Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology
(Autonomous Institute)

Faculty of Science and Technology

Board of Studies

Information Technology

Syllabus

Honor Courses

(2025 Pattern)
(w.e.f. AY: 2026-27)

Bucket of HONORS DEGREE

HONORS DEGREE **(only for students having CGPA >= 7.5)**
Honor: Computational Intelligence
Honor: Cloud Computing and Virtualization, Data Science
Honor: Data Science
Honor: Artificial Intelligence
Honor: Cyber security
Honor: VLSI Design Technology
Honor: Advanced Communication Systems
Honor: Advances in Construction Technology
Honor: Advanced Structural Engg.
Honor: Robotics and Automation
Honor: Refrigeration & Air-conditioning
Honor: Renewable Energy and E- mobility

Syllabus: HONORS Information Technology
w. e. f. AY:2026-2027

Honors in Cyber Security

Sr. No.	Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
1	IT25281TH	Cryptography and Network Security	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25281PR	Cryptography and Network Security	-	2	-	-	-	-	30	-	-	30	-	1	-	
2	IT25291TH	Ethical Hacking	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25291PR	Ethical Hacking	-	2	-	-	-	-	30	-	-	30	-	1	-	
3	IT25381TH	Information Security	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25381PR	Information Security	-	2	-	-	-	-	30	-	-	30	-	1	-	
4	IT25391TH	Cyber Security	3		-	10	30	60	-	-	-	100	3	-	-	4
	IT25391PR	Cyber Security	-	2	-	-	-	-	30	-	-	30	-	1	-	
5	IT25491TH	Digital Forensics	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25491PR	Digital Forensics	-	2	-	-	-	-	30	-	-	30	-	1	-	
Total			**13**	**10**	**0**	**50**	**90**	**300**	**150**	**0**	**0**	**590**	**13**	**5**	**0**	**18**

Prof.S.A.Takale
HOD-IT

Prof.S.M.Bhosle
Dean Academics

Dr.A.H. Kolekar
CoE

Prof.S.B.Lande
Principal

Honors in Artificial Intelligence

Sr. No.	Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
1	IT25282TH	Artificial Intelligence: Search Methods and Knowledge Representation	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25282PR	Artificial Intelligence: Search Methods and Knowledge Representation	-	2	-	-	-	-	30	-	-	30	-	1	-	
2	IT25292TH	Deep Learning for Computer Vision	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25292PR	Deep Learning for Computer Vision	-	2	-	-	-	-	30	-	-	30	-	1	-	
3	IT25382TH	Computer Vision	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25382PR	Computer Vision	-	2	-	-	-	-	30	-	-	30	-	1	-	
4	IT25392TH	Deep Learning for Natural Language Processing	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25392PR	Deep Learning for Natural Language Processing	-	2	-	-	-	-	30	-	-	30	-	1	-	
5	IT25492TH	Generative AI and Large Language Models	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25492PR	Generative AI and Large Language Models	-	2	-	-	-	-	30	-	-	30	-	1	-	
Total			**13**	**10**	**0**	**50**	**90**	**300**	**150**	**0**	**0**	**590**	**13**	**5**	**0**	**18**

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Principal

Cryptography and Network Security								
Course Code : IT25281			**Course Credits: 03**			**Course Type: HONOR**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
2	**2**	**-**	**10**	**-**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping:
1.Basics of Computer Networks

Future Course Mapping: Cyber Security

Importance of Course: This Subject will help to get acquainted with skills and knowledge required network administrator.

Course Objectives:
1.To learn network security concepts
2. To differentiate private and public key cryptography.

Course Outcomes:
1.Understand Network security concepts
2.Identify software Vulnerabilities
3.Understand Private Key Cryptography
4.Understand and Analyse Public key cryptography

Syllabus

UNIT No.	Syllabus	Hrs.
I	**Introduction to Security**: Vulnerabilities, Threats, Threat Modeling, Risk, attack and attack types, Avoiding attacks, Security services. key security properties - Confidentiality, Integrity, Availability. Protocol Vulnerabilities: DoS and DDoS, session hijacking, ARP spoofing, Pharming attack, Dictionary Attacks.	6
II	**Software vulnerabilities:** Phishing, buffer overflow, Cross-site scripting attack, Virus and Worm Features, Trojan horse, Social engineering attacks, ransomware, SYN-Flooding, SQL- injection, DNS poisoning, Sniffing	6
III	**Private Key Cryptography**: Mathematical background for cryptography: modulo arithmetic, GCD (Euclid's algorithm), Role of random numbers in security, Importance of prime number, DES, AES. Chinese remainder theorem.	6

IV	**Public key cryptography:** RSA: RSA algorithm, Key generation in RSA, attacks on RSA. Diffie-Hellman key exchange	6

Text Books:

1. "Cryptography and Network Security-Principles and Practices" by William Stallings, Pearson Education, 2006, ISBN 81-7758-774-9, 4th Edition.
2. "Network Security and Cryptography", by Bernard Menezes, Cengage Learning, 2010, ISBN 81
315-1349-1, 1st Edition.

Reference Books:

1. "Computer Security: Art and Science", by Matt Bishop, Pearson Education, 2002, ISBN 0201440997, 1st Edition.
2. "Network security, private communication in a public world", by Charlie Kaufman, Radia Perlman and Mike Spencer, Prentice Hall, 2002, ISBN 9780130460196, 2nd Edition.

Online Resources: https://archive.nptel.ac.in/courses/106/105/106105162/

Cryptography and Network Security Lab

Guidelines for Instructor's Manual:

The faculty member should prepare the laboratory manual for all the assignments and it should be made available to students and laboratory instructor/Assistant.

Guidelines for Student's Lab Journal:

1. Students should submit term work in the form of a handwritten journal based on a specified list of assignments.
2. Practical Examination will be based on the term work.
3. Students are expected to know the theory involved in the experiment.
4. The practical examination should be conducted if and only if the journal of the candidate is complete in all respects

Guidelines for Lab /TW Assessment:

1.Examiners will assess the term work based on performance of students considering the parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.

2.Examiners will judge the understanding of the practical performed in the examination by asking some questions related to theory & implementation of experiments he/she has carried out. Appropriate knowledge of usage of software and hardware related to respective laboratories should be as a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers of the program in a journal may be avoided. There must be hand-written write-ups for every assignment in the journal.

3.The HDD/SSD/USB drive containing student programs should be attached to the journal by every student and the same to be maintained by the department/lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Term work shall consist of 5 assignments and Practical's on each Unit-1 to Unit-4 and is based on performance and continuous internal assessment

Guidelines for Laboratory Conduction:

1.All the assignments should be implemented.
2.All assignments are compulsory.
3.The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic.
4.All the assignments should be conducted on latest version of Windows OS and MS office.
5.The following practical should be conducted batch wise using Computer System, with Webcam and headphone facility.

Practical for the subject shall be engaged in minimum four batches (batch size of 20 students

Guidelines for Practical Examination:

1. Both internal and external examiners should jointly set problem statements for practical examination. During practical assessment, the expert evaluator should give the maximum weightage to **the satisfactory** implementation of the problem statement.
2. The supplementary and relevant questions may be asked at the time of evaluation to judge the student's understanding of the fundamentals, effective and efficient implementation.

The evaluation should be done by both external and internal examiners.

List of Assignments

1.Implement symmetric key algorithm.
2 Implement asymmetric key algorithm and key exchange Algorithm.
3.Demonstrate intrusion detection system using any tool.
4.Explore network monitoring tools as wire shark , snort etc.
5.Study to configure Firewall.
6. Study and analyse the Honey Pots.
7. Configuration of Virtual Private Network .
8. Study and Analyse Digital Signature standards.

Ethical Hacking								
Course Code : IT25291			**Course Credits: 03**			**Course type: HONOR**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
2	**2**	**–**	**10**	**-**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping:
1. Computer Network, Cyber security basics, operating system

Future Course Mapping:
1. Certified Ethical Hacking, Ethical Hacking NPTEL

Importance of Course: Ethical Hacking concepts will be understood and those are important to become cyber security analyst

Course Objectives:
1. Understand Importance of Ethical Hacking and legalities of penetration Testing
2. Create awareness about web application security and Hacking
3. Analyze Meta sploit tool with Kali Linux for penetration testing
4. Apply WiFi Hacking and security Techniques

Course Outcomes:
1. Identify Ethical hacking processes and become acquainted with Penetration testing.
2. Construct Secure Web Applications to understand Hacking Techniques.
3. Build knowledge about Meta sploit tool with Kali Linux
4. Recognize Wifi Hacking and Security techniques.

Unit No.	Syllabus	Hrs.
1	**Introduction to Basics of Ethical Hacking and Penetration Testing** Introduction to basic Terminologies of Ethical Hacking, CIA(confidentiality, Integrity Availability , Types of Hackers , Ethical Hacking Process, Different tools for Ethical Hacking, Introduction to Kali Linux, What Is a Penetration Test, Vulnerability Assessments versus Penetration Test,Types of Penetration Testing:Network Penetration Test, Web Application Penetration Test,Mobile Application Penetration Test, Social Engineering Penetration Test, Physical Penetration Test	6
2	**Web Application Hacking and Security** Introduction to Hacking Web Applications, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), XML External Entity (XXE), Injections: SQL Injection& Code Injection, Denial of Service (DoS), Exploiting Third-Party Dependencies Web Application Security: Securing Modern Web Applications,	6

	Secure Application Architecture, OWASP Top 10 Web Application Security Risks and tools	
3	**System Security and Hacking** Introduction to Metasploit ,Reconnaissance with Metasploit , Port Scanning with Metasploit , Compromising a Windows Host with Metasploit ,Client Side Exploitation Methods , E– Mails with Malicious Attachments ,Creating a Custom Executable , Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post– Exploitation Introduction :Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools – Password Cracking Countermeasures – Escalating Privileges – Executing Applications – Keyloggers and Spyware	6
4	**Wi-Fi Hacking and Security** Wi-Fi Security: Introduction to Wireless Security, Working, Types of Security, Protocols- WEP, WPA, WPA2 cracking, Threats to Wi-Fi Security, Secure Home and Business Wi-Fi Network, Stronger Wi-Fi Security, Updating WiFi Security Settings for Home WiFi Networks. Wi-Fi Hacking: Essential Tools for Hacking Wireless Networks, Evil Twin attack, Network Sniffing and social engineering	6

Practical Assignments

Assign No	Title
1	Study installation of Kali Linux
2	Learn various tools related to security
3	To perform reconnaissance on a website using google dorking technique on a tryhackme room. Perform Google Dorking: https://tryhackme.com/room/googledorking
4	To perform reconnaissance on a website using web OSINT technique on a tryhackme room. Perform Web OSINT: https://tryhackme.com/room/webosint.
5	Scanning, enumeration, and analysis: To perform scanning using nmap(a powerful network scanning tool) in a tryhackme room. Perform scanning using Nmap tools: https://tryhackme.com/room/furthernmap
6	To perform scanning using nessus
7	Perform vulnerability analysis using Nessus tool: https://tryhackme.com/room/rpnessusredux
8	POST-EXPLOITATION: Perform Windows Privilege Escalation: https://tryhackme.com/room/windowsprivescarena
9	Perform Post-Exploitation: https://tryhackme.com/room/postexploit Perform Linux

	Privilege Escalation: https://tryhackme.com/room/linuxprivesc
10	Study Web application security tools

Text Books:

1. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.
2. Andrew Hoffman, Web Application Security-Exploitation and Countermeasures for Modern Web Applications, O’Reilly publication
3. Marcus Pinto, DafyddStuttard, The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws, Wiley Publication
4. Alexis Ahmed, “Privilege Escalation Techniques, O'Reilly Media Company. Packt publishing. 2021

Reference Books:

1. Hacking: The Art of Exploitation by Jon Erickson
2. Basics of Hacking and Penetration testing: Made Easy by Patrick Engebreston
3. Penetration Testing: A Hands-on Introduction to Hacking by Georgia Weidman

Online Resources:

1. https://resources.infosecinstitute.com/topic/process-scanning-and-enumeration/
2. https://owasp.org/Top10
3. https://medium.com/techloop/reconnaissance-the-key-to-ethical-hacking-3b853510d977

Information Security								
Course Code : IT25381			**Course Credits: 04**			**Course type: Honors**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
3	2	-	10	30	60	30	-	-

Prerequisite Course Mapping:
1.Basics of Computer Networks
2.Discrete Mathematics

Future Course Mapping:
1.Cyber Security

Course Objectives:
1.To understand the basic approaches in cyber security and Information Security
2. To analyze the cryptography and networking terms.
3. To Understand Cryptography and network basics.
4. To Use different authentication techniques
5. To study digital Signature.

Course Outcomes:
1. Understand and explain the risks faced by computer systems and networks.
2. Identify and analyze security problems in computer systems and networks.
3. Explain how standard security mechanisms work.
4. Develop security mechanisms to protect computer systems and networks.
5. Design more secure information system.
6. Use cryptography algorithms and protocols to achieve computer security.

UNIT No.	Syllabus	Hrs.
I	Introduction to Information Security : Attacks -Definition, Types Vulnerability, Security Goals, Security Services and Security mechanisms.	6
II	Conventional Cryptographic Techniques : Conventional substitution and transposition ciphers, One-time Pad, Block cipher and Stream Cipher, steganography.	6
III	Symmetric and Asymmetric Cryptographic Techniques : Data Encryption Algorithm (DES), Advanced Encryption Standard (AES), (Rivest–Shamir–Adelman)RSA, (Secure Hash Algorithm) SHA, (Message-Digest Algorithm 5) MD5 algorithms.	7
IV	Authentication and Digital Signatures : Use of Cryptography for authentication, Secure Hash function, Key management – Kerberos.	6
V	Program Security : Non malicious Program errors – Buffer overflow, Incomplete mediation, Time-of-check to Time-of use Errors, Viruses, Trapdoors, Salami attack, Man-in-the middle attacks, Covert channels.	7
VI	Security in Networks : Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls –IDS, Email Security.	7

List of Practical Assignments:

Implement symmetric key algorithm.

2 Implement asymmetric key algorithm and key exchange Algorithm.

3. Demonstrate intrusion detection system using any tool.

4. Explore network monitoring tools as wire shark, snort etc.

5. Study to configure Firewall.

6. Study and analyze the Honey Pots.

7. Configuration of Virtual Private Network .

8. Study and Analyze Digital Signature standards.

Text Books :

1. Network Security Essentials: Applications and Standards, by William Stallings,Prentice Hall.

2. Security in Computing, Fourth Edition, by Charles P. Pfleeger, Pearson Education.

Reference Books:

1. Cryptography And Network Security Principles And Practice, Fourth or Fifth Edition, William Stallings, Pearson.

2. Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall.

Online Resources:

1. https://onlinecourses.swayam2.ac.in/cec22_cs15/

2 https://archive.nptel.ac.in/courses/106/106/106106129/

Cyber Security								
Course Code : IT25391			**Course Credits: 04**			**Course type: Honor**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
3	**2**	**-**	**10**	**30**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping: Basics of computer network and computer programming

Future Course Mapping: Quantum cryptography

Course Objectives:

1. To understand the basic approaches in cyber security and Information Security.
2. To analyze the cryptography and networking terms.
3. To understand about different types of hacking and cyber-crimes.
4. To apply and analyze the issues related to cyber forensics.
5. To learn cyber security implications.
6. To understand privacy issues.

Course Outcomes:

1. Understand various basic approaches in cyber security and Information Security.
2. Understand Cryptography and network basics.
3. To analyze the types of hacking and cyber crimes.
4. Understand cyber forensics.
5. Learn security implications.
6. Analyze privacy issues.

UNIT No.	Syllabus	Hrs.
I	**Introduction to Cyber Security,Information Security Basics** Confidentiality, Integrity & Availability (CIA),The challenges of Security, Threats, Attacks , Operational Model of Security,Cryptography**,**Symmetric and Asymmetric Cryptography,Brute-Force Attack. **Cyber Security Basics**: Introduction to Cyber Security, Need, Importance and challenges in Cyber Security, Cyberspace, Cyber threats, Cyber-warfare, Cyber Terrorism.	8
II	**Network Fundamentals, Cryptography Basics** LAN, MAN, WAN, Wi-Fi, Network Protocols (TCP/IP, DNS, HTTP), Network Devices (Routers, Switches, Firewalls),**Cryptography Basics**: Encryption, Decryption, Types of Encryption (Symmetric Cipher-DES, Asymmetric Cipher-RSA,Diffie Hellman, Cryptographic Hash functions and MessageAuthentication codes).	6
III	**Cyber Crimes and Hacking** Cyber stalking, forgery, software piracy, cyber terrorism, phishing,computer hacking,creating and distributing viruses over the internet, spamming, cross site scripting,cybersquatting, logic bombs, web jacking, internet time thefts, DoS attack, Man in the middle attack,salami attack, data diddling, email spoofing.Types of Hacking.	7
IV	**Cyber Forensics** Cyber forensics,cyber forensics investigation process, digital evidence,challenges in cyber forensics,Web Attack Forensics: Intrusion forensics, database forensics, preventive forensics,Anti forensics practices, Anti-forensics detection techniques, Network forensics analysis tools,Email Forensics: e-mail Protocols, email crimes, email forensics, Bitcoin Forensics:crypto currency, crimes related to bitcoin.	6

V	**Cyber Security- Organizational Implications:** Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.	6
VI	**Privacy Issues:** Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc Cybercrime: Examples and Mini-Cases Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances. MiniCases: The Indian Case of Online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.	6

List of Practical Assignments:

1. Perform port scanning with nmap.
2. Install Wireshark and monitor network communication with sniffers.
3. Install Jscript/Cryptool tool (or any other equivalent) and demonstrate Asymmetric, Symmetric crypto algorithm, Hash and Digital/PKI signatures.
4. Studyand execute OpenSSL commands to generate minimum 10 passwords of length 12 characters.
5. Perform email analysis using the Autopsy tool.

Text Books :

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2. B.B. Gupta, D.P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.
3. Real Digital Forensics for Handheld Devices, E. P. Dorothy, Auerback Publications, 2013.
4. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics, J. Sammons, Syngress Publishing, 2012.

Reference Books:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Handbook of Digital Forensics and Investigation, E. Casey, Academic Press, 2010.
4. Malware Forensics Field Guide for Windows Systems: Digital Forensics Field Guides, C. H. Malin, E. Casey and J. M. Aquilina, Syngress, 2012.
5. The Best Damn Cybercrime and Digital Forensics Book Period, J. Wiles and A. Reyes, Syngress, 2007.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2. https://www.netacad.com/courses/introduction-to-cybersecurity?courseLang=en-US

Digital Forensics

Course Code: IT25491	Course Credits: 04	Course type: Honors

Teaching Scheme			Evaluation Scheme					
TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR
3	2	-	10	30	60	30	-	-

Prerequisite Course Mapping: 1. Computer Network and Security 2. Cyber Security

Future Course Mapping: Cyber Crime Investigation

Course Objective:

1. To discuss the need and process of digital forensics and Incident Response Methodology.
2. To explore the procedures for identification, preservation, and acquisition of digital evidence.
3. To explore techniques and tools used in digital forensics for Operating system and malware investigation.
4. To explore techniques and tools used for Mobile forensics and browser, email forensics.

Course Outcomes: On completion of the course, learner will be able to

1. Understand the phases of Digital Forensics and methodology to handle the computer security incident.
2. Analyze the process of collection, analysis and recovery of the digital evidence.
3. Explore various tools to analyze malwares and acquired images of RAM/hard drive.
4. Acquire adequate perspectives of digital forensic investigation in mobile devices
5. Analyze the source and content authentication of emails and browsers.
6. Produce unambiguous investigation reports which offer valid conclusions.

UNIT No.	Syllabus	Hrs
I	**Introduction to Digital Forensics** Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics, Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	7
II	**Digital Evidence, Forensics Duplication and Digital Evidence Acquisition** Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody, Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques.	7
III	**Forensics Investigation** Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers, Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques	6
IV	**Windows and Unix Forensics Investigation** Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics, Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches,	6

	Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships.	
V	**Mobile Forensics** Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis, GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and Track Points, Display the Tracks on a Map. SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.	7
VI	**Browser, Email Forensic & Forensic Investigation Reporting** Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC), Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report.	6
Total Teaching Hours		**39**

List of Practical Assignments:

1: To identify & study different types of Digital forensics.
2. To understand incident response process.
3. To study incident response process.
4. To create a forensic image of a USB drive.
5. To study Hard Drive Forensic Analysis.
6. To Investigate memory artifacts.
7. To analyze router logs.
8. To understand malware behavior.
9. To study Malware Analysis Tools.
10. To study Windows Registry Analysis & Linux Log Analysis.

Text Books:

1. Kevin Mandia, Chris Prosise, ―Incident Response and computer forensics‖, Tata McGrawHill, 2006.
2. Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019.
3. Xiaodong Lin, ―Introductory Computer Forensics: A Hands-on Practical Approach‖, Springer Nature, 2018
4. Computer Forensics: Computer Crime Scene Investigation, Author: John R. Vacca
5. Guide to Computer Forensics and Investigations, by Bill Nelson, Amelia Phillips, Christopher Steuart, Publisher: Cengage Learning
6. Digital Forensics, Author: Andre Arnes, Wiley Publication
7. Digital Forensics Basics: A Practical Guide Using Windows OS, Author: Nihad A. Hassan Publisher: Apress

Reference Books:

1. Guide to Computer Forensics and Investigations, Bill Nelson, Amelia Phillips, Christopher Steuart, Cengage Learning.
2. Digital Forensics and Incident Response, Gerard Johansen, Packt Publishing.
3. Practical Mobile Forensics, Rohit Tamma, Oleg Skulkin, Heather Mahalik, Satish Bommisetty, Packt Publishing.

Online Resources:
https://onlinecourses.nptel.ac.in/noc26_lw01/preview?
https://nptel.ac.in/courses/106104467
https://nptel.ac.in/courses/106105217

Honors in Artificial Intelligence

Sr. No.	Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
1	IT25282TH	Artificial Intelligence: Search Methods and Knowledge Representation	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25282PR	Artificial Intelligence: Search Methods and Knowledge Representation	-	2	-	-	-	-	30	-	-	30	-	1	-	
2	IT25292TH	Deep Learning for Computer Vision	2	-	-	10	-	60	-	-	-	70	2	-	-	3
	IT25292PR	Deep Learning for Computer Vision	-	2	-	-	-	-	30	-	-	30	-	1	-	
3	IT25382TH	Computer Vision	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25382PR	Computer Vision	-	2	-	-	-	-	30	-	-	30	-	1	-	
4	IT25392TH	Deep Learning for Natural Language Processing	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25392PR	Deep Learning for Natural Language Processing	-	2	-	-	-	-	30	-	-	30	-	1	-	
5	IT25492TH	Generative AI and Large Language Models	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	IT25492PR	Generative AI and Large Language Models	-	2	-	-	-	-	30	-	-	30	-	1	-	
Total			**13**	**10**	**0**	**50**	**90**	**300**	**150**	**0**	**0**	**590**	**13**	**5**	**0**	**18**

Prof.S.A.Takale **Prof.S.M.Bhosle** **Dr.A.H. Kolekar** **Prof.S.B.Lande**

HOD-IT **Dean Academics** **CoE** **Principal**

Artificial Intelligence: Search Methods And Knowledge Representation								
Course Code : IT25282			**Course Credits: 03**			**Course type: HONOR**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
2	2	-	10	-	60	30	-	-

Prerequisite Course Mapping:
1. Discrete Mathematics
2. Machine Learning
3. Data Structures and Algorithms

Future Course Mapping:
1. Deep Learning

Importance of Course: This course forms the basis for all computer learning and is also the future of all complex decision making.

Course Objectives:
1. To understand Fundamental concepts of Artificial Intelligence
2. Application of different search strategies for problem solving.
3. To understand Fundamentals of Game Theory.
4. To explore Various knowledge representations and reasoning schemes.

Course Outcomes:
1. **Identify** and **apply** suitable Intelligent agents for various AI applications
2. **Implement** smart system using different informed search / uninformed search or heuristic approaches
3. **Application** of adversarial search techniques and **designing** of games.
4. **Illustrate** knowledge reasoning and knowledge representation methods.

UNIT No.	Syllabus	Hrs.
I	**Introduction** Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents.	6
II	**Problem Solving** Search Strategies: Problem spaces (states, goals and operators), problem solving by search, Uninformed search (breadth-first, depth-first, depth first with iterative deepening) Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best-first Search; Problem Reduction. Local Search algorithms.	6
III	**Adversarial Search and Games** Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search,	6

	Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.	
IV	**Reasoning** Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information	6

List of Practical Assignments:

1. Implement depth first search algorithm and Breadth First Search algorithm. Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph or tree data structure.
2. Implement n-queens problem using A star (A*) Algorithm for any game search problem.
3. Write a program for the Information Retrieval System using appropriate NLP tools (such as NLTK, Open NLP, …) a. Text tokenization b. Count word frequency c. Remove stop words d. POS tagging.
4. Develop an elementary chatbot for any suitable customer interaction application.
5. Implement Greedy search algorithm for any of the following application: I. Selection Sort II. Minimum Spanning Tree III. Single-Source Shortest Path Problem IV. Job Scheduling Problem V. Prim's Minimal Spanning Tree Algorithm VI. Kruskal's Minimal Spanning Tree Algorithm VII. Dijkstra's Minimal Spanning Tree Algorithm

Text Books :

1. Stuart Russel, Peter Norvig, “AI – A Modern Approach”, Third Edition, Pearson Education, 2009 2.
2. Elaine Rich, Kevin Knight and Shivashankar B Nair”, Artificial Intelligence “, Tata McGraw Hill Edition 3rd Edition, 2009

Reference Books:

1. Algorithmic Game theory Edited by N Nishan, T Roughgarden; Cambridge University Press
2. Allen B. Downey, "Think Stats", Second Edition, O’Reilly Media, ISBN: 978-1-491-90733-7
3. Game Theory - D Fudenberg & J Tirole; MIT Press
4. K. Boyer, L. Stark, H. Bunke, “Applications of AI, Machine Vision and Robotics, World Scientific PubCo, 1995

Online Resources:

1. https://nptel.ac.in/courses/106102220
2. http://onlinestatbook.com/Online_Statistics_Education.pdf
3. https://london.ac.uk/sites/default/files/study-guides/introduction-tonatural-language-processing.pdf
4. https://www.deeplearningbook.org/contents/TOC.html
5. https://cvlesalfabegues.com/search/natural-language-understanding-2nd--dition/ww.ebookphp.com/data-structures-and-algorithms-professional-edition-beginners-guide-epubpdf/

Deep Learning For Computer Vision								
Course Code : IT25292			**Course Credits: 03**			**Course type: HONOR**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
2	**2**	**–**	**10**	**-**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping:
1. Machine Learning 2. Mathematics 1. Image Processing

Future Course Mapping: Computer Vision

Course Objectives:
1. Students will understand the concept of computer vision, image processing using python programming and as well as students will learn to build the model using neural network and deep learning with its algorithm
2. Students will learn the concept of image analytics, convolutional neural networks

Course Outcomes:
1. Students will understand the basic concepts and methods in the field of computer vision
2. Understand the Concept of Deep Learning and activation functions.
3. Students will be able to understand how CNN is implemented and its usage in different areas.
4. Students will be able to understand recurrent Neural network, Deep generative models and its applications.

Unit No.	Syllabus	Hrs.
1	**Introduction and Overview:** Introduction to Image Formation, Capture and Representation. Read, display, Linear Filtering, Correlation, Convolution. Introduction to opencv. **Visual Features and Representations:** Edge, Blobs, Corner Detection, Scale Space and Scale Selection, SIFT, SURF, HoG, LBP. **Visual Matching:** Bag-of-words, VLAD, RANSAC, Hough transform, Pyramid Matching	6
2	**Deep Learning Review:** Review of Deep Learning, Multi-layer Perceptrons, Backpropagation. **Introduction to CNN:** Convolution Operation, Parameter Sharing, Equivariant Representation, Pooling, Variants of the Basic Convolution Function, The basic Architecture of CNN, Popular CNN Architecture – AlexNet. Introduction to tensorflow, pytorch	6

3	**CNNs for Recognition, Verification, Detection, Segmentation:** CNNs for Recognition and Verification, CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, CNNs for Segmentation: FCN, SegNet, U-Net, Mask - R CNN	6
4	**Recurrent Neural Networks (RNNs):** Review of RNNs, CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition. **Deep Generative Models:** Review of (Popular) Deep Generative Models: GANs, VAEs, Other Generative Models: PixelRNNs **Applications of Generative Models in Vision:** Applications: Image Editing, Inpainting, Superresolution, 3D Object Generation, Security	6

Practical Assignments

Assign No	Title
1	Introduction to Tensorflow/pytorch, OpenCV Image Processing Tool
2	Write a program to perform following operations: 1) Read image 2) Display image along with colorbar 3) Thresholding 4) Crop, Resize, Rotation, Translation operation
3	Implement image filtering over image and comment on them
4	Design a system for edge detection
5	Visual Features and Representations: 1) Detect boundaries (edges) of objects, or regions within an image 2) BLOB extraction BLOB representation BLOB classification 3) Feature Extraction using HOG 4) Pattern & Texture extraction using LBP 5) Image Matching using SIFT & SURF
6	Implemented Hough Transform for circles detection
7	Implemented Harris Corner Detection
8	Convolutional Neural Networks (CNNs): 1) Implementation of object detection using CNN 2) Implementation of image classification using CNN 3) Apply Activation functions 4) Apply Optimizations to reduce the loss of build model
9	Perform image segmentation using Unet / Mask-RCNN

10	Image Classification: Extracted features from pretrained network model and perform classification

Text Books:

1. Gonzalez & Woods, “Digital Image Processing”, Pearson Education
2. Richard Szeliski, Computer Vision: Algorithms and Applications

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016
2. Michael Nielsen, Neural Networks and Deep Learning, 2016
3. Yoshua Bengio, Learning Deep Architectures for AI, 2009
4. Richard Szeliski, Computer Vision: Algorithms and Applications, 2010.
5. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
6. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs93/preview
2. NPTEL Course on “Deep Learning”, by Prof. Prabir Kumar Bhiswas, IIT Kharagpur. Link of the Course: https://nptel.ac.in/courses/106105215
3. NPTEL Course on “Deep Learning - Part I”, by Prof. Sudarshan Iyengar, Prof Sanatan Sukhija IIT Ropar Link of the Course: https://nptel.ac.in/courses/106106184

Computer Vision								
Course Code : IT25382			**Course Credits: 04**			**Course type: Honor**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
3	**2**	**-**	**10**	**30**	**60**	**30**	**--**	**-**

Prerequisite Course Mapping:

1. Vectors, Linear algebra
2. Python, Matlab

Future Course Mapping:

1. Robotics
2. Applied AI

Course Objectives:

1. To review image processing techniques for computer vision
2. To understand basic image intensity transforms, shape and region analysis.
3. To understand Feature extraction techniques.
4. To understand segmentation techniques.
5. To understand Motion estimation and Object detection as well as pattern recognition
6. To study some applications of computer vision algorithms.

Course Outcomes:

On completion of the course, students will be able to:

1. **Understand** mathematical modeling methods for low, intermediate and high- level image processing tasks.
2. **Apply** and **Evaluate** basic image enhancement and filtering techniques.
3. **Implement and Analyze** feature detection, extraction and matching techniques.
4. **Apply** image segmentation and Deep learning based methods.
5. **Demonstrate** understanding of motion analysis and 3D vision techniques.
6. **Design and Develop** a computer vision applications to solve a computer vision problem.

UNIT No.	Syllabus	Hrs
I	**Fundamentals of digital image processing** What is Computer vision? Image Formation: Geometric primitives and transformations, Photometric image formation, the digital camera, Image Processing: Introduction, Applications and examples of digital image processing, Fundamental steps in digital image processing, components of digital image processing system, Digital image, basic relationship between pixels. Binocular Stereopsis: Camera calibration and Epipolar Geometry, Homography, Rectification.	7
II	**Intensity transformation, Spatial Filtering and Shape** Basic intensity transformation functions, Histogram equalization, Histogram matching, Local Histogram Processing, Using histogram statistics for image enhancement,	7

	Contrast Limited Adaptive Histogram Equalization (CLAHE), Spatial filtering, smoothing and sharpening spatial filters. Color Image Processing: Color models. Shape and Regions: Object labelling and counting	
III	**Feature Detection and Matching** Points and Patches: Feature detectors, Feature descriptors, Feature matching, Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris corner detection, Orientation Histogram, SIFT, SURF, HOG, ORB, ScaleSpace Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters, Image Matching, Principal Component Analysis (PCA)	7
IV	**Image Segmentation:** Introduction, Segmentation techniques: Region Growing, Edge Based approaches to segmentation, Texture Segmentation, Object detection, Object segmentation, Active contours Deep learning models for segmentation, High-level vision, Deep learning for object detection	6
V	**Motion Analysis:** Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo, Motion parameter estimation. **Shape from shading:** Light at Surfaces, Reflectance Map, Albedo estimation. Photometric Stereo, Use of Surface Smoothness Constraint	6
VI	**Applications of Image Processing and Computer vision:** Real-world applications of Computer Vision for various industries: Manufacturing, Healthcare, Agriculture, Transportation, Sports using Gesture Recognition, Motion Estimation and Object Tracking, Face Recognition, Facial Expression Recognition, Optical Character Recognition, Automated Video Surveillance	6

List of Practical Assignments:

1. Implement various grey level transformations (Log, gamma, inversion).
2. Apply Histogram Equalization and CLAHE on grayscale and color images.
3. Perform smoothing and sharpening using spatial filters.
4. Implement SIFT, ORB and Histogram of Oriented Gradient (HOG) feature descriptors and perform keypoint matching between two images using SIFT/ORB.
5. Implement region growing and edge-based segmentation technique
6. Apply a pre-trained U-Net or Mask R-CNN for semantic segmentation using Tensorflow or Pytorh
7. Implement object detection using Haar cascades or YOLO
8. Implement background subtraction for detecting moving objects in a video.
9. Track moving objects using Kalman filter or DeepSORT.
10. Implement Principal Component Analysis to reduce the dimensionality.
11. Mini Project : Develop a computer vision application in a group of 2 - 3 students.

Text Books :

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer
2. Digital Image Processing- Refael C. Gonzalez and Richard E. Woods, Wesley

Reference Books:

1. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2ndEdition, Cambridge University Press, March 2004
3. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.

Online Resources:

1. Modern Computer Vision by Prof. A.N. Rajagopalan, IIT Madras
   https://onlinecourses.nptel.ac.in/noc25_ee51/preview
2. Computer Vision And Image Processing - Fundamentals And Applications By Prof. M. K. Bhuyan | IIT Guwahati
   https://onlinecourses.nptel.ac.in/noc25_ee13/preview
3. https://www.cse.iitd.ac.in/~suban/vision/index.html
4. https://www.sci.utah.edu/~gerig/CS6320-S2015/CS6320_3D_Computer_Vision.html
5. https://www.cse.iitb.ac.in/~ajitvr/CS763_Spring2017/
6. https://www.cs.auckland.ac.nz/courses/compsci773s1c/lectures/ImageProcessing-html/topic3.htm

Deep Learning For Natural Language Processing								
Course Code : IT25392			**Course Credits: 04**			**Course type: Honor**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
3	**2**	**–**	**10**	**30**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping:

1. Deep Neural Network

Course Objectives:

1. To realize the fundamental concepts of Natural Language Processing
2. To discover the relation between Deep Neural Network and NLP
3. To absorb advanced concept of Natural Language Processing
4. To apply the NLP for Indian language/multiple languages

Course Outcomes:

1. **Understand** fundamental elements of Natural Language Processing
2. **Design,** implement and evaluate word representation
3. **Understand** Pretrained Transformers
4. **Build** an application for Indian language
5. **Study** Large Language Model and Parameter Efficient Fine-tuning (PEFT)
6. **Analyze** the handling of long context

Unit No.	Syllabus	Teaching Hours
1	**Introduction to NLP** What is Natural Language Processing? A brief primer on word and sentence level tasks and n-gram language Model. Deep Learning: Shallow and Deep Neural Networks, Representation Learning	7
2	**Word Representations and Recurrent Neural Networks** Word2Vec, Glove, fastText, Multilingual representations with emphasis on Indian Languages Recurrent Neural Networks: RNN LMs, GRUs, LSTMs, Bi-LSTMs, LSTMs for Sequence Labeling, LSTMs for Sequence to Sequence	7
3	**Attention Mechanism and Pretrained Transformers** Sequence to Sequence with Attention, Transformers: Attention is all you need, Designing SSL objectives, Pretrained Bi-LSTMs: ELMO. Pretrained Transformers: BERT, GPT, T5, BART	7
4	**Application to Indian languages and Reinforcement Learning** Applications: Question Answering, Dialog Modeling, Text Summarization Multilingual extension with application to Indian languages, Instruction Fine-tuning, FLAN-T5, Reinforcement Learning through Human Feedback (RLHF)	6
5	**Large Language Models** In-context learning, chain-of-thought prompting. Scaling Laws. Various Large Language Models and unique architectural differences, Parameter Efficient Fine-	6

	tuning (PEFT) - LoRA, QLoRA	
6	**Long Context Handling** Handling Long Context, Retrieval Augmented Generation(RAG), Analysis and Interpretability, ethical considerations	6

PRACTICAL ASSIGNMENTS

Assign No	Title
1	**Text Preprocessing** Perform Text preprocessing for the data, such as removal of stopwords, punctuation, hyperlinks, handles, emoticons.
2	**Tokenization** Social Media Data Tokenization & Normalization
3	**Word representation** Perform text preprocessing and implement word embedding for English/Hindi/Marathi language.
4	**Classification using RNN** Build a classifier using Recurrent Neural Networks for English/Hindi/Marathi language.
5	**ELMO** Build an application using ELMO to solve real-time problem.
6	**BERT** Build an application for Text Summarization using BERT for English language
7	**T5** Using Pretrained T5 Transformers develop multitask learning application for emotion detection and subsequent categorization
8	**Data Augmentation** Perform data augmentation and differentiate between the performance of imbalanced and balanced dataset
9	**Mini Project** Build an application using NLP to solve real-time problem.

Text Books :

1. Daniel Jurafsky and James H. Martin. 2024. Speech andLanguage Processing. 3rd Edition. https://web.stanford.edu/~jurafsky/slp3/
2. Chris Manning and Hinrich Schütze. Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA: May 1999.

Online Resources:

1.NPTEL Course "**Deep Learning for Natural Language Processing**"
https://onlinecourses.nptel.ac.in/noc25_cs22/preview

Generative AI and LLM								
Course Code : IT25492			**Course Credits: 04**			**Course type: Honor**		
Teaching Scheme			**Evaluation Scheme**					
TH	**PR**	**TUT**	**CAA**	**ISE**	**ESE**	**TW**	**PR**	**OR**
03	**02**	**–**	**10**	**30**	**60**	**30**	**-**	**-**

Prerequisite Course Mapping:

1. Fundamentals of Artificial Intelligence
2. Machine Learning
3. Deep Learning
4. Basic probability and linear algebra

Future Course Mapping:

1. Agentic AI Systems
2. Applied NLP

Course Objectives:

1. To introduce the foundations of Generative AI and Large Language Models.
2. To develop practical skills in prompt engineering, LLM application design, and API-based development.
3. To enable students to build GenAI solutions using embeddings, vector databases, and Retrieval-Augmented Generation.

Course Outcomes: On completion of the course, learner will be able to

1. **Understand** the principles, architecture, and capabilities of Generative AI and Large Language Models.
2. **Apply** prompt engineering techniques to solve practical tasks using LLMs.
3. **Develop** LLM-based applications using embeddings, vector databases, and Retrieval Augmented Generation.
4. **Analyze** multimodal generative AI models..
5. **Design** agent-based AI workflows for intelligent automation using LLM frameworks..
6. **Evaluate** the performance, reliability, and ethical implications of Generative AI systems.

UNIT No.	Syllabus	Hrs
I	**Introduction to Generative AI and LLMs** Introduction to Generative AI, Generative vs discriminative models. Generative model families: Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Diffusion Models, and Autoregressive Models. Evolution of Natural Language Processing and transformer-based architectures. Transformer architecture and attention mechanism. Tokenization, embeddings, positional encoding. Decoder-only LLM architectures. Pretraining strategies, instruction tuning, and Reinforcement Learning from Human Feedback (RLHF). Applications of Generative AI in healthcare, education, finance, media, and software development.	7

II	**Prompt Engineering and LLM Interaction** Principles of prompt engineering, prompt structure, zero-shot, one-shot, few-shot prompting, chain-of-thought reasoning, role prompting, Prompt templates and structured output generation (JSON/XML), prompt debugging, prompt safety, using LLM APIs for summarization, translation, classification and text generation.	7
III	**LLM Application Development and RAG** LLM APIs, open-source LLM models,,embeddings and semantic similarity, vector databases, document chunking, Retrieval Augmented Generation (RAG), document QA systems, hybrid search and reranking, parameter efficient fine tuning, enterprise LLM applications.	7
IV	**Multimodal Generative AI and Computer Vision Generative Models** Introduction to multimodal Generative AI, Overview of generative models for images: GANs and Diffusion Models, Text-to-image generation models, Vision-language models for joint text-image understanding, Image captioning using multimodal transformers, Visual Question Answering (VQA), Multimodal Large Language Models integrating text, images, and documents, Applications of generative AI in media generation, design automation, document understanding, healthcare imaging, and autonomous systems.	6
V	**Agentic AI and Intelligent Automation** AI agents, agent architectures, planning, memory and tools, function calling, single-agent and multi-agent systems, workflow automation, LLM frameworks (LangChain concepts), enterprise automation using agents	6
VI	**Evaluation, Deployment and Responsible AI** LLM evaluation metrics, hallucination detection, human vs automated evaluation, guardrails and safety, bias and fairness, ethical AI, privacy and governance, LLM deployment, monitoring and LLMOps lifecycle	6

List of Practical Assignments:

1. Write a program to use a pre-trained transformer model (e.g., GPT, BERT) for basic text generation.
2. Write a program to demonstrate the difference between generative AI models and traditional machine learning models using sample datasets.
3. Implement prompt engineering techniques to perform tasks such as text summarization, translation, and classification using an LLM
4. Develop a program to compare zero-shot, one-shot, and few-shot prompting techniques for a selected NLP task.
5. Develop a simple chatbot application using LLM APIs to generate responses for user queries.
6. Write a program to generate text embeddings and perform semantic similarity search using an embedding model.
7. Develop a document question-answering system using RAG architecture and evaluate its performance.
8. Develop a text-to-image generation application using a diffusion model or generative AI API.
9. Write a program to extract text from images using OCR and generate summaries using an LLM.
10. Develop an AI agent that performs multi-step reasoning tasks using an LLM.
11. Implement evaluation techniques to measure the quality of LLM responses using relevance and accuracy metrics.
12. Mini project: Develop a Generative AI application in a group of 3–4 students.

Text Books :

1. Tunstall et al., Natural Language Processing with Transformers, O'Reilly, 2022.
2. Tong Xiao & Jingbo Zhu, Foundations of Large Language Models, Springer / arXiv Open Access, 2024.
3. Zhang , Dive into Deep Learning, Cambridge University Press (Open Access), 2023

Reference Books:

1. Jurafsky & Martin, Speech and Language Processing, 3rd Ed., Stanford University, 2023
2. Chollet, Deep Learning with Python, Manning Publications, 2021.
3. Rao & McMahan, Natural Language Processing with PyTorch, O'Reilly, 2019.
4. Huyen, AI Engineering, O'Reilly, 2025
5. Paaß & Giesselbach, Foundation Models for NLP, Springer, 2023.

Online Resources:

1. https://huggingface.co/learn/llm-course
2. https://www.deeplearning.ai/courses/
3. https://platform.openai.com/docs/tutorials
4. https://docs.langchain.com
5. https://learnprompting.org