications, andVPN.

Course Outcomes (COs):

Sr. No.	On completing the urse, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Demonstrate understanding of Linux server administration principles and system architecture.	PO1, PO2	PSO1	Un, Ap
CO 2	Configure and manage users, groups, file systems, and essential Linux services.	PO1, PO2, PO3	PSO1, PSO2	Ap , An
CO 3	Install, configure, and secure essential network services like DNS, FTP, Apache, SMTP, POP, IMAP, and SSH.	PO1, PO2, PO5, PO6	PSO2, PSO3	Ap , An .
CO 4	Design and manage advanced network services including NFS, Samba, DFS, NIS, LDAP, and DHCP for seamless connectivity and resource sharing.	PO1, PO2, PO4, PO5	PSO2, PSO3	An, E
CO 5	Configure and troubleshoot services like MySQL, LAMP stack, file and mail servers, chat apps, and VPN to support dynamic applications.	PO1, PO2, PO4, PO5,PO10	PSO2, PSO3	Ap, E
CO 6	Apply effective security measures in Linux system and network services using tools like Netfilter, Kerberos, and SSH.	PO1, PO2, PO6 ,PO10	PSO2, PSO3	Ap, E

List of Experiments:

1. Install DHCP Server in Ubuntu 16.04
2. Initial settings: Add a User, Network Settings, Change to static IP address, DisableIPv6if not needed, Configure Service, display the list of services which are running. Stopand turn OFF auto-start setting for a service if you don’t need it, Sudo Settings
3. Configure NP Server (NTPd), Install and configure NTPd, Configure NTP Client (Ubuntu and Windows) ++

4. SSH Server : Password Authentication Configure SSH server to manage a server from the remote computer, SSHClient : (Ubuntu and Windows)
5. Install DNS server BIND, Configure DNS server which resolves domain name or IPaddress, Install BIND 9, Configure BIND, Limit ranges You allow to access if needed.
6. Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS server to share directories on your NFS, Configure NFS Client. (Ubuntu and Windows Client OS)
7. Configure LDDAP Server, Configure LDAP Server in order to share users' accountsinyour local networks, Add LDAP User Accounts In the networks. Install phpLDAPadmin to operate LDAP server via Web browser.
8. Configure NIS Server in order to share users; accounts in your local networks, Configure NIS Client to bind NIS Server.
9. Install MySQL to configure database server, Install phpMyAdmin to operate MySQLon web browser from Clients.
10. Install Samba to share folders or files between Windows and Linux

References:

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

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-V: Elective
Course Title: Cyber Forensic
Course Code: GNKUSCSEL1105
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand the principles and concepts of computer forensics.
2	Develop skills in conducting computer investigations using a systematic approach.
3	Gain proficiency in acquiring and preserving digital evidence from different storage formats.
4	Explore the use of specialized tools and software for computer forensics analysis.
5	Learn the techniques for investigating network-related incidents and conducting live acquisitions.

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 a solid understanding of the principles and techniques used in computer forensics investigations.	PO1 PO3 PO8	PSO 1 PSO 10	U
CO 2	Apply systematic approaches to acquire, preserve, and analyze digital evidence from various sources.	PO2 PO4 PO8	PSO 2 PSO 5	Ap
CO 3	Utilize specialized tools and software for conducting effective computer forensics analysis.	PO4 PO7 PO2	PSO 5 PSO 6	An,Ap
CO 4	Develop strong skills in investigating network-related incidents, including live acquisitions and network forensics.	PO2 PO3 PO8	PSO 2 PSO 9	An
CO 5	Generate comprehensive and well-written reports that accurately document the findings of computer forensic investigations.	PO5 PO6 PO8	PSO 3 PSO 7	C,E

Unit		Title	No. of lectures	CO Mapping
Unit 1			15	
	1.1	Introduction: Understanding Computer Forensics, Preparing for Computer Investigations, Maintaining Professional Conduct		CO 1

	1.2	Computer Investigations: Preparing a Computer Investigation, Taking a Systematic Approach, Procedures for Corporate High-Tech Investigations, Understanding Data Recovery Workstations and Software, Conducting an Investigation		CO 1
	1.3	Data Acquisition: Storage Formats for Digital Evidence, Determining the Best Acquisition Method, Contingency Planning for Image Acquisitions		CO 2
Unit 2			**15**	
	2.1	Processing Crime and Incident Scenes: Identifying Digital Evidence, Preparing for a Search, Securing a Computer Incident or Crime Scene, Seizing Digital Evidence at the Scene, Storing Digital Evidence		CO 2
	2.2	Current Computer Forensics Tools: Evaluating Computer Forensics Tool Needs, Computer Forensics Software Tools, Computer Forensics Hardware Tools		CO 3
	2.3	Computer Forensics Analysis and Validation: Determining What Data to Collect and Analyze, Validating Forensic Data, Addressing Data-Hiding Techniques, Performing Remote Acquisitions Recovering Graphics Files: Recognizing a Graphics File, Locating and Recovering Graphics Files, Identifying Unknown File Formats		CO 3
Unit 3			**15**	

	3.1	Network Forensics and Live Acquisitions: Network Forensics Overview, Performing Live Acquisitions, Developing Standard Procedures for Network Forensics, Using Network Tools		CO 4
	3.2	E-mail Investigations: Role of E-mail in Investigations, Investigating E- mail Crimes and Violations, Using Specialized E-mail Forensics Tools		CO 4
	3.3	Cell Phone and Mobile Device Forensics: Overview, Acquisition Procedures for Cell Phones and Mobile Devices Report Writing for Investigations: Importance of Reports, Guidelines for Writing Reports, Generating Report Findings with Forensics Software Tools		CO 5

References:

1. Bill Nelson,Amelia Philips and Christopher Steuart, "Guide to computer forensics and investigations", course technology,6th edition

2. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics",Tata McGrawHill

Total Marks: 75 Marks

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)

- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours

- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y.B.Sc. CS Practical

Semester-V: Elective
Course Title: Cyber Forensic
Course Code: GNKUSCSEL1P105
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand the principles and concepts of computer forensics.
2	Develop skills in conducting computer investigations using a systematic approach.
3	Gain proficiency in acquiring and preserving digital evidence from different storage formats.
4	Explore the use of specialized tools and software for computer forensics analysis.
5	Learn the techniques for investigating network-related incidents and conducting live acquisitions.

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 a solid understanding of the principles and techniques used in computer forensics investigations.	PO1 PO3 PO8	PSO 1 PSO 10	U
CO 2	Apply systematic approaches to acquire, preserve, and analyze digital evidence from various sources.	PO2 PO4 PO8	PSO 2 PSO 5	Ap
CO 3	Utilize specialized tools and software for conducting effective computer forensics analysis.	PO4 PO7 PO2	PSO 5 PSO 6	An,Ap
CO 4	Develop strong skills in investigating network-related incidents, including live acquisitions and network forensics.	PO2 PO3 PO8	PSO 2 PSO 9	An
CO 5	Generate comprehensive and well-written reports that accurately document the findings of computer forensic investigations.	PO5 PO6 PO8	PSO 3 PSO 7	C,E

References:

1. Bill Nelson,Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, course technology,6th edition

2. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”,Tata McGrawHill

List of Experiments:

Sr. No.	Title
1	Creating a Forensic Image using FTK Imager/Encase Imager : · Creating Forensic Image · Check Integrity of Data · Analyze Forensic Image
2	Data Acquisition: · Perform data acquisition using: · USB Write Blocker + Encase Imager · SATA Write Blocker + Encase Imager · Falcon Imaging Device
3	Analyze the memory dump of a running computer system. · Extract volatile data, such as open processes, network connections, and registry information.
4	Capturing and analyzing network packets using Wireshark (Fundamentals) : · Identification the live network · Capture Packets · Analyze the captured packets
5	Using Sysinternals tools for Network Tracking and Process Monitoring : · Check Sysinternals tools · Monitor Live Processes · Capture RAM · Capture TCP/UDP packets · Monitor Hard Disk · Monitor Virtual Memory · Monitor Cache Memory

6	Recovering and Inspecting deleted files · Check for Deleted Files · Recover the Deleted Files · Analyzing and Inspecting the recovered files · Perform this using recovery option in ENCASE and also Perform manually through command line
7	Steganography Detection · Detect hidden information or files within digital images using steganography analysis tools. · Extract and examine the hidden content.
8	Mobile Device Forensics · Perform a forensic analysis of a mobile device, such as a smartphone or tablet. · Retrieve call logs, text messages, and other relevant data for investigative purposes.

