MOHAN BABU UNIVERSITY

Sree Sainath Nagar, Tirupati – 517 102

SCHOOL OF COMPUTING

M.Tech - Computer Science and Engineering

CURRICULUM AND SYLLABUS
(From 2025-26 Admitted Students)

FULLY FLEXIBLE CHOICE BASED CREDIT SYSTEM (FFCBCS)

MOHAN BABU UNIVERSITY

Vision

To be a globally respected institution with an innovative and entrepreneurial culture that offers transformative education to advance sustainability and societal good.

Mission

- ❖ Develop industry-focused professionals with a global perspective.
- ❖ Offer academic programs that provide transformative learning experience founded on the spirit of curiosity, innovation, and integrity.
- ❖ Create confluence of research, innovation, and ideation to bring about sustainable and socially relevant enterprises.
- ❖ Uphold high standards of professional ethics leading to harmonious relationship with environment and society.

SCHOOL OF COMPUTING

Vision

To lead the advancement of computer science research and education that has real-world impact and to push the frontiers of innovation in the field.

Mission

- ❖ Instil within our students fundamental computing knowledge, a broad set of skills, and an inquisitive attitude to create innovative solutions to serve industry and community.
- ❖ Provide an experience par excellence with our state-of-the-art research, innovation, and incubation ecosystem to realise our learners' fullest potential.
- ❖ Impart continued education and research support to working professionals in the computing domain to enhance their expertise in the cutting-edge technologies.
- ❖ Inculcate among the computing engineers of tomorrow with a spirit to solve societal challenges.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Vision

To become a Centre of Excellence in Computer Science and its emerging areas by imparting high quality education through teaching, training and research.

Mission

➢ Imparting quality education in Computer Science and Engineering and emerging areas of IT industry by disseminating knowledge through contemporary curriculum, competent faculty and effective teaching-learning methodologies.

➢ Nurture research, innovation and entrepreneurial skills among faculty and students to contribute to the needs of industry and society.

➢ Inculcate professional attitude, ethical and social responsibilities for prospective and promising engineering profession.

➢ Encourage students to engage in life-long learning by creating awareness of the contemporary developments in Computer Science and Engineering and its emerging areas.

M.Tech. COMPUTER SCIENCE AND ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of M.Tech. (CSE) will be:

PEO1. Able to carry out research in the frontier areas of Computer Science and Engineering and develop innovative solutions to meet the opportunities and challenges in the society. (Research)

PEO2. Employed in academia, software development, Government organizations or would have established startup companies. (Career)

PEO3. Able to demonstrate effective communication and leadership skills, gain knowledge of contemporary and global issues and strive for continuous learning and practice their profession with high regard to legal and ethical responsibilities. (Professionalism, Intellectual Curiosity)

PROGRAM OUTCOMES

On successful completion of the Program, the graduates of M.Tech. (CSE) Program will be able to:

PO1. Demonstrate knowledge to select, learn and apply appropriate techniques, skills and modern engineering tools to solve engineering problems appropriate to the Computer Science and Engineering discipline. (Knowledge, Skills, Tools)

PO2. Analyze engineering problems critically, design, implement, evaluate and manage scientific/technological solutions in the context of Computer Science and Engineering discipline. (Analyze, Design, Implement, Evaluate, Manage)

PO3. Practice ethical principles and norms of engineering to assess societal, environmental, health, safety, legal and cultural issues pertaining to Computer Science and Engineering problems. (Professionalism, Society, Environment)

PO4. Independently carry out research/investigation and development of solutions to solve practical Computer Science and Engineering problems. (Research)

PO5. Function effectively as an individual and in a team to acquire knowledge and recognize opportunities for career progression in Computer Science and Engineering discipline. (Individual and Team Work)

PO6. Communicate effectively in professional practice through verbal and written formats. (Communication)

M.Tech. COMPUTER SCIENCE AND ENGINEERING

Basket Wise - Credit Distribution

Sl. No.	Basket	Credit (Min.- Max.)
1	SCHOOL CORE	31-34
2	PROGRAM CORE	21-24
3	PROGRAM ELECTIVE	12-18
4	UNIVERSITY ELECTIVE	6
	TOTAL CREDITS	**Min. 70**

School Core (31 - 34 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	**T**	**P**	**S**	**C**	
25EE201001	Research Methodology	3	-	-	-	3	-
25EE201002	Innovation and Intellectual Property Rights	2	-	-	-	2	-
25CS211001	Internship	-	-	-	-	2	-
25CS209001	Project Work Phase -I	-	-	-	-	10	-
25CS210001	Project Work Phase -II	-	-	-	-	14	-
Mandatory Courses (Min. 4 Credits) Earned Credits will not be considered for CGPA							
25CB207601	Essentials of Cyber Security *	2	-	-	-	2	-
25LG207601	Technical Report Writing	2	-	-	-	2	-
25AI207601	Statistics with R	2	-	-	-	2	-
25MG207601	Project Management	2	-	-	-	2	-
25MG207602	Essentials of Business Etiquette	2	-	-	-	2	-

*Compulsory Course

Program Core (21 - 24 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
25CS201001	Advanced Data Structures and Algorithms	3	-	-	-	3	-
25CS201002	Parallel and High Performance Computing	3	-	-	-	3	-
25CB202001	Advanced Computer Networks	3	-	3	-	4.5	-
25AI202002	Machine Learning	3	-	3	-	4.5	-
25CS202001	MERN Stack Development	3	-	3	-	4.5	-
25AI202004	Cloud Practitioner	3	-	3	-	4.5	-
25CS202002	Quantum Computing	3	-	3	-	4.5	-
25AI201010	IoT and Edge Computing	3	-	-	-	3	-

Program Elective (12 - 18 Credits)

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
25CB201008	Cyber Security	Machine Learning for Cyber Security	3	-	-	-	3	Machine Learning
25CB202003		Computer System Security	3	-	3	-	4.5	-
25CB201013		Blockchain Technologies	3	-	-	-	3	Computer System Security

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
25CB201009		Wireless and Mobile Network Security	3	-	-	-	3	Computer System Security
25CB202008		Network Operations and Security	3	-	3	-	4.5	Advanced Computer Networks
25AI201001	Intelligent Systems	Artificial Intelligence	3	-	-	-	3	-
25AI201002		Reinforcement Learning	3	-	-	-	3	Machine Learning
25AI201005		Text Analytics	3	-	-	-	3	Machine Learning
25AI202006		Deep Learning	3	-	3	-	4.5	Machine Learning
25AI202007		Computer Vision	3	-	3	-	4.5	Machine Learning
25AI201011		Generative AI	3	-	-	-	3	Artificial Intelligence
25CS201005	Data Science	Data Science	3	-	-	-	3	-
25AI201006		Data Analytics	3	-	-	-	3	-
25AI201009		Malware Analysis	3	-	-	-	3	Machine Learning
25AI202009		Data Visualization	3	-	3	-	4.5	-
25AI202010		Business Intelligence Tools	3	-	3	-	4.5	Data Visualization
25AI201007	Big Data	Data Mining	3	-	-	-	3	-
25AI202003		Big Data Frameworks	3	-	3	-	4.5	-
25AI202008		Data Engineering	3	-	3	-	4.5	Big Data Frameworks
25AI201004		Predictive Analytics	3	-	-	-	3	Machine Learning
25AI201008		Stream Processing and Analytics	3	-	-	-	3	Big Data Frameworks

University Elective (6 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits
		L	T	P	S	C
25AI201701	Business Analytics	3	-	-	-	3
25AI201702	Ethics for AI	3	-	-	-	3
25CM201701	Cost Management of Engineering Projects	3	-	-	-	3
25CE201701	Disaster Management	3	-	-	-	3
25SS201701	Value Education	3	-	-	-	3
25SS201702	Pedagogy Studies	3	-	-	-	3
25LG201701	Personality Development through Essential Life Skills	3	-	-	-	3
25MG201701	Entrepreneurship and Innovation Management	3	-	-	-	3

Note:

1. If any student has chosen a course or equivalent course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s under University Elective.
2. The student can choose courses from other disciplines offered across the schools of MBU satisfying the pre-requisite other than the above list.