9	Email Forensics · Analyze email headers and content to trace the origin of suspicious emails. · Identify potential email forgeries or tampering.
10	Web Browser Forensics · Analyze browser artifacts, including history files, bookmarks, and download records. · Analyze cache and cookies data to reconstruct user-browsing history and identify visited websites or online activities. · Extract the relevant log or timestamp file, analyze its contents and interpret the timestamp data to determine the user's last internet activity and associated details.

Total Marks: 25 Marks

l Experiment Marks: 15 Marks

l Journal & Viva Marks: 5 + 5 Marks

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

Course: T.Y.B.Sc. CS
Semester-V: Elective
Course Title: Architecting of IoT
Course Code: GNKUSCSEL2P105
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	To provide learners with a solid understanding of the fundamental concepts and basic architecture of the Internet of Things (IoT).
2	To equip students with the skills required to design and develop IoT-enabled devices and systems.
3	To introduce learners to the evolving landscape of Machine-to-Machine (M2M) communication and the role of data analytics in IoT environments.
4	To discuss current trends, challenges, and advancements in the field of IoT and M2M communications.
5	To interpret IoT-generated data using basic analytics techniques to derive meaningful insights.

Course Outcomes:

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Describe the fundamental components of IoT architecture including its design principles, capabilities, and standardization considerations.	PO1, PO2	PSO 1,PSO 2	U
CO 2	Explain state-of-the-art IoT architectural models and reference frameworks including functional, information, deployment, and operational views.	PO2, PO3	PSO 3, PSO 5	R
CO 3	Compare and contrast various IoT architecture models and evaluate their applicability across different use cases.	PO6, PO7	PSO 4, PSO 6	U, E
CO 4	Identify and classify the protocols used in the Data Link and Network Layers of IoT including 3GPP MTC, IEEE 802.11/15,	PO4,PO5	PSO 7, PSO 8	Ap, C

	WirelessHART, Zigbee, 6LoWPAN, IPv6, RPL, and others.			
CO 5	Analyze the suitability of transport layer protocols (TCP, UDP, SCTP, etc.) and secure communication methods (TLS, DTLS) in IoT environments.	PO2, PO8	PSO 9,PSO 10	An, C
CO 6	Evaluate different session layer protocols (HTTP, CoAP, MQTT, AMQP, XMPP) based on efficiency, scalability, and real-time communication needs in IoT systems.	PO1, PO5	PSO 2, PSO 7	E , An
CO 7	Discuss service layer standards such as oneM2M, ETSI M2M, OMA, and BBF and their roles in enabling interoperability in IoT ecosystems.	PO6, PO7	PSO 8, PSO 9	R, U
CO 8	Integrate appropriate protocols and architecture components to design secure and efficient IoT communication stacks.	PO7, PO8	PSO 5, PSO 10	Ap, C
CO 9	Illustrate the flow of data through various protocol layers in an IoT system and its transformation across the architecture.	PO2, PO3	PSO 9, PSO 10	An, C

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1			**15**	
	1.1	IoT-An Architectural Overview: Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.		**CO 1**
	1.2	IoT Architecture-State of the Art : Introduction, State of the art, Reference Model and architecture,		**CO 2**
	1.3	IoT reference Model - IoT Reference Architecture Introduction, Functional View, Information view, Deployment and Operational View, Other Relevant architectural views.		**CO 3**
Unit 2			**15**	
	2.1	IoT Data Link Layer and Network Layer Protocols: PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15)		**CO 4**
	2.2	Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy DASH7		**CO 5**
	2.3	Network Layer:IPv4, IPv6, 6LoWPAN, DHCP, ICMP, RPL, CORPL.		**CO 6**
Unit			**15**	

3				
	3.1	Transport layer protocols : Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS)		**CO 7**
	3.2	Session layer: Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT		**CO 8**
	3.3	Service layer protocols: Service Layer -oneM2M, ETSI M2M, OMA, BBF		**CO 9**

References:

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle,1st Edition, Academic Press, 2014.
2. Learning Internet of Things, Peter Waher, PACKT publishing, BIRMINGHAM – MUMBAI,2015
3. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications,2013
4. Internet of Things (A Hands-onApproach), Vijay Madisetti and ArshdeepBahga,1st Edition, VPT, 2014.
5. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Total Marks: 75 Marks

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours
- Combined passing of 40% with minimum 20% in Internal Component.

Course: TY B.Sc. CS Practical
Semester-V: Elective
Course Title: Architecting of IoT
Course Code: GNKUSCSEL2P105
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	To develop foundational scripting skills using Bash and Python to automate tasks, launch applications, and manage system behavior on the Raspberry Pi.
2	To build competency in programming and logic development by writing Python scripts for mathematical computations and understanding concepts like recursion

	and iteration.
3	To interface the Raspberry Pi with external hardware components such as LCD displays, sensors, and actuators for real-time data collection and output display.
4	To implement network communication protocols including MQTT and TCP/IP using Python, enabling data transmission and remote control capabilities in IoT applications.
5	To design and deploy interactive web-based dashboards using Node-Red for visualizing sensor data, controlling GPIO, and automating tasks through browser-based interfaces.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Apply basic Bash scripting and system configuration skills to automate application launches and autostart processes on the Raspberry Pi.	PO1, PO2	PSO 1, PSO 2	R, Ap
CO 2	Develop and analyze Python programs for performing computational tasks, such as generating Fibonacci sequences using both recursion and iteration.	PO2, PO3	PSO 3, PSO 4	C, Ap
CO 3	Interface and control external hardware components (e.g., 16x2 LCD, MPU6050 sensor) using Raspberry Pi, and transmit sensor data via MQTT protocol	PO4, PO5	PSO 5, PSO 6	An, E
CO 4	Create and manage TCP client-server communication using Python to send messages and execute system commands programmatically.	PO7, PO8	PSO 6, PSO 7	C, An
CO 5	Design interactive web-based dashboards using Node-Red, incorporating data visualization tools (gauges, charts) and automation through JavaScript and email-triggered GPIO actions.	PO6, PO7, PO8	PSO 8, PSO 9, PSO 10	U, C

List of Experiments:

1. Write a basic bash script to open programs in kiosk mode. Learn how to autostart programs on boot.
2. Open the Python idle editor and run simple Python scripts to print Fibonacci numbers. Learn the comparison between Recursion output and function output.
3. Interface the Raspberry Pi with a 16x2 LCD and print values.
4. Interface with an Accelerometer Gyro Mpu6050 on the i2c bus and send sensor values over the internet via MQTT.
5. Set up a TCP server and TCP client on a Raspberry Pi using Python modules to send messages and execute shell commands from within Python such as starting

another application.

6. Write simple JavaScript functions in Node-Red, simple HTTP server page to measure temperature of Raspberry Pi using node red.
7. Create a user interface with gauge to display any real-world scenario in the dashboard.
8. Use Node-red to explore charts to create a dashboard.
9. Explore Node-red to use multiple components with a web browser.
10. Run the node red editor, run simple programs, and trigger GPIO by sending an E-mail.

References:

1. Internet of Things: IoT Practicals Kindle Edition, by Umesh Kumar, Depanshu Goyal
2. Practical Internet of Things Networking, Understanding IoT Layered architecture, Rolando Herrero

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Course: T.Y.B.Sc. CS
Semester-V: Vocational Skill Course (VSC)
Course Title: Software Engineering & Testing
Course Code: GNKUSCSVSC105
Credits: 2
No of lectures (Hours): 60
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To learn and understand the Concepts of Software Engineering
2	To learn and understand Software Development Life Cycle
3	To apply the project management and analysis principles to software project development.
4	To apply the design & testing principles to software project development.
5	

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Plan a software engineering process life cycle, including the specification, design, implementation, and testing of software systems that meet specification, performance, maintenance and quality requirements	PO1,PO2, PO4	PSO2	U,Ap.An
CO 2	Analyze and translate a specification into a design, and then realize that design practically, using an appropriate software engineering methodology.	PO4	PSO3	An, C
CO 3	Know how to develop the code from the design and effectively apply relevant standards and perform testing, and quality management and practice	PO2,PO7	PSO3,PSO4	Ap, E,C
CO 4	Able to use modern engineering tools necessary for software project management,testing, time management and software reuse.	PO8	PSO7	Ap, C

List of Experiments:

1. Write down the problem statement for a suggested system of relevance
2. Perform requirement analysis and develop Software Requirement Specification Sheet(SRS) for the suggested system.
3. Draw the function oriented diagram: Data Flow Diagram (DFD) and Structured chart.
4. Draw the user‘s view analysis for the suggested system: Use case diagram.
5. Draw the structural view diagram for the system: Class diagram, object diagram.
6. Draw the behavioral view diagram : State-chart diagram, Activity diagram
7. Draw the behavioral view diagram for the suggested system: Sequence diagram, Collaboration diagram
8. Draw the implementation and environmental view diagram: Component diagram, Deployment diagram
9. Perform Estimation of effort using FP Estimation
10. Prepare time line chart/Gantt Chart/PERT Chart
11. Develop test cases for unit testing and integration testing
12. Develop test cases for various white box and black box testing

References:

1. Software Engineering, A Practitioner’s Approach, Roger S, Pressman, 2019
2. Software Engineering: principles and Practices, Deepak Jain, OXFORD University Press, 2008
3. Software Engineering, Ian Sommerville, Pearson Education, 2017
4. Fundamentals of Software Engineering, Fourth Edition, Rajib Mall, PHI, 2018

Total Marks: 50

- **Experiment Marks: 40 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Major I
Course Title: Data Science
Course Code: GNKUSCSMJ1106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand Foundations and scope of DataScience, including its applications and comparison fields like Business Intelligence andArtificialIntelligence.
2	Develop skills in data preprocessing, including cleaning, transforming, selecting, and merging data,to ensure data quality and suitability for analysis.
3	Gain knowledge of machine learning algorithms and techniques, such as regression, classification, clustering, and ensemble learning,to build predictive models and make data-driven decisions.
4	Learn how to evaluate and select models using appropriate evaluation metrics sandcross validation techniques ensure reliable and robust model performance.
5	Develop Proficiency in data visualization techniques and tools to effectively communicate insights and tell compelling stories using data.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Apply data preprocessing techniques to clean and transform raw data,handle missing values and outliers ,and merge datasets.	PO1	PSO1, PSO2	U, Ap,An
CO 2	Implement machine learning algorithms to perform tasks such as regression, classification, clustering and ensemble learning.	PO2, PO4	PSO3,PSO 7	An, E
CO 3	Evaluate and compare different machine learning models using appropriate evaluation metrics and cross-validation techniques.	PO2, PO3	PSO3,PSO 7,	E, C
CO 4	Create informative and visually appealing data visualizations to communicate insights and patterns in data.	PO1,PO4	PSO9	C
CO 5	Understand the principles and practices of data management,including data governance,data quality assurance,and data privacy considerations.	PO4,PO7	PSO	R, U, Ap

Unit		Title	No. of lectures	CO Mapping
Unit 1			**15**	
	1.1	**Introduction to Data Science and Data Preprocessing**: **What is Data Science?:**Definition and scope of Data Science, Applications and domains of Data Science, Comparison with other fields like Business Intelligence(BI), Artificial		**CO1**

		Intelligence(AI),Machine Learning(ML), and Data Warehousing/Data Mining(DW-DM)		
	1.2	**Data Types and Sources:** Different types of data: structured, unstructured, semi-structured, Data sources: databases, files, APIs, web scraping, sensors, social media		**CO1,CO2**
	1.3	**DataPreprocessing:**Data Cleaning:handling missing values,outliers,duplicates, Data Transformation:scaling,normalization,encoding categorical variables,Feature Selection:selecting relevant features/columns,Data Merging: combining multiple datasets **Data Wrangling and Feature Engineering:** Data wrangling techniques:reshaping,pivoting,aggregating,Feature Engineering:creating new features,handling time-series data Dummification: converting categorical variables into binary indicators,Feature Scaling: standardization, normalization **ToolsandLibraries:**Introduction to popular libraries and technologies used in Data SciencelikePandas, NumPy, Sci-kit Learn,etc.		**CO3**
Unit 2			**15**	
	2.1	**DataAnalysisandMachineLearning ExploratoryDataAnalysis(EDA):** Data Visualization Techniques: histograms, scatterplots, boxplots etc., Descriptive statistics: mean,median,mode, standard deviation, etc., Hypothesis testing: t-tests, chi-square tests,ANOVA,etc.		**CO4**
	2.2	**IntroductiontoMachineLearning:** Supervised Learning: classification and regression, Unsupervised learning: clustering and dimensionality reduction, Bias-variance tradeoff, underfitting, and overfitting		**CO3,CO4**
	2.3	**Regression Analysis:** Simple linear regression, Multiple linear regression,Stepwise regression, Logistic Regression For Classification		**CO2, CO3**
Unit 3			**15**	
	3.1	**Model Evaluation and Selection:** Techniques For Evaluating Model Performance: accuracy, precision, recall, F1-		**CO3**

		score, Confusion matrix and ROC curve analysis,Cross-validation:k-fold cross validation,stratified cross-validation, Hyperparameter Tuning And model selection		
	3.2	**Data Visualization and Communication:** Principles Of Effective data visualization, Types of visualizations: bar charts, line charts, scatter plots,etc. Visualization tools: matplotlib, seaborn, Tableau, etc. Data storytelling:communicating insights through visualizations		**CO4**
	3.3	**DataManagement:** Introduction To Data Management Activities,Data Pipelines: data extraction,transformation,and loading(ETL), Data governance and data quality assurance, Data Privacy And Security Considerations		**CO5**

References:

1. Data Science from Scratch First Principles with Python-Joel Grus O'reilly, 2nd Edition

2. Advancingin Analytics From Excel to Python and R,George Mount,Oreilly,FirstEdition

3. Introduction to Machine Learning with Python,Andreas. Muller,Sarah Guido, Oreilly, FirstEdition

Total Marks: 75 Marks

- **Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)**
- **End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours**
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: TY B.Sc. CS Practical
Semester-V: Major I
Course Title: Data Science
Course Code: GNKUSCSMJ1P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand Foundations and scope of DataScience, including its applications and comparison fields like Business Intelligence andArtificialIntelligence.
2	Develop skills in data preprocessing, including cleaning, transforming, selecting, and merging data,to ensure data quality and suitability for analysis.
3	Gain knowledge of machine learning algorithms and techniques, such as regression, classification, clustering, and ensemble learning,to build predictive models and make data-driven decisions.
4	Learn how to evaluate and select models using appropriate evaluation metrics sandcross validation techniques ensure reliable and robust model performance.
5	Develop Proficiency in data visualization techniques and tools to effectively communicate insights and tell compelling stories using data.

Course Outcomes (COs):

Sr. No.	On completing the course, the udent will be able to:	POs addressed	PSOs ddressed	Cognitive Levels addressed
CO 1	Apply data preprocessing techniques to clean and transform raw data,handle missing values and outliers ,and merge datasets.	PO1	PSO1, PSO2	U, Ap,An

CO 2	Implement machine learning algorithms to perform tasks such as regression, classification, clustering and ensemble learning.	PO2, PO4	PSO3,PSO 7	An, E
CO 3	Evaluate and compare different machine learning models using appropriate evaluation metrics and cross-validation techniques.	PO2, PO3	PSO3,PSO 7,	E, C
CO 4	Create informative and visually appealing data visualizations to communicate insights and patterns in data.	PO1,PO4	PSO9	C
CO 5	Understand the principles and practices of data management,including data governance,data quality assurance,and data privacy considerations.	PO4,PO7	PSO	R, U, Ap

List of Experiments:

1. Introduction to Excel Perform conditional formatting on a dataset using various criteria. Create A Pivot table to analyze and summarize data. Use VLOOKUP function to retrieve information from different worksheet portable. Performwhat-if analysis using Goal Seek to determine input values for desired output.
2. Data Frames and Basic DataPre-processing Read data from CSV and JSON files into a dataframe. Perform basic data source-processing tasks such as handling missing values and outliers. Manipulate and transform data using functions like filtering,sorting,and grouping.
3. Feature Scaling and Dummification Apply feature scaling techniques like standardization and normalization to numerical features. Perform feature dummification to convert categorical variables into numerical representations.
4. HypothesisTesting Formulate Null and alternative hypotheses for given problem. Conduct a hypothesis test using appropriate statistical tests(e.g.,t-test,chi squaretest). Interpret The Results And draw conclusions based interest outcomes.
5. ANOVA(AnalysisofVariance) Perform One-wayANOVA to compare means across multiplegroups. Conduct post-hoc tests to identify significant differences between group means.
6. Regression and ItsTypes Implements linear regression using Dataset. Explore and interpret the regression model coefficients goodness-of-fit measures.

Extend the analysis to multiple linear regression and assess the impact of additional predictors.

7. LogisticRegressionand DecisionTree Buildalogisticregressionmodel to predict a binary outcome. Evaluate the model' sperformance using classification metrics(e.g.,accuracy,precision,recall). Construct a decisio tree model and interpret the decision rules for classification.
8. K-MeansClustering Apply the-Meansalgorithmt Group Similar Data Points Into Clusters. Determine the optimal number of clusters using elbow method or silhouette analysis. Visualizetheclusteringresultsandanalyzetheclustercharacteristics.
9. PrincipalComponentAnalysis(PCA) Perform PCA on a data set to reduce dimensionality. Evaluate the explained variance and select the appropriate number of principal components. Visualize the data in the reduced-dimensional space.
10. Data Visualization and Storytelling Create meaningful visualizations using data visualization tools Combine Multiple Visualizations to tell a compelling datastory. Present the findings and insights in a clear and concise manner.

References:

1. Data Science from Scratch First Principles with Python-Joel Grus O'reilly, 2nd Edition
2. Advancingin Analytics From Excel to Python and R,George Mount,Oreilly,FirstEdition
3. Introduction to Machine Learning with Python,Andreas. Muller,Sarah Guido, Oreilly, FirstEdition

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Major Paper II
Course Title: Cloud Computing and Web Services
Course Code: GNKUSCSMJ2106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Understand the basics of cloud computing, including types of clouds, deployment models, and essential characteristics of cloud platforms.
2	Explore web services technologies such as SOAP and REST and understand their role in distributed computing and parallel computing.
3	Gain proficiency in utilizing virtualization technologies, including creating virtual machines and managing virtualized environments using tools like KVM and oVirt.
4	Explore and utilize popular cloud computing platforms such as OpenStack and AWS to architect, deploy, and manage cloud-based applications and services.
5	Learn about cloud security fundamentals, including confidentiality, integrity, availability, and secure development practices.

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 a comprehensive understanding of cloud computing concepts, including different types of clouds and their characteristics.	PO1, PO2	PSO 1	U,R,An
CO 2	Implement and utilize web service technologies, such as SOAP and REST, to develop distributed and parallel computing applications.	PO2, PO4	PSO 2	Ap,U,C
CO 3	Design, deploy, and manage cloud-based applications and services using popular cloud computing platforms such as OpenStack and AWS.	PO2 PO4 PO7	PSO 2, PSO 5	Ap,C, An
CO 4	Apply secure development practices and implement cloud security policies to ensure the confidentiality, integrity, and availability of cloud software solutions.	PO2 PO7	PSO 2, PSO 3	Ap, U, E
CO 5	Utilize virtualization technologies to create and manage virtualized environments, considering the benefits and drawbacks of virtualization.	PO1, PO7	PSO 5, PSO 6	Ap,U, An

Unit		Title	No. of lectures	CO apping
1				
	1.1	**Introduction to Cloud Computing:** Definition, Types of Clouds, Deployment of software solutions and web applications, Types of Cloud Platforms, Essential characteristics – On- demand self-service, Broad network access, Location independent resource pooling ,Rapid elasticity , Measured service, Comparing cloud providers with traditional IT service providers		CO 2
	1.2	**Cloud Computing Software Security fundamentals:** Cloud Information Security Objectives, Confidentiality, Integrity, Availability, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Secure Development practices, Approaches to Cloud Software Requirement Engineering, Cloud Security Policy Implementation.		CO 1, CO 4
2				
	2.1	**Web Services –** Distributed Computing, Parallel Computing, WSDL structure, SOAP- Structure of SOAP Message (In JAX-WS), SOAP Messaging Architecture, SOAP Header, Client-side SOAP Handler,		CO 2
	2.2	**REST Web Services:** REST- What is REST? HTTP methods, Java API for RESTful Web Services (JAX- RS)		CO 2
	2.3	**Virtulization:-** Characteristics of Virtualized Environments.. Pros and Cons of Virtualization. Virtualization using KVM, Creating virtual machines, oVirt - management tool for virtualization environment.		CO 5
3				
	3.1	CloudSim: Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code,		CO 3

		CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim,		
	3.2	AWS: Architecting on AWS, Building complex solutions with Amazon Virtual Private Cloud (Amazon VPC)		**CO 3**
	3.3	OpenStack: Introduction to OpenStack, OpenStack test-drive, Basic OpenStack operations, OpenStack CLI and APIs, Tenant model operations, Quotas, Private cloud building blocks, Controller deployment, Networking deployment, Block Storage deployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application orchestration using OpenStack Heat		**CO 3**

References:

1. Java Web Services Up and Running 2nd edition, Martin Kalin, O'Reilly (2013)

2. Pro Power Shell for Amazon Web Services, Brian Beach, Apress, 2014

3. Enterprise Cloud Computing Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010

4. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013

5. OpenStack in Action, V. K. CODY BUMGARDNER, Manning Publications Co, 2016

6. OpenStack Essentials, Dan Radez, PACKT Publishing, 2015 2

7. OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014

8. https://www.openstack.org

Total Marks: 75 Marks

- **Internal Examination (15 Marks)**: 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)

- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours

- Combined passing of 40% with minimum 20% in Internal Component.

Course: TY B.Sc. CS Practical

Semester-VI: Major Paper II
Course Title: Cloud Computing and Web Services
Course Code: GNKUSCSMJ2P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Understand the basics of cloud computing, including types of clouds, deployment models, and essential characteristics of cloud platforms.
2	Explore web services technologies such as SOAP and REST and understand their role in distributed computing and parallel computing.
3	Gain proficiency in utilizing virtualization technologies, including creating virtual machines and managing virtualized environments using tools like KVM and oVirt.
4	Explore and utilize popular cloud computing platforms such as OpenStack and AWS to architect, deploy, and manage cloud-based applications and services.
5	Learn about cloud security fundamentals, including confidentiality, integrity, availability, and secure development practices.

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 a comprehensive understanding of cloud computing concepts, including different types of clouds and their characteristics.	PO1, PO2	PSO 1	U,R,An
CO 2	Implement and utilize web service technologies, such as SOAP and REST, to develop distributed and parallel computing applications.	PO2, PO4	PSO 2	Ap,U,C
CO 3	Design, deploy, and manage cloud-based applications and services using popular cloud computing platforms such as OpenStack and AWS.	PO2 PO4 PO7	PSO 2, PSO 5	Ap,C, An
CO 4	Apply secure development practices and implement cloud security policies to ensure the confidentiality, integrity, and availability of cloud software solutions.	PO2 PO7	PSO 2, PSO 3	Ap, U, E
CO 5	Utilize virtualization technologies to create and manage virtualized environments, considering the benefits and drawbacks of virtualization.	PO1, PO7	PSO 5, PSO 6	Ap,U, An

List of Experiments:

Sr. No.	**Title**
1.	To create a Simple Web Service CurrencyConverter in Java that converts the INR to dollars. Also create a Java client to consume it.
2.	To create a Simple Web Service UnitConverter in Java that converts the m to cm. Also create a .Net client to consume it.
3.	To create a Simple Web Service UnitConverter in Java that converts the m to cm. Also create a Python client to consume it.

4.	To create a Simple Web Service CurrencyConverter in .Net that converts the INR to dollars. Also create a .Net client to consume it
5.	Create a Simple REST Service.
6.	Create Virtual Machines(VM) of Ubuntu and Windows 10 using i. VMWare Workstation ii. Oracle VirtualBox
7.	Installation and Configuration of virtualization using KVM.
8.	Implement FOSS-Cloud Functionality Virtual Server Infrastructure(VSI) for creating Virtual Machine.
9.	Implement FOSS-Cloud Functionality for demonstrating Software as a Service (PaaS).
10.	Develop application to download image/video from server or upload image/video to server using MTOM techniques

References:

1. Java Web Services Up and Running 2nd edition, Martin Kalin, O'Reilly (2013)

2. Pro Power Shell for Amazon Web Services, Brian Beach, Apress, 2014

3. Enterprise Cloud Computing Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010

4. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013

5. https://www.openstack.org

6.https://youtube.com/playlist?list=PLSDyGb_vtanxjbp9uqn-UHpmza7A2MMRF&si=mNuy_C0wuZNhcjBK

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Major Paper III
Course Title: Wireless and Sensor Network
Course Code: GNKUSCSMJ3106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	To provide a foundational understanding of Wireless Sensor Networks by exploring their architectural elements, applications, advantages, challenges, and sensor node technologies.
2	To analyze and evaluate the components of radio communication and network architectures in WSNs, including optimization goals, design principles, service interfaces, and gateway concepts.
3	To understand the role of operating systems and ad-hoc networks in WSNs, focusing on their characteristics, energy efficiency, security, privacy concerns, and examples of existing WSN operating systems.
4	To examine communication protocols in WSNs, including Medium Access Control (MAC), routing protocols, and transport control protocols, through case studies such as IEEE 802.15.4 LR-WPANs and Sensor-MAC.

5	To explore wireless and mobile communication technologies such as GSM, DECT, UMTS, and satellite systems, emphasizing system architectures, protocols, signal transmission methods, and handover/localization techniques.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Describe the basic architecture, components, and applications of Wireless Sensor Networks (WSNs), along with their advantages and challenges.	PO1, PO7	PSO 1, PSO2	R, U
CO 2	Analyze sensor node technology and radio communication principles including signal propagation, antennas, and modulation techniques.	PO2, PO3	PSO 3, PSO 4	Ap, An
CO 3	Evaluate WSN network architectures, optimization goals, service interfaces, and design principles for efficient and scalable sensor network design.	PO3, PO4	PSO 5, PSO 6	E, C
CO 4	Explain the functionality and architecture of Wireless Sensor Network Operating Systems and identify the key challenges in ad-hoc networks related to energy efficiency, security, and privacy.	PO5, PO6	PSO 6, PSO 7	C
CO 5	Assess the role of Medium Access Control (MAC) protocols in WSNs with a focus on the Sensor-MAC protocol and its operational characteristics.	PO1, PO7	PSO 8, PSO 9	U, Ap

CO 6	Identify and analyze routing challenges and strategies in WSNs with emphasis on IEEE 802.15.4 LR-WPANs and other routing approaches.	PO2, PO8	PSO 3, PSO 4	An
CO 7	Compare traditional transport control protocols and understand the design issues in developing efficient transport protocols for WSNs and middleware architectures.	PO1, PO2	PSO 9, PSO 10	An, E
CO 8	Understand the principles of wireless transmission including frequency selection, multiplexing, spread spectrum, and cellular system fundamentals.	PO5, PO7	PSO 6, PSO 7	U
CO 9	Explain the system architecture, radio protocols, and services offered by GSM, DECT, UMTS, and satellite communication systems (GEO, LEO, MEO), including handover and localization mechanisms.	PO6, PO7, PO8	PSO 8, PSO 9, PSO 10	R, C

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1			15	

	1.1	History of Wireless and Sensor Networks in India, Early Developments (Pre-2000s), Emergence of WSNs (2000–2010). Basic Sensor Network Architectural Elements, Advantage and challenges, Applications, Sensor Node Technology. Growth and Application (2010–2020)		CO 1
	1.2	Radio Technology, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts. Wireless Sensor Network Operating Systems and Ad-hoc Networks: Overview of Wireless Sensor Network Operating Systems,		CO 2
	1.3	Characteristics and Challenges of Ad-hoc Networks in WSNs, Energy Efficiency Considerations in Ad-hoc Networks, Security and Privacy in Ad- hoc Networks, Examples of WSN OS, Ad-hoc Network.		CO 3
Unit 2			15	
	2.1	Medium Access Control Protocol: Fundamentals of MAC Protocols, Sensor-MAC Case Study, Routing in WSN: Routing Challenges and Design Issues in Wireless Sensor Networks		CO 4
	2.2	IEEE 802.15.4 LR-WPANs Standard Case Study, Routing Strategies in Wireless Sensor Networks,		CO 5
	2.3	Transport Control Protocol: Traditional Transport Control Protocols, Transport Protocol Design Issues, WSN Middleware Architecture. Recent Trends (2020–Present).		CO 6
Unit 3			15	

	3.1	Wireless Transmission: Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems.		CO 7
	3.2	GSM: Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services;		CO 8
	3.3	History of Satellite System in India, beginnings (1960s–1970s), Experimental Phase (1970s–1980s), Operational Phase (1990s), Technological Growth (2000s), Global Recognition and Breakthroughs (2010–Present) Satellite Systems: Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover.		CO 9

References:

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

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

3. Mobile communication, Second Edition, Jochan Schiller, Pearson

4. Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian Poellabauer, Wiley Series on wireless Communication and Mobile Computing, 2011

5. Networking Wireless Sensors, Bhaskar Krishnamachari, Cambridge University Press, 2005

Total Marks: 75 Marks

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)

- **End Semester theory examination (60 Marks)**: Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours

- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: TY B.Sc. CS Practical
Semester-VI: Major Paper III
Course Title: Wireless and Sensor Network
Course Code: GNKUSCSMJ3P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	To introduce students to the fundamental hardware components of Wireless Sensor Networks (WSNs) such as sensor motes, base stations, and graphical interfaces, enabling them to understand the physical structure and operation of sensor nodes.
2	To develop an in-depth understanding of network communication protocols in WSNs, including IPv6 static and dynamic routing, ICMP, and the use of ping packets for network diagnostics.
3	To enable students to analyze and interpret routing tables, gaining skills in reading and understanding network paths, metrics, and decision-making processes within WSN environments.
4	To equip students with hands-on skills in simulating and implementing WSN functionalities, such as MAC protocols, mobile ad hoc networks (MANETs) with directional antennas, and home/office automation scenarios.

5	To provide practical exposure to mobile communication systems, including the simulation of mobile networks involving cell towers, servers, and smartphones to demonstrate real-time connectivity and communication workflows.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Identify and explain the components of sensor node hardware including sensors, motes, base stations, and GUI interfaces used in Wireless Sensor Networks (WSNs).	PO1, PO2	PSO 1, PSO 2	R, U
CO 2	Configure and analyze static and dynamic IPv6 routing in a wireless sensor network and utilize ICMP tools such as ping for network diagnostics.	PO1, PO2, PO4	PSO 3, PSO 4	Ap, An
CO 3	Interpret and evaluate routing tables to understand data transmission paths and decision-making within a network.	PO3, PO4, PO8	PSO 5, PSO 6	An, E
CO 4	Design and implement simulations of wireless sensor networks and MAC protocols to analyze communication efficiency and network performance.	PO4, PO6	PSO 7, PSO 8	An, C

CO 5	Develop and demonstrate simulations of mobile networks and ad hoc networks, including real-world applications such as home automation, office automation, and mobile communication through cell towers.	PO5, PO7, PO8	PSO 9, PSO 10	R, C

List of Experiments:

1. Understanding the Sensor Node Hardware. (For Eg. Sensors, Nodes (Sensor mote), Base Station, Graphical User Interface.)

2. Understanding static / Dynamic routing.

3. Use of ICMP and Ping packets in WSN.

4. Understanding, Reading and Analyzing Routing Table of a network.

5. Implement a Wireless sensor network simulation.

6. Create MAC protocol simulation implementation for wireless sensor Network.

7. Simulate Mobile Adhoc Network with Directional Antenna. (e.g. Home Automation)

8. Create a mobile network using Cell Tower, Central Office Server, Web browser and Web Server. Simulate connection between them

9. Implement Office automation using WSN.

10. Demonstrate Smartphone communication using Mobile cell towers.

References:

1. Packet Tracer Network Simulator by Jesin A, PACKT Publishing.

2. Cisco Packet Tracer Implementation: Building and Configuring Networks: 1, by S R Jena

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Elective I
Course Title: Ethical Hacking
Course Code: GNKUSCSEL1106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Understand the terminology and concepts related to ethical hacking and penetration testing.
2	Explore various hacking technologies and the skills required to become an ethical hacker.
3	Learn the different phases involved in ethical hacking and the methodologies used in penetration testing.
4	Gain knowledge of common hacking techniques, such as footprinting, scanning, enumeration, and session hijacking.
5	Develop proficiency in identifying and exploiting vulnerabilities in web servers, web applications, and wireless networks.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Apply ethical hacking methodologies to conduct comprehensive security assessments and penetration tests.	PO1,PO3	PSO1,PSO 2	U,Ap,An
CO 2	Perform effective footprinting and reconnaissance techniques to gather critical information about target systems.	PO2	PSO2	Ap
CO 3	Identify and exploit vulnerabilities in various network and system components using appropriate tools and techniques.	PO3,PO4	PSO3, PSO5	Ap, E
CO 4	Evaluate the security posture of web servers, web applications, and wireless networks, and recommend appropriate countermeasures.	PO4,PO7	PSO4. PSO5, PSO6	Ap, E, C
CO 5	Demonstrate an understanding of ethical and legal considerations in conducting ethical hacking activities and adhere to professional codes of conduct.	PO6,PO7	PSO6, PSO7	Ap, E, C

Unit		Title	No. of lectures	CO Mapping
Unit 1			**15**	
	1.1	**Introduction:** Terminology, Hacking Technology Types, Ethical Hacking Phases, Hacktivism, Hacker Classes, Skills Required for an Ethical Hacker, Vulnerability Research, Ways to Conduct Ethical Hacking		**CO1,CO2**
	1.2	**Footprinting:** Definition, Information Gathering Methodology, Competitive Intelligence, DNS Enumeration, Whois and ARIN Lookups, Types of DNS Records, Traceroute in Footprinting, E-Mail Tracking **Social Engineering:** Common Types Of Attacks		**CO2**
	1.3	**Scanning and Enumeration:** Port Scanning, Network Scanning, Techniques, Nmap Command Switches, SYN, Stealth, XMAS, NULL, IDLE, FIN Scans, Anonymizers, HTTP Tunneling Techniques, IP Spoofing Techniques, SNMP Enumeration, Steps Involved in Enumeration Vulnerability Scanning, CEH Scanning Methodology, Ping Sweep		**CO2,CO3**
Unit 2			**15**	
	2.1	**System Hacking:** Password-Cracking Techniques, Types of Passwords, Keyloggers and Other Spyware Technologies, Escalating Privileges, Rootkits		**CO3,CO4**
	2.2	**Sniffers:** Protocols Susceptible to Sniffing, Active and Passive Sniffing, ARP Poisoning,		**CO3,CO4**

		MAC Flooding, DNS Spoofing Techniques, Sniffing Countermeasures **Denial of Service:** Types of DoS Attacks, Working of DoS Attacks,BOTs/BOTNETs, "Smurf" Attack, "SYN" Flooding, DoS/DDoS Countermeasures		
	2.3	**Session Hijacking:** Spoofing vs. Hijacking, Types, Sequence Prediction, Steps, Prevention **Hacking Web Servers:** Web Server Vulnerabilities, Attacks against Web Servers, Patch Management Techniques, Web Server Hardening		**CO2,CO3**
Unit 3			**15**	
	3.1	**Web Application Vulnerabilities:** Web Application Hacking, Web Application Threats, Google Hacking, Countermeasures **Web-Based Password Cracking Techniques:** Authentication Types, Password Crackers, Countermeasures		**CO3,CO4**
	3.2	**SQL Injection:** Steps, SQL Server Vulnerabilities, Countermeasures **Buffer Overflows:** Types, Stack-Based Buffer Overflows, Mutation Techniques		**CO3,CO4**
	3.3	**Wireless Hacking:** WEP, WPA Authentication Mechanisms, and Cracking Techniques, Wireless Sniffers, Rogue Access Points, Wireless Hacking Techniques, Securing Wireless Networks **Penetration Testing Methodologies:** Methodologies, Steps, Automated Tools, Pen-Test Deliverables		**CO3,CO4, CO5**

References:

1. CEH official Certfied Ethical Hacking Review Guide, Wiley India Edition

2.Certified Ethical Hacker: Michael Gregg, Pearson Education

3. Certified Ethical Hacker: Matt Walker, TMH.

Total Marks: 75 Marks

- **Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)**

- **End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours**

- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: TY B.Sc. CS Practical
Semester-VI: Elective-I
Course Title: Ethical Hacking
Course Code: GNKUSCSEL1P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	
1	Understand the terminology and concepts related to ethical hacking and penetration testing.
2	Explore various hacking technologies and the skills required to become an ethical hacker.
3	Learn the different phases involved in ethical hacking and the methodologies used in penetration testing.
4	Gain knowledge of common hacking techniques, such as footprinting, scanning, enumeration, and session hijacking.
5	Develop proficiency in identifying and exploiting vulnerabilities in web servers, web applications, and wireless networks.

Course Outcomes (COs):

Sr. No.	**On completing the course, the student will be able to:**	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Apply ethical hacking methodologies to conduct comprehensive security assessments and penetration tests.	PO1,PO3	PSO1,PSO 2	U,Ap,An

CO 2	Perform effective footprinting and reconnaissance techniques to gather critical information about target systems.	PO2	PSO2	Ap
CO 3	Identify and exploit vulnerabilities in various network and system components using appropriate tools and techniques.	PO3,PO4	PSO3, PSO5	Ap, E
CO 4	Evaluate the security posture of web servers, web applications, and wireless networks, and recommend appropriate countermeasures.	PO4,PO7	PSO4. PSO5, PSO6	Ap, E, C
CO 5	Demonstrate an understanding of ethical and legal considerations in conducting ethical hacking activities and adhere to professional codes of conduct.	PO6,PO7	PSO6, PSO7	Ap, E, C

List of Experiments:

1. Google and Whois Reconnaissance

- Use Google search techniques to gather information about a specific target or organization.
- Utilize advanced search operators to refine search results and access hidden information.
- Perform Whois lookups to retrieve domain registration information and gather details about the target's infrastructure

2. Password Encryption and Cracking with CrypTool and Cain and Abel

- Password Encryption and Decryption:
  - Use CrypTool to encrypt passwords using the RC4 algorithm.
  - Decrypt the encrypted passwords and verify the original values.
- Password Cracking and Wireless Network Password Decoding:
  - Use Cain and Abel to perform a dictionary attack on Windows account passwords.
  - Decode wireless network passwords using Cain and Abel's capabilities

3. Linux Network Analysis and ARP Poisoning

- Linux Network Analysis:
  - Execute the ifconfig command to retrieve network interface information.

    - Use the ping command to test network connectivity and analyze the output.
    - Analyze the netstat command output to view active network connections.
    - Perform a traceroute to trace the route packets take to reach a target host.
- ARP Poisoning:
    - Use ARP poisoning techniques to redirect network traffic on a Windows system.
    - Analyze the effects of ARP poisoning on network communication and security.

4. Port Scanning with NMap
- Use NMap to perform an ACK scan to determine if a port is filtered, unfiltered, or open.
- Perform SYN, FIN, NULL, and XMAS scans to identify open ports and their characteristics.
- Analyze the scan results to gather information about the target system's network services.

5. Network Traffic Capture and DoS Attack with Wireshark and Nemesy
- Network Traffic Capture:
    - Use Wireshark to capture network traffic on a specific network interface.
    - Analyze the captured packets to extract relevant information and identify potential security issues.
- Denial of Service (DoS) Attack:
    - Use Nemesy to launch a DoS attack against a target system or network.
    - Observe the impact of the attack on the target's availability and performance.

6. Persistent Cross-Site Scripting Attack
- Set up a vulnerable web application that is susceptible to persistent XSS attacks.
- Craft a malicious script to exploit the XSS vulnerability and execute arbitrary code.
- Observe the consequences of the attack and understand the potential risks associated with XSS vulnerabilities

7. Session Impersonation with Firefox and Tamper Data
- Install and configure the Tamper Data add-on in Firefox.
- Intercept and modify HTTP requests to impersonate a user's session.
- Understand the impact of session impersonation and the importance of session management.

8. SQL Injection Attack
- Identify a web application vulnerable to SQL injection.
- Craft and execute SQL injection queries to exploit the vulnerability.
- Extract sensitive information or manipulate the database through the SQL injection attack.

9. Creating a Keylogger with Python
- Write a Python script that captures and logs keystrokes from a target system.
- Execute the keylogger script and observe the logged keystrokes.
- Understand the potential security risks associated with keyloggers and the importance of protecting against them.

10. Exploiting with Metasploit (Kali Linux)
- Identify a vulnerable system and exploit it using Metasploit modules.
- Gain unauthorized access to the target system and execute commands or extract information.

- Understand the ethical considerations and legal implications of using Metasploit for penetration testing

References:

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

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Elective II
Course Title: Information Retrieval
Course Code: GNKUSCSEL2106
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To understand the fundamental principles and components of information retrieval systems.
2	To explore various techniques for document indexing, storage, and retrieval.
3	To analyze and compare different retrieval models and understand their strengths and limitations.
4	To gain practical experience in implementing and evaluating information retrieval systems.
5	To explore advanced topics in information retrieval, such as web information retrieval and machine learning techniques

Course Outcomes (COs):

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

				Levels addressed
CO 1	Explain the key components and principles of information retrieval systems.	PO1,PO3	PSO1,PSO 2	U,Ap,An
CO 2	Apply indexing, storage, and retrieval techniques to efficiently retrieve relevant documents.	PO2	PSO2	Ap
CO 3	Compare and contrast different retrieval models and select appropriate models for specific search scenarios.	PO3,PO4	PSO4, PSO5	Ap, E
CO 4	Develop practical skills in implementing and evaluating information retrieval systems.	PO7	PSO4. PSO5	Ap, E, C
CO 5	Demonstrate an understanding of advanced topics in information retrieval, including web search and machine learning techniques.	PO6,PO7	PSO6, PSO7	Ap, E, C

Unit		**Title**	**No. of lectures**	**CO Mapping**

Unit 1			**15**	
	1.1	**Foundations of Information Retrieval:** **Introduction to Information Retrieval (IR) systems:** Definition and goals of information retrieval, Components of an IR system, Challenges and applications of IR Document Indexing, Storage, and Compression: Inverted index construction and compression techniques, Document representation and term weighting, Storage and retrieval of indexed documents		**CO1, CO2**
	1.2	**Retrieval Models: Boolean model:** Boolean operators, query processing,Vector space model: TF-IDF, cosine similarity, query-document matching, Probabilistic model: Bayesian retrieval, relevance feedback		**CO2**
	1.3	**Spelling Correction in IR Systems:** Challenges of spelling errors in queries and documents, Edit distance and string similarity measures, Techniques for spelling correction in IR systems **Performance Evaluation**: Evaluation metrics: precision, recall, F-measure, average precision, Test collections and relevance judgments, Experimental design and significance testing		**CO3,CO4**
Unit 2			**15**	
	2.1	**Text Categorization and Filtering:** Text classification algorithms: Naive Bayes, Support Vector Machines, Feature selection and dimensionality reduction, Applications of text categorization and filtering		**CO4**
	2.2	**Text Clustering for Information Retrieval:** Clustering techniques: K-means, hierarchical clustering, Evaluation of		**CO3,CO4**

		clustering results, Clustering for query expansion and result grouping. Web Information Retrieval: Web search architecture and challenges, Crawling and indexing web pages, Link analysis and PageRank algorithm.		
	2.3	**Learning to Rank:** Algorithms and Techniques, Supervised learning for ranking: RankSVM, RankBoost, Pairwise and listwise learning to rank approaches Evaluation metrics for learning to rank Link Analysis and its Role in IR Systems: Web graph representation and link analysis algorithms, HITS and PageRank algorithms, Applications of link analysis in IR systems		**CO1,CO5**
Unit 3			**15**	
	3.1	**Advanced Topics in Information Retrieval** Crawling and Near-Duplicate Page Detection: Web page crawling techniques: breadth-first, depth-first, focused crawling, Near-duplicate page detection algorithms, Handling dynamic web content during crawling		**CO2,CO3**
	3.2	**Advanced Topics in IR:** Text Summarization: extractive and abstractive methods, Question Answering: approaches for finding precise answers, Recommender Systems: collaborative filtering, content-based filtering Cross-Lingual and Multilingual Retrieval: Challenges and techniques for cross-lingual retrieval, Machine translation for IR, Multilingual document representations and query translation, Evaluation Techniques for IR Systems		**CO3,CO5**

	3.3	**User-based evaluation:** user studies, surveys, Test collections and benchmarking, Online evaluation methods: A/B testing, interleaving experiments		**CO4,CO5**

References:

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

Total Marks: 75 Marks

- **Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. (10 Marks will be converted to 5 Marks). Duration of exam: 20 minutes. 5 Marks for either Quiz/Assignments/Presentation/Viva and 5 Marks for Overall Performance (Class Participation, Attendance)**

- **End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours**

- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: TY B.Sc. CS Practical
Semester-VI: Elective-II
Course Title: Information Retrieval
Course Code: GNKUSCSEL2P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	**Course objectives**
The course aims at:	

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

Course Outcomes (COs):

Sr. No.	**On completing the course, the student will be able to:**	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the key components and principles of information retrieval systems.	**PO1,PO3**	**PSO1,PSO 2**	**U,Ap,An**
CO 2	Apply indexing, storage, and retrieval techniques to efficiently retrieve relevant documents.	**PO2**	**PSO2**	**Ap**
CO 3	Compare and contrast different retrieval models and select appropriate models for specific search scenarios.	**PO3,PO4**	**PSO4, PSO5**	**Ap, E**

CO 4	Develop practical skills in implementing and evaluating information retrieval systems.	**PO7**	**PSO4. PSO5**	**Ap, E, C**
CO 5	Demonstrate an understanding of advanced topics in information retrieval, including web search and machine learning techniques.	**PO6,PO7**	**PSO6, PSO7**	**Ap, E, C**

List of Experiments:

Document Indexing and Retrieval

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

10. Advanced Topics in Information Retrieval. Implement a text summarization algorithm (e.g., extractive or abstractive). Build a question-answering system using techniques such as information extraction.

References:

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

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

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

Department of Computer Science

Course: T.Y.B.Sc. CS
Semester-VI: Minor
Course Title: Computer Network
Course Code:GNKUSCSMI1106
Credits: 1
No of lectures (Hours): 15
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To Understand Basic Concepts of Networking
2	To Understand Working of Network Layer Architecture.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Learn basic networking concepts and layered architecture.	PO1 PO2 PO4 PO7	PSO1, PSO2, PSO5, PSO10	Remembering, Understanding, Applying, Analyzing
CO 2	Understand the concepts of networking, which are important for them to be known as a 'networking professionals'.	PO1, PO2, PO6, PO7, PO8	PSO1, PSO2, PSO3, PSO5	Understanding, Applying, Analyzing, Evaluating

Unit		Title	No. of lectures	CO Mapping

Unit 1			**15**	
	1.1	Introduction: Networking standards and Administrations, networks, network types – LAN, MAN, WAN. Network Models: The OSI model, TCP/IP protocol suite		CO1, CO2
	1.2	Introduction to Physical layer: Data and signals, periodic analog signals, digital signals, transmission impairment, data rate limits, performance. Transmission media: Guided Media, Unguided Media		CO1, CO2
	1.3	Digital transmissions:Digital-to-digital conversion, analog-to-digital conversion, transmission modes Analog transmissions: digital-to-analog conversion, analog-to-analog conversion		CO1, CO2

References:

1. Data Communications and Networking, Behrouz A. Forouzan, Fifth Edition, TMH, 2018.
2. Computer Network, Andrew S. Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2018.
3. Data and Computer Communication, William Stallings, PHI, 2017
4. https://youtube.com/playlist?list=PLSDyGb_vtanx5Ad0S4WxRqTSSH9e34O_M&si=u5SQ-C_nsIeiGw2z

Total Marks: 25 Marks (20 Marks External + 05 Marks Internal)

Course: T.Y.B.Sc. CS Practical
Semester-VI: Minor
Course Title: Computer Network
Course Code:GNKUSCSMI1P106
Credits: 01
No of Practical (Hours): 30
Marks: 25

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To Understand Basic Concepts of Networking
2	To Understand Working of Network Layer Architecture.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Learn basic networking concepts and layered architecture.	PO1 PO2 PO4 PO7	PSO1, PSO2, PSO5, PSO10	Remembering, Understanding, Applying, Analyzing
CO 2	Understand the concepts of networking, which are important for them to be known as a 'networking professionals'.	PO1, PO2, PO6, PO7, PO8	PSO1, PSO2, PSO3, PSO5	Understanding, Applying, Analyzing, Evaluating

List of Experiments:

Sr. No.	Title
1	Using, linux-terminal or Windows-cmd, execute following networking commands and note the output: ping, traceroute, netstat, arp, ipconfig, Getmac, hostname, NSLookUp, pathping, SystemInfo

2	Using Packet Tracer, create a basic network of two computers using appropriate network wire. Use Static IP address allocation and show connectivity
3	Using Packet Tracer, create a basic network of One server and two computers using appropriate network wire. Use Dynamic IP address allocation and show connectivity
4	Using Packet Tracer, create a basic network of One server and two computers and two mobile / movable devices using appropriate network wire. Show connectivity
5	Using Packet Tracer, create a network with three routers with RIPv1 and each router associated network will have minimum three PC. Show Connectivity
6	Using Packet Tracer, create a network with three routers with RIPv2 and each router associated network will have minimum three PC. Show Connectivity
7	Using Packet Tracer, create a network with three routers with OSPF and each router associated network will have minimum three PC. Show Connectivity
8	Using Packet Tracer, create a network with three routers with BGP and each router associated network will have minimum three PC. Show Connectivity
9	Using Packet Tracer, create a wireless network of multiple PCs using appropriate access point.
10	Using Wireshark, network analyzer, set the filter for ICMP, TCP, HTTP, UDP, FTP and perform respective protocol transactions to show/prove that the network analyzer is working

References:

1. https://youtube.com/playlist?list=PLSDyGb_vtanx5Ad0S4WxRqTSSH9e34O_M&si=u5SQ-C_nsIeiGw2z
2. Data Communications and Networking, Behrouz A. Forouzan, Fifth Edition, TMH, 2018.
3. Computer Network, Andrew S. Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2018.
4. Data and Computer Communication, William Stallings, PHI, 2017

Total Marks: 25 Marks

Experiment Marks: 15 Marks
Journal & Viva Marks: 5 + 5 Marks