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25EE201001	**RESEARCH METHODOLOGY**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:
The course is developed for the students' to understand the underlying concepts of research methodology and a systematic approach for carrying out research in the domain of interest. The course is emphasised on developing skills to recognise and reflect the strength and limitation of different types of research; formulation of the research hypothesis and its systematic testing methods. The course also emphasises on interpreting the findings and research articulating skills along with the ethics of research.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the underlying concepts of research methodology, types of research and the systematic research process.

CO2. Demonstrate the philosophy of research design, types of research design and develop skills for a good research design.

CO3. Demonstrate the philosophy of formulation of research problem, methods of data collection, review of literature and formulation of working hypothesis.

CO4. Analyse the data and parametric tests for testing the hypothesis.

CO5. Interpret the findings and research articulating skills along with the ethics of research.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	3	-	-
CO2	-	-	-	3	-	-
CO3	-	-	-	3	-	-
CO4	-	-	-	3	-	-
CO5	-	-	-	-	3	-
Course Correlation Mapping	**-**	**-**	**-**	**3**	**3**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO RESEARCH METHODOLOGY   (08 Periods)

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research.

Module 2:   RESEARCH DESIGN   (08 Periods)

Research design—Basic Principles, Need of research design, Features of good design, Important concepts relating to research design, Different research designs, Basic principles of experimental designs, Developing a research plan.

Module 3:   RESEARCH FORMULATION   (08 Periods)

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Data collection – Primary and secondary sources; Critical literature review – Identifying gap areas from literature review; Hypothesis— Types of hypothesis, Development of working hypothesis.

Module 4:   ANALYSIS OF DATA AND HYPOTHESIS TESTING   (14 Periods)

Quantitative Tools: Testing and Significance of Measures of Central Tendency, Dispersion; correlation, Principles of least squares—Regression; Errors-Mean Square error, Mean absolute error, Mena absolute percentage errors.
Testing of Hypothesis: Hypothesis Testing Procedure, Types of errors, Parametric testing (t, z and F), Chi-Square Test as a Test of Goodness of Fit; Normal Distribution-Properties of Normal Distribution; Analysis of Variance.

Module 5:   INTERPRETATION AND REPORT WRITING   (07 Periods)

Interpretation: Meaning of interpretation; Techniques of interpretation; Precautions in Interpretation.
Report Writing –Significance, Different Steps, Layout, Types of reports, Mechanics of Writing a Research Report, Precautions in Writing Reports; Research ethics—Plagiarism, Citation and acknowledgement.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Should conduct a survey based on a hypothesis, analyze the data collected and draw the inferences from the data.

2. Should review the literature on the given topic and should identify the scope/gaps in the literature and develop a research hypothesis.

3. Should study a case, formulate the hypothesis and identify an appropriate testing technique for the hypothesis.

4. Study an article and submit a report on the inferences and should interpret the findings of the article.

RESOURCES

TEXT BOOKS:
1. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2nd revised edition, New Delhi, 2004.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, 2002.

REFERENCE BOOKS:
1. R. Panneerselvam, Research Methodology, PHI learning Pvt. Ltd., 2009.
2. Singh, Yogesh Kumar. Fundamental of research methodology and statistics. New Age International, 2006.

VIDEO LECTURES:
1. https://nptel.ac.in/courses/121106007
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
3. https://www.youtube.com/watch?v=VK-rnA3-41c

WEB RESOURCES:
1. https://www.scribbr.com/category/methodology/
2. https://leverageedu.com/blog/research-design/
3. https://prothesiswriter.com/blog/how-to-formulate-research-problem
4. https://www.formpl.us/blog/hypothesis-testing
5. https://www.datapine.com/blog/data-interpretation-methods-benefits-problems/
6. https://leverageedu.com/blog/report-writing/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25EE201002	INNOVATION AND INTELLECTUAL PROPERTY RIGHTS	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The course is designed to provide comprehensive knowledge to the students regarding the general principles of innovation and intellectual property rights, significance of innovation and steps for innovation, Concept and Theories, Criticisms of Intellectual Property Rights, International Regime Relating to IPR. The course provides an awareness on how to protect ones unique creation, claim ownership, knowledge of what falls under the purview of someone's rights and what doesn't, and safeguard their creations and gain a competitive edge over the peers.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the significance of innovation and steps for innovative thinking, and the concepts of intellectual property right and avenues for filling intellectual property rights.

CO2. Understand the legislative practices and protocols for acquisition of trademark and the judicial consequences for violating laws of trademark protection.

CO3. Understand the legislative practices and protocols for acquisition of copyrights and the judicial consequences for violating laws of copyrights protection.

CO4. Understand the fundamentals of patent laws, legislative practices and protocols for acquisition of trade secrets and the judicial consequences for violating laws of trade secrets protection.

CO5. Understand the latest developments and amendments in protection and filling of intellectual rights at international level.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	3
CO2	-	-	-	-	-	3
CO3	-	-	-	-	-	3
CO4	-	-	-	-	-	3
CO5	-	-	-	-	-	3
Course Correlation Mapping	-	-	-	-	-	3

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO INNOVATION AND IPR   (06 Periods)
Innovation: Difference between Creativity and Innovation – Examples of innovation; Being innovative; Identify Blocks for creativity and innovation – overcoming obstacles; Steps for Innovation
Intellectual property rights: Need for intellectual property rights (IPR); types of intellectual property- Design, Geographical Indication; International organizations, agencies and treaties.

Module 2: TRADEMARKS   (06 Periods)
Introduction to trademark, Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Module 3: LAW OF COPYRIGHTS   (06 Periods)
Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.
Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Module 4: TRADE SECRETS   (06 Periods)
Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.
Unfair competition: Misappropriation right of publicity, false advertising.

Module 5: NEW DEVELOPMENT OF INTELLECTUAL PROPERTY   (06 Periods)
New developments in: trade mark law, copy right law, patent law, intellectual property audits. International overview on intellectual property; international - trade mark law, copy right law, international patent law, international development in trade secrets law.

Total Periods: 30

EXPERIENTIAL LEARNING

1. Should conduct a survey based on the real scenario, where IPR is misused or unethically used and present an article.
2. Prepare an article on the registration processes of IPR practically (copy right/trade mark/ patents).
3. Should study a case of conflict on trademarks/patents and should produce an article mentioning the circumstances and remedial measures.
4. Prepare an article on the latest development in the international intellectual property rights.
5. Refining the project, based on the review report and uploading the text

RESOURCES

TEXT BOOKS:

1. Deborah, E. Bouchoux, Intellectual property: The law of Trademarks, Copyright, Patents, and Trade Secrets, Cengage learning, 4th Edition, 2013.

2. Prabuddha Ganguli, Intellectual property right - Unleashing the knowledge economy, McGraw Hill Education, 1st Edition, 2017.

3. Tom Kelley & Jonathan Littman, The Art of Innovation, Profile Books Ltd, UK, 2008

REFERENCE BOOKS:

1. Neeraj P., & Khusdeep D, Intellectual Property Rights, PHI learning Private Limited, 1st Edition, 2019.

2. Nithyananda, K V. Intellectual Property Rights: Protection and Management, Cengage Learning India Private Limited, 2019

3. Edward debone, How to have Creative Ideas, Vermilon publication, UK, 2007.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105139

2. https://www.youtube.com/watch?v=bEusrD8g-dM

3. https://www.youtube.com/watch?v=LS7TTb23nzU

WEB RESOURCES:

1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf

2. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

3. http://cipam.gov.in/

4. https://www.wipo.int/about-ip/en/

5. http://www.ipindia.nic.in/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25CS211001	**INTERNSHIP**	-	-	-	-	2

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: Expose students to the industrial environment; Create competent professionals for the industry; sharpen the real time technical / managerial skills required at the job; Gain professional experience and understand engineer's responsibilities and ethics; Familiarize with latest equipment, materials and technologies; Gain exposure to technical report writing; Gain exposure to corporate working culture

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze latest equipment, materials and technologies that are used in industry to solve complex engineering problems following relevant standards, codes, policies and regulations.

CO2. Analyze safety, health, societal, environmental, sustainability, economical and managerial factors considered in industry in solving complex engineering problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on practicing engineering.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	-	-
CO2	-	3	3	3	-	-
CO3	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25CS209001	**PROJECT WORK PHASE -I**	-	-	-	-	10

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1.   Create/Design computer science engineering systems or processes to solve complex computer science engineering and allied problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2.   Consider society, health, safety, environment, sustainability, economics and project management in solving complex computer science engineering and allied problems.

CO3.   Perform individually or in a team besides communicating effectively in written, oral and graphical forms on computer science engineering systems or processes.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	-	3	3	3	-	-
CO3	-	-	-	-	3	3
Course Correlation Mapping	3	3	3	3	3	3

Correlation Level: 3-High;   2-Medium;   1-Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25CS210001	**PROJECT WORK PHASE -II**	-	-	-	-	14

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. Create/Design computer science engineering systems or processes to solve complex computer science engineering and allied problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider society, health, safety, environment, sustainability, economics and project management in solving complex computer science engineering and allied problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on computer science engineering systems or processes.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	-	3	3	3	-	-
CO3	-	-	-	-	3	3
Course Correlation Mapping	3	3	3	3	3	3

Correlation Level: 3-High; 2-Medium; 1-Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25CB207601	**ESSENTIALS OF CYBER SECURITY**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Cyber Security Fundamentals, Cyber Security Fundamentals, Attacker techniques and motivations, Fraud techniques, Threat infrastructure, Exploitation, Malicious code, Defense and analysis techniques, Intrusion detection techniques

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understanding the fundamental concepts of cyber security concepts

CO2. Identify the pattern of launching attacker and fraud techniques to reduce risk and impact of cyber-attacks.

CO3. Identify the vulnerabilities using the SQL injection and web exploitation techniques in a system for securing data.

CO4. Apply code obfuscation techniques to prevent any unauthorized party from accessing logic of an application

CO5. Apply honey pots and malicious code-naming techniques to defend against attacks in memory.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	-	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	2	-	-
CO5	3	2	3	2	-	-
Course Correlation Mapping	**3**	**3**	**3**	**2**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: CYBER SECURITY FUNDAMENTALS (05 Periods)

Network Security Concepts: Information assurance fundamentals, Basic cryptography, Symmetric encryption, Public key encryption, The Domain Name System (DNS), Firewalls, Virtualization, Radio-Frequency Identification.

Module 2: ATTACKER TECHNIQUES (07 Periods)

Attacker techniques and motivations: Anti forensics, proxy usage, Tunneling techniques: HTTP, DNS, ICMP, Intermediaries, Steganography and other concepts, Detection and prevention.

Fraud techniques: Phishing, smishing, vishing and mobile malicious code, rogue antivirus, click fraud.

Threat infrastructure: Botnets, Fast Flux, Advanced Fast Flux.

Module 3: EXPLOITATION (06 Periods)

Shellcode, Integer overflow vulnerabilities, Stack based buffer overflows, Format string vulnerabilities, SQL injection, Malicious PDF files, Race conditions, Web exploit tools, Do's conditions, Brute force and dictionary attacks.

Module 4: MALICOUS CODE (06 Periods)

Worms, viruses, Evading detection and elevating privileges: obfuscation, Virtual Machine obfuscation Persistent software techniques, Token kidnapping, Virtual machine Detection, Rootkits, Spyware, Attacks against privileged user accounts and escalation of privileges, Stealing information and Exploitation.

Module 5: DEFENSE AND ANALYSIS TECHNIQUES (06 Periods)

Importance of memory forensics, Capabilities of memory forensics, Memory analysis frameworks, Dumping physical memory, Installing and using volatility, Finding hidden processes, Volatality analyst pack.

Honeypots, Malicious code naming, Automated malicious code analysis systems, Intrusion detection techniques

Total Periods:30

EXPERIENTIAL LEARNING

1. Observe the firewall settings on your personal computer or smartphone.

   - What configurations are enabled?
   - How does this firewall protect your device from threats?

2. Compare phishing, smishing, and vishing using real-life examples. Which of these do you think people are most vulnerable to, and why?

3. Research a recent Do's attack in the news.

  - What services were affected?
  - What preventive measures could have reduced the impact?

4. Explore your antivirus software logs.

  - What types of threats were blocked recently?
  - Were any of them worms, viruses, or spyware?

5. Reflect on the importance of intrusion detection systems (IDS).

  - How does an IDS differ from a firewall?
  - Why are both needed in an organisation's security framework?

RESOURCES

TEXT BOOKS:

1. James Graham, Richard Howard, Ryan Olson, "Cyber Security Essentials", CRC Press, 2011.

2. Chwan-Hwa(john) Wu,J. David Irwin, "Introduction to Cyber Security", CRC Press T&F Group.

REFERENCE BOOKS:

1. Nina Godbole and SunitBelpure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley publications.

2. B.B.Gupta, D.P.Agrawal, HaoxiangWang, "Computer and Cyber Security: Principle s, Algorithm, Applications, and Perspectives", CRC Press, ISBN 9780815371335, 2018.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106129

2. https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst

WEB RESOURCES:

1. https://www.interpol.int/en/Crimes/Cybercrime

2. https://www.geeksforgeeks.org/ethical-hacking/cyber-security-tutorial/

3. https://owasp.org/www-project-top-ten/

4. https://www.netacad.com/courses/cybersecurity-essentials?courseLang=en-US

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25LG207601	**TECHNICAL REPORT WRITING**	2	-	-	-	2

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course deals with preparing effective technical documents for both written and digital media, with particular emphasis on technical memos, problem-solving and decision-making reports, and organizational, product-support, and technical-information webs.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge of Technical Report Writing and structures with a scientific attitude.
CO2. Analyze the process of writing in preparing effective reports.
CO3. Demonstrate styles of writing for Publication in a Scientific Journal.
CO4. Apply the process of referencing and editing techniques for effective communication in written documents.
CO5. Analyze the strategies in the technical report presentation.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	2	3	2	-	-	-
CO3	3	-	-	-	-	-
CO4	2	-	-	-	3	-
CO5	2	3	2	-	2	-
Course Correlation Mapping	**2**	**3**	**2**	**-**	**3**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO TECHNICAL REPORT WRITING   (06 Periods)

Concepts of Technical Report, Types of Reports, Planning Technical Report Writing, Components of a Technical Report, Report Writing in Science and Technology, Selecting and Preparing a Title, Language Use

Module 2:   PROCESS OF WRITING   (06 Periods)

Writing the 'Introduction', Writing the 'Materials and Methods, Writing the Findings/Results, Writing the 'Discussion', Preparing and using "Tables'.

Module 3:   STYLE OF WRITING   (06 Periods)

Preparing and using Effective 'Graphs', Citing and Arranging References, Writing for Publication in a Scientific Journal.

Module 4:   REFERENCING   (06 Periods)

Literature citations, , Bibliographical data according to ISO standards, Citations in the text, Copyright, and copyright laws, the text of the Technical Report, Using a word processing and desktop publishing (DTP) systems, Document or page layout, hints on editing Typographic details, Cross-references.

Module 5:   PRESENTATION   (06 Periods)

Presentation with appropriate pointing, Dealing with intermediate questions, Review and analysis of the presentation, Rhetoric tips from A to Z.

Total Periods: 30

EXPERIENTIAL LEARNING

1.   Prepare a report on technologies of modern times that enriched the originality of research works and their impacts on society concerning plagiarism.

2.   Make PowerPoint presentations on the various style of writing academic reports.

3.   Error-free Reports are so important for successful communication and sharing of information. Prepare a detailed chart on proofreading techniques to make a report effective and error-free.

4.   Design a logo for a company and write down the copy-right laws for that.

5.   Read research articles from any international journal of science and technology and differentiate research writing from other academic and non-academic writings.

6.   Write an organizational memo Include a heading, introduction, and summary at the beginning of your memo, and present the details of your discussion in a logical order. Use headings and topic or main-idea sentences to clarify the organization.

7.   Prepare an appraisal report on the staff performance of your company.

8.   Prepare a PowerPoint presentation on the annual performance report of a company.

9.   Critically review and write a report on any one of the recently released products.

10.   Read the newspaper and write a detailed report about the content coverage and analyse the factors for the popularity of the newspaper.

RESOURCES

TEXTBOOK

1. RC Sharma Krishna Mohan, "Business Correspondence and Report" McGraw-Hill Publishing. Writing," Tata Company Limited, New Delhi", 3rd Edition, 2005 (reprint).

2. Patrick Forsyth, "How to Write Reports and Proposals", THE SUNDAY TIMES (Kogan Page), New Delhi, Revised 2ndEdition, 2010.

REFERENCE BOOKS:

1. John Seely, "The Oxford Writing & Speaking", Oxford University Press, Indian Edition

2. Anne Eisenberg, "A Beginner's Guide to Technical Communication", McGraw-Hill Education (India) Private Limited, New Delhi, 2013.

VIDEO LECTURES:

1. https://vimeo.com/143714818

2. https://digitalmedia.sheffield.ac.uk/media/002.+The+Anatomy+of+a+Technical+Report/1_u8wntcge

WEB RESOURCES:

1. http://www.resumania.com/arcindex.html

2. http://www.aresearchguide.com/writing-a-technical-report.htm

3. http://www.sussex.ac.uk/ei/internal/forstudents/engineeringdesign/studyguides/tec report writing

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25AI207601	**STATISTICS WITH R**	2	-	-	-	2

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course introduces the basic concepts of statistics using R language. The course also deals with various types of sampling methods and its impact in the scope of inference through the computation of confidence intervals. The topics covered in the course also includes descriptive statistics, marginal and conditional distribution, statistical transformations, chi-squared test and ANOVA.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

- **CO1.** Import, manage, manipulate, structure data files and visualize data using R programming.
- **CO2.** Identify trends and patterns in data using Marginal, Conditional distributions and Statistical transformations.
- **CO3.** Analyse data using sampling and probability distribution methods and compute confidence intervals for statistical inference.
- **CO4.** Apply chi-squared goodness-of-fit test, Pearson's $\square$ 2-statistic and ANOVA to investigate the distribution of data.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	-	-	-	-
CO3	2	2	-	-	-	-
CO4	3	2	-	-	-	-
Course Correlation Mapping	3	2	-	-	-	-

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1: INTRODUCTION **(05 Periods)**

Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Module 2: BIVARIATE AND MULTIVARIATE DATA **(07 Periods)**

Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

Module 3: POPULATIONS **(06 Periods)**

Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

Module 4: CONFIDENCE INTERVALS **(06 Periods)**

Confidence intervals for a population proportion, p - population mean, other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

Module 5: GOODNESS OF FIT **(06 Periods)**

The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's □ 2-statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using lm for ANOVA.

Total Periods: 30

EXPERIENTIAL LEARNING

1. The data set baby boom (Using R) contains data on the births of 44 children in a one- day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed? The variable running.time records the time after midnight of each birth. The command diff(running.time) records the differences or inter-arrival times. Is this variable skewed?

2. An elevator can safely hold 3, 500 pounds. A sign in the elevator limits the passenger count to 15. If the adult population has a mean weight of 180 pounds with a 25-pound standard deviation, how unusual would it be, if the central limit theorem applied, that an elevator holding 15 people would be carrying more than 3, 500 pounds?

3. The data set MLB Attend (Using R) contains attendance data for Major League Baseball between the years 1969 and 2000. Use lm to perform a t-test on attendance for the two levels of league. Is the difference in mean attendance significant? Compare your results to those provided by t-test.

RESOURCES

TEXT BOOKS:

1. John Verzani, Using R for Introductory Statistics, CRC Press, 2nd Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, Statistics Using R, Narosa Publishing house, 2nd Edition, 2021.

REFERENCE BOOKS:

1. Francisco Juretig, R Statistics Cookbook, Packt Publishing, 1st Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, A Course in Statistics with R, Wiley, 2018.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_ma76/preview
2. https://onlinecourses.nptel.ac.in/noc19_ma33/preview
3. https://youtu.be/WbKiJe5OkUU?list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa-6Gz
4. https://youtu.be/svDAkvh6utM?list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa-6Gz
5. https://nptel.ac.in/courses/111104120

WEB RESOURCES:

1. https://www.geeksforgeeks.org/r-statistics/
2. https://www.geeksforgeeks.org/r-programming-exercises-practice-questions-and-solutions/
3. https://www.w3schools.com/r/r_stat_intro.asp
4. https://www.w3schools.com/r/r_stat_intro.asp
5. https://statsandr.com/blog/descriptive-statistics-in-r/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25MG207601	**PROJECT MANAGEMENT**	2	-	-	-	2

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: To understand the importance of decision-making while implementing any project and interpret and discuss the results of qualitative and quantitative analysis

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic introduction to project management

CO2. Apply the methods of project identification and selection.

CO3. Understand project allocation methods and evaluation.

CO4. Analyse the techniques for project time, review, and cost

CO5. Understand the factors of risk and quality of a project.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	-	-
CO2	1	1	2	2	-	-
CO3	2	2	1	2	1	-
CO4	3	1	2	2	1	-
CO5	2	2	1	2	1	1
Course Correlation Mapping	**2**	**2**	**2**	**2**	**1**	**1**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: INTRODUCTION   **(05 Periods)**
Concept of project management, project definition and key features of projects, project life cycle phases, typical project management issues, basic project activities

Module 2: PROJECT IDENTIFICATION AND SELECTION   **(06 Periods)**
Identification and screening (brainstorming, strength and weakness in the system, environmental opportunities and threats), Project evaluation methods- Payback period, Net present value, Internal rate of return and project evaluation under uncertainty.

Module 3: PROJECT RESOURCE MANAGEMENT   **(07 Periods)**
Scheduling resources, resource allocation methods, project crashing and resource leveling, working of systems, design of systems, project work system design, project execution plan, project procedure manual project control system, planning scheduling and monitoring

Module 4: TIME AND COST MANAGEMENT   **(05 Periods)**
Time Management-Network diagram, forward and backward pass, critical path, PERT and CPM, AOA and AON methods, tools for project network, Cost management-earned value method

Module 5: RISK AND QUALITY MANAGEMENT   **(07 Periods)**
Risk identification, types of risk, risk checklist, risk management tactics, risk mitigation and contingency planning, risk register, communication management, Quality assurance and quality control, quality audit, methods of enhancing quality

Total Periods: 30

EXPERIENTIAL LEARNING

1. Refer to any video lecture on project evaluation methods and give a brief seminar using PPT

2. Select any company wherein you will get the details of activities and time and draw the project network diagram and submit a report.

3.

Activity	Predecessor Activity	Normal Time (Weeks)	Crash Time (Weeks)	Normal Cost (Rs.)	Crash Cost (Rs.)
A	-	4	3	8,000	9,000
B	A	5	3	16,000	20,000
C	A	4	3	12,000	13,000
D	B	6	5	34,000	35,000
E	C	6	4	42,000	44,000
F	D	5	4	16,000	16,500
G	E	7	4	66,000	72,000
H	G	4	3	2,000	5,000

   Determine a crashing scheme for the above project so that the total project time is reduced by 3 weeks.

4. Collect any case study that discusses the process of probability calculation of success of the project and submit a report.

RESOURCES

TEXT BOOKS:

1. R.Panneerselvam and P.Senthil Kumar (2013), Project Management, PHI Learning Private Limited.

2. Prasanna Chandra (2014), Projects: Planning, Analysis, Selection, Financing, implementation, and Review.

REFERENCE BOOKS:

1. A Guide to the Project Management Body of Knowledge: (PMBOK Guide) by Project Management Institute, 2013.

2. Gopala Krishnan & Rama Murthy, A Text book of Project Management, McMillan India.

3. S. Choudhary (2004), Project Management, Tata McGraw Hill Publication.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc19_mg30/preview

2. https://archive.nptel.ac.in/courses/110/104/110104073/

WEB RESOURCES:

1. https://www.pmi.org/about/learn-about-pmi/what-is-project-management

2. https://www.manage.gov.in/studymaterial/PM.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25MG207602	**ESSENTIALS OF BUSINESS ETIQUETTE**	2	-	-	-	2

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course develops the concept of business etiquette and the proper etiquette practices for different business scenarios. It builds student awareness of professional conduct and cultural sensitivity, preparing them to navigate diverse global environments with confidence, respect, and appropriate etiquette for every scenario.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. To understand the concept of Etiquette.

CO2. Develop life skills or etiquette in order to succeed in corporate culture.

CO3. Present oneself with finesse and making others comfortable in a business

CO4. Adopt behaviors consistent with standard workplace expectations

CO5. Demonstrate an understanding of professionalism in terms of workplace behaviors and lace relationships.

CO-PO Mapping Table

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	-	-
CO2	2	3	-	-	-	-
CO3	2	2	-	-	3	-
CO4	1	1	-	-	-	-
CO5	-	-	-	-	-	-
Course Correlation Mapping	2	2	3	-	3	-

Correlation Levels: **3: High;   2: Medium;   1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO ETIQUETTE   (06 Periods)

Introduction to etiquette, benefits- Business etiquette – ABCs of etiquette- Manners, poor manners and good manners- - Role of good manners in business –Professional conduct and personal spacing.

Module 2:   CLASSIFICATION OF ETIQUETTE   (06 Periods)

Telephone Etiquette - Email etiquette - Dining Etiquette - Dress Etiquette, - Online chat etiquette - Virtual Etiquette - Work place Etiquette

Module 3:   MULTI-CULTURAL ETIQUETTE   (06 Periods)

Inclusivity and Diversity - cultural awareness –cultural sensitivity - Adaptability and Flexibility - Inter-cultural communication - Ethical Considerations -Taboos and practices

Module 4:   WORKPLACE COURTESY AND BUSINESS ETHICS   (06 Periods)

Workplace Courtesy - Business Ethics - Hierarchy and Protocol - Developing good relations with peers, superiors, subordinates - Offering compliments and criticism- Preventing Sexual Harassment - Conflict Resolution Strategies

Module 5:   NEW ISSUES IN ETIQUETTE & WORKPLACE SUCCESS   (06 Periods)

Ethical Issues in Business Etiquette - Cultural Differences and their Effects on Business Etiquette - Sexual Etiquette in the Workplace - Preventing Sexual Harassment- Professionalism - Interpersonal relations- Following Company Policy for Business Etiquette

Total Periods: 30

EXPERIENTIAL LEARNING

1. Role play activity in Telephone etiquette practices.

2. As a new employee, how do you follow workplace courtesies?

3. Group presentation of Etiquette in different countries.

4. Imagine you are a supervisor and explain your subordinates the importance of business etiquette.

5. You came to know that one of male employees in your company sexually harassed a female employee. As a boss of a company, how do you handle the situation and suggest steps to prevent sexual harassment at work place.

RESOURCES

TEXTBOOK:

1. Dhanavel, S.P. English and Soft Skills. Hyderabad: Orient Black Swan, 2021.
2. Pachter Barbara & Cowie Denis (2013) Essentials of Business Etiquette, New York:
   McGraw Hill Education.

REFERENCE BOOKS:

1. Fox Sue (2010) Business Etiquette for Dummies, New Jersey: Wiley
2. Stephen P. Robbins and Timothy A. Judge, Organizational Behaviour, Prentice Hall, Delhi, 16th edition, 2014
3. Kumar Suresh E, Shreehari P, Savithri J (2010) Communication Skills and Soft Skills: An Integrated Approach, Chennai: Pearson Education.

VIDEO LECTURES:

1. https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2723087361&p=cultural+awareness+%E2%80%93cultural+sensitivity+video&type=type80160-2362144563#id=8&vid=11d76fd8f4c9b5419344ccfd30f291c1&action=click

2. https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2723087361&p=cultural+awareness+%E2%80%93cultural+sensitivity+video&type=type80160-2362144563#id=9&vid=ea7c85dbd21b03e8dec303c23c6bcb7b&action=view

WEB RESOURCES:

1. https://theengine.biz/wp-content/uploads/2020/12/Business-Etiquette-ebook.pdf

2. https://insights.si/wp-content/uploads/hunt-chaney-l.-i-st.-clair-martin-j.-2007.-the-essential-guide-to-business-etiquette.pdf

3. https://www.scribd.com/document/732526337/Types-of-Business-Etiquette-and-its-Importance

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25CS201001	**ADVANCED DATA STRUCTURES AND ALGORITHMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Data Structure Concepts, Stacks, Queues, Trees, Graphs, Skip Lists, Heaps, Hashing, and Real-Time Applications of Data Structures. This course also examines Design and Analysis of Algorithmic Concepts on Divide and Conquer, Greedy Method, Dynamic Programming, Backtracking, NP-Completeness and advanced algorithms Approximation algorithms and Number-Theoretic algorithms.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze linear data structures such as linked lists, stacks, and queues for efficient data organization and manipulation.

CO2. Analyze data structures such as trees, graphs, heaps and hash tables for efficient storage, search and retrieval of data.

CO3. Design and evaluate the performance of efficient techniques such as Divide-and-conquer, Greedy Method, Dynamic Programming, Backtracking, to solve engineering problems.

CO4. Apply NP-Hard and NP-complete, Approximation and Number theoretic algorithms to solve complex problems.

CO5. Apply knowledge to select appropriate data structures and algorithms for solving Societal applications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	-	-	-	-
CO3	3	2	-	-	-	-
CO4	3	2	-	-	-	-
CO5	2	3	1	-	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**

Correlation Levels: **3: High;** **2: Medium;** **1: Low**

COURSE CONTENT

Module 1: ELEMENTARY DATA STRUCTURES AND TREES   **(08 Periods)**

Elementary Data Structures: Introduction, Time and space complexity, Asymptotic notations, Stacks, Queues - Circular Queue, Dequeue; Linked lists.
Trees: Binary trees, Binary search trees, AVL Trees, Red Black Trees.

Module 2: GRAPHS AND SKIP LISTS   **(09 Periods)**

Graphs: Graph traversal techniques, Minimum spanning trees, Maximum Bipartite Matching, Minimum cost flow.
Skip Lists: Need for Randomizing data structures and algorithms, Search and update operations on skip lists, Probabilistic analysis of skip lists, Deterministic skip lists.

Module 3: HEAPS AND HASHING   **(09 Periods)**

Heaps: Heap Implementation, priority queues, Applications, Binomial heaps, operations on binomial heaps, Fibonacci heaps, Mergeable heap operations.
Hashing: Hash functions and problems, Collision resolution techniques, Universal hashing, Applications.

Module 4: DIVIDE AND CONQUER, GREEDY METHOD, DYNAMIC   **(10 Periods)**
PROGRAMMING AND BACK TRACKING

Divide and Conquer: General method, Binary search.
Greedy Method: General method, Job sequencing with deadlines.
Dynamic Programming: 0/1 Knapsack problem, Traveling salesperson problem.
Backtracking: N–Queen's problem.

Module 5: NP-COMPLETENESS, APPROXIMATION ALGORITHMS   **(09 Periods)**
AND NUMBER-THEORETIC ALGORITHMS

NP-Completeness: Polynomial-time, Polynomial-time verification, NP-completeness and reducibility, NP-complete problems.
Approximation Algorithms: The vertex-cover problem, Traveling salesman problem, Subset-sum problem.
Number Theoretic Algorithms: Elementary number-theoretic notions, Greatest common divisor.

Total Periods: 45

EXPERIENTIAL LEARNING

1.   Perform a study on the challenges, existing solutions, applications related to solving the layout problem and submit a detailed report with your findings on several optimal and heuristic algorithms that provide useful insight into the layout problem to provide near-optimal solutions. The following research papers can be studied. Other relevant papers can also be studied.

   a) https://www.taylorfrancis.com/chapters/mono/10.1201/9781003285090-12/advanced-algorithms-layout-problem-sunderesh-heragu
   b) https://doi.org/10.3182/20060517-3-FR-2903.00208

RESOURCES

TEXT BOOKS:

1. Ellis Horowitz, Sartaj Sahni, and S Rajasekaran, Fundamentals of Computer Algorithms, Universities Press, 2nd Edition, 2008.

2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, PHI Learning, 3rd Edition, 2009.

3. Goodrich, Tamassia, Goldwasser, Data structures & Algorithms in Java, 6th Edition, Wiley, 2014.

REFERENCE BOOKS:

1. John R. Hubbard, Programming with Java, 2nd Edition, McGraw Hill, 2009.

2. Debasis Samanta, Classic Data Structures, 2nd Edition, Prentice Hall, 2009.

3. Robert Lafore, Data Structures & Algorithms in Java, 2nd Edition, Pearson, 2007.

4. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson, 4th Edition, 2014.

5. Michael T. Goodrich, Roberto Tomassia, Algorithm Design: Foundations, Analysis and Internet Examples, Wiley, 2002

VIDEO LECTURES:

3. https://nptel.ac.in/courses/106102064

4. http://nptel.ac.in/courses/106106127

5. https://www.youtube.com/watch?v=RBSGKlAvoiM

6. https://www.youtube.com/watch?v=xZKqH7ZcS_Y

7. https://www.youtube.com/watch?v=8hly31xKli0

8. https://www.youtube.com/watch?v=P5IH4lqCJSk

WEB RESOURCES:

1. https://www.cs.auckland.ac.nz/software/AlgAnim/red_black.html

2. https://www.geeksforgeeks.org/maximum-bipartite-matching/

3. https://www.gatevidyalay.com/job-sequencing-with-deadlines/

4. https://www.tutorialandexample.com/collision-resolution-techniques-in-data-structure

5. https://developers.google.com/optimization/cp/queens

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25CS201002	**PARALLEL AND HIGH PERFORMANCE COMPUTING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course introduces the fundamentals of parallel and high-performance computing. Major topics of the course include: Vectorization Methods, Open MP, GPU architecture, GPU programming model, CUDA and HIP GPU languages, Affinity process with MPI, chaos in Batch schedulers, High performance file system, MPI file operations and parallel file systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on parallel computing, parallel strategies, profiling and vectorization.

CO2. Analyze Open MP for Threading and Vectorization.

CO3. Apply GPU and programming languages to design a parallel processor

CO4. Analyze controlling affinity for parallel applications and batch schedules.

CO5. Explore the concepts of data using parallel file operations with MPI-IO and HDF5.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	-	-
CO2	2	3	-	-	-	-
CO3	3	2	-	-	-	-
CO4	3	1	-	-	-	-
CO5	3	2	-	-	-	-
Course Correlation Mapping	**3**	**2**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1: **INTRODUCTION TO PARALLEL COMPUTING,** **(09 Periods)**
PERFORMANCE LIMITS AND PROFILING

Introduction to parallel computing: Introduction, The fundamental laws of parallel computing, How does parallel computing work, Categorizing parallel approaches, Parallel strategies, Parallel speedup versus comparative speedups: Two different measures.

Performance limits and profiling: Know your application's potential performance limits, Determine your hardware capabilities: Benchmarking, Characterizing your application: Profiling.

Module 2: **VECTORIZATION, OPENMP** **(10 Periods)**

Vectorization: Vectorization and single instruction, multiple data (SIMD) overview, Hardware trends for vectorization, Vectorization methods, Programming style for better vectorization.

Open MP: Open MP introduction, Typical Open MP use cases: Loop-level, high-level, and MPI plus Open MP, Examples of standard loop-level Open MP, Function-level Open MP: Making a whole function thread parallel, Hybrid threading and vectorization with Open MP.

Module 3: **GPU ARCHITECTURES, PROGRAMMING MODEL,** **(09 Periods)**
LANGUAGES

GPU architectures and concepts: The CPU-GPU system as an accelerated computational

Platform, The GPU and the thread engine, Characteristics of GPU memory spaces, Potential benefits of GPU-accelerated platforms.

GPU programming model: GPU programming abstractions: A common Framework, Optimizing GPU resource usage.

GPU languages: Features of a native GPU programming language, CUDA and HIP GPU languages: The low-level performance option.

Module 4: **HIGH PERFORMANCE COMPUTING: AFFINITY,** **(10 Periods)**
BATCH SCHEDULERS

Affinity Truce with the kernel: Why is affinity important, Discovering your architecture, Thread affinity with Open MP, Process affinity with MPI, Affinity for MPI plus Open MP, Controlling affinity from the command line, The future: Setting and changing affinity at run time.

Batch schedulers: The chaos of an unmanaged system, How not to be a nuisance when working on a busy Cluster, Submitting your first batch script, Automatic restarts for long-running jobs, Specifying dependencies in batch scripts.

Module 5: **FILE OPERATIONS FOR A PARALLEL WORLD** **(07 Periods)**

The components of a high-performance file system, Standard file operations: A parallel-to-serial Interface, MPI file operations (MPI-IO) for a more parallel World, HDF5 is self-describing for better data management, Other parallel file software packages, Parallel filesystem: The hardware interface.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Perform a detailed study and submit a report on how HPE (Hewlett Packard Enterprise) solves   most complex problems with HPE's HPC solutions, and ML Ops solutions that reduce complexity.
   https://www.hpe.com/in/en/compute/hpc/deep-learning.html

RESOURCES

TEXT BOOKS:

1. Robert Robey, Yuliana Zamora, Parallel and High Performance Computing, Manning Publications, 2021.

REFERENCE BOOKS:

1. Thomas Sterling, Matthew Anderson and Maciej Brodowicz, High Performance Computing, Morgan Kaufmann, 2017.
2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands- on Approach, Elsevier Science, 2nd Edition, 2013.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112105293
2. https://onlinecourses.nptel.ac.in/noc20_me61/preview
3. https://www.coursera.org/learn/introduction-high-performance-computing
4. https://nptel.ac.in/courses/106102114
5. https://onlinecourses.nptel.ac.in/noc20_cs41/preview
6. https://nptel.ac.in/courses/106105220

WEB RESOURCES:

4. https://www.digimat.in/nptel/courses/video/128106014/L02.html
5. https://open.umn.edu/opentextbooks/textbooks/560
6. https://www.nvidia.com/en-in/technologies/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25CB202001	**ADVANCED COMPUTER NETWORKS**	3	-	3	-	4.5

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on computer network concepts, TCP-IP reference model, IPV6 message format, network interfaces, performance issues in Local Area and wide area networks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the concepts behind Opportunistic, IoT and Software Defined Networking.

CO2. Identify different issues in Opportunistic, Social, IoT and SDN Networks.

CO3. Analyze various protocols proposed to handle issues related to Opportunistic, Social, IoT and SDN Networks.

CO4. Demonstrate about the Cellular Communications Networks and Wireless System Evolution & TCP/IP protocols.

CO5. Analyze performance of Cellular and Ad Hoc Networks protocols of a network.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	3	-	-	-	-
CO4	3	-	-	-	-	-
CO5	3	3	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: **INTRODUCTION TO OPPORTUNISTIC AND SOCIAL NETWORKS** **(08 Periods)**

Opportunistic and Social Networks: Handling Spectrum Scarcity and Disruption, Architecture of Cognitive Radio Network (CRN) and Delay Tolerant Networks (DTN), Routing in Opportunistic Mobile and Social Networks, Multicasting, Single-node, Multiple-copy, and Single-copy model, Interest-based Data Dissemination, User Interest Profile, Multi-party data transmission, System Implementation, Quality-of-Service (QoS), QoS parameters, Metrics and classification, Network QoS parameters (bandwidth, delay, etc.), System QoS parameters (reliability, capacity, etc.), Task QoS parameters (memory, CPU usage, response time, etc.), Extension QoS parameters (reputation, security, etc.).

Module 2: **IoT NETWORKS** **(09 Periods)**

IoT Networks: Convergence of domains, Key technologies for IoT and its components, Multi-homing, Sensing, Actuation, Data Aggregation, IoT communication patterns, IoT data and its impact on communication, Characteristics of IoT networks, Protocols for IoT, NFC (Near field communication), Tactile Internet, Caching, Edge computing, Inter-dependencies, SoA, Gateways, Comparison between IoT and Web, Complexity of IoT networks, Scalability, Protocol classification, MQTT, SMQTT, CoAP, XMPP, AMQP, Wireless HART protocol and layered architecture, HART network manager, HART vs ZigBee, Cross layer QoS parameters

Module 3: **SOFTWARE DEFINED NETWORKS (SDN)** **(10 Periods)**

Network Function Virtualization (NFV), Unicast and multicast routing, Fundamental graph algorithms, Modern protocols for content delivery, Video delivery using HTTP, HTTP Live Streaming, DASH, Content Delivery Networks (CDN), TVOD and SVOD, Architecting a content distribution system over IP-based networks, CDN topologies, Edge-Caching, Streaming-Splitting, Pure-Play, Operator, Satellite, Hybrid, Computer hosting and orchestration for dedicated appliances and virtualization, Robust synchronization of absolute and difference clocks, Precision time protocol, Clock synchronization in SDN, ReversePTP scheme.

Module 4: **WIRELESS NETWORKS** **(10 Periods)**

Generic Characteristics, Wireless Local Area Networks and Cellular Communications Networks. TCP Performance Issues over Wireless Links, Inappropriate Reduction of Congestion Window, Throughput Loss in WLANs and Throughput Loss in Cellular Communication Systems. Improving TCP Performance over Wireless Links: Splitting TCP Connections, Snooping TCP at Base Stations, Notifying the Causes of Packet Loss, Adding Selective Acknowledgments to TCP and Comparison of Enhancement Schemes. Wireless System Evolution and TCP/IP: Trends in Cellular Communication Systems, Trends in Wireless LAN Systems, TCP/IP over Heterogeneous Wireless systems.

Module 5: **CELLULAR AND AD HOC NETWORKS** **(08 Periods)**

Cellular and Ad Hoc Networks: TCP Performance in Cellular Networks, Mobile IP, Impact of Mobility on TCP Performance, Approaches to Improve TCP Performance, TCP Performance in Ad Hoc Networks, Dynamic Source Routing, Impact of Mobility on TCP Performance, Approaches to Improve TCP Performance. Evolution of Optical Networks, IP over DWDM, Multiprotocol Label Switching, Multiprotocol Lambda Switching, Optical Burst Switching, Optical Packet Switching: Optical Packet Format, Congestion Resolution in Optical Packet Switches, Performance of TCP/IP over Optical Networks, Optical Packet Network End-to-End Performance, Mapping of TCP in Optical Packets, Optical Packet Design in the TCP/IP Environment.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Basic Network commands like: ipconfig, hostname, ping, tracert, netstat.
2. Windows 2003 server installation and basic configuration.
3. DHCP server configuration.
4. DNS & HTTP, FTP server configuration.
5. Basic Routing configuration.
6. Configure RIP2, OSPF.
7. Configure EIGRP.
8. Implement Access list / NAT technology.
9. Implement WiFi configuration.
10. Implementation of Uni cast Routing Algorithm

SOFTWARE/TOOLS:

1. Cisco packet tracer simulation software.

RESOURCES

TEXT BOOKS:

1. Opportunistic Mobile Social Networks, Jie Wu and Yunsheng Wang, CRC Press, 2015.
2. High Performance TCP/IP: Networking Concepts, Issues, and Solutions, Mahbub Hassan and Raj Jain, 1st Edition, PHI Learning, 2009.

REFERENCE BOOKS:

1. TCP/IP Illustrated (Volume I, Volume II and Volume III), W. Richard Stevens, Addison-Wesley
2. Computer Networking: A Top-down Approach Featuring the Internet, James F. Kurose and Keith W. Ross, Addison-Wesley, 2001.

VIDEO LECTURES:

1. Opportunistic Mobile Networks:
   https://www.youtube.com/watch?v=j1__cQien94
2. Software Defined Networks:
   https://www.digimat.in/nptel/courses/video/106105183/L43.html
3. Basics Of IOT Networking:
   https://www.youtube.com/watch?v=fByKuk2VmJc
4. Wireless Ad Hoc and Sensor Networks:
   https://www.digimat.in/nptel/courses/video/106105160/L01.html

WEB RESOURCES:

1. Adhoc and Wireless Sensor Networks:
   https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/EC8702-%20AWSN/Unit-I%20-EC8702-Adhoc%20and%20Wireless%20Sensor%20Networks.pdf
2. Types of IoT Networks: https://www.fogwing.io/types-of-iot-networks/
3. Software-Defined Networking (SDN):
   https://www.vmware.com/topics/glossary/content/software-defined-networking.html
   https://www.cisco.com/c/en/us/solutions/software-defined-networking/overview.html
4. Wireless Networks:
   https://www.tutorialspoint.com/Wireless-Networks

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25AI202002	**MACHINE LEARNING**	3	-	3	-	4.5

Pre-Requisite   -

Anti- Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course introduces the essential methods that are at the core of modern machine learning. It covers theoretical foundations as well as key supervised and unsupervised learning algorithms. Classes on theoretical and algorithmic aspects are augmented by laboratory exercises.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Perform mathematical analysis of machine learning algorithms using computational complexity theory concepts.

CO2. Demonstrate how Bayesian Methods can be used to solve real world problems.

CO3. Build predictive models by constructing hierarchical and compact representation of the available observations.

CO4. Evaluate the performance of the trained classification models and implement necessary measures for improving its performance.

CO5. Select and Apply appropriate clustering algorithms to solve real-time problems and optimize the models learned.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**2**	**3**	**-**	**3**	**3**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: INTRODUCTION   (09 Periods)

Machine Learning, Applications, Supervised Learning - Learning a class from examples, Vapnik Chervonenkis (VC) dimension, Probably Approximately Correct (PAC) learning, Noise, Learning multiple classes, Regression, Model selection, and generalization

Module 2:   BAYESIAN DECISION THEORY AND LINEAR   (09 Periods)
                 DISCRIMINATION

Bayesian Decision Theory: Classification, Losses, and risks, Discriminant functions, Utility theory, Value of information, Bayesian networks, Influence diagrams, Association rules.

Linear Discrimination: Generalizing linear model, Geometry of the linear discriminant, Pairwise separation, Parametric discrimination, Gradient descent, Support vector machines.

Module 3:   DECISION TREES AND DIMENSIONALITY   (09 Periods)
                 REDUCTION

Decision trees: Univariate trees, Pruning, Rule extraction from trees, Learning rules from data, Multivariate trees.

Dimensionality Reduction: Subset Selection, Principal Component Analysis, Feature Embedding, Factor Analysis, Singular Value Decomposition and Matrix Factorization, Multidimensional Scaling.

Module 4:   PERFORMANCE EVALUATION OF CLASSIFICATION   (09 Periods)
                 ALGORITHMS

Cross-validation and resampling methods, Measuring error, Interval estimation, Hypothesis testing, Assessing a classification algorithm's performance, and Comparing two classification algorithms. Combining Multiple Learners- Rationale, Voting, Bagging, Boosting, The mixture of experts revisited, Stacked generalization, Cascading

Module 5:   CLUSTERING   (09 Periods)

Introduction, Mixture Densities, k-Means Clustering, Expectation, Maximization Algorithm, Mixtures of Latent Variable Models, Spectral Clustering, Hierarchical Clustering, Choosing the Number of Clusters.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Solve the house price prediction problem using linear regression analysis method. Optimize the parameters of the regression function using gradient descent method.

2. Learn the best association rule using the Apriori algorithm with reference to a customer's transaction dataset.

3. Using Opt digits from the UCI repository, implement PCA. For various number of eigenvectors, reconstruct the digit images and calculate the reconstruction error.

4. Build a binary classifier using Support vector Machine and evaluate the performance of the different kernels using a grid search method. (Use breast cancer dataset)

5. Visualize the decision tree built for solving diabetes disease prediction problem and measure the impurity of nodes created via Decision Tree Analysis.

6. Investigates whether the means of two independent data samples differ from one another using a two-sample T-test.

7. Checks whether a sample mean differs from the population mean using One-Sample T-test.

8. Evaluate the gradient boosting ensemble technique for regression problem. Calculate the error residuals and fine-tune the hyperparameters of the model.

9. Using stacked ensembling approach build sub-models and aggregator model to make predictions on the Sonar dataset.

10. Cluster the handwritten digits data using the EM algorithm with a principle components step within each maximization.

11. Use the k-means clustering for color image compression.

12. Generate new handwritten digits from the standard digits corpus using the Gaussian Mixture Model. Identify the optimal number of components Akaike Information Criteria.

RESOURCES

TEXT BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press (Adaptive Computation and Machine Learning Series), 3rd Edition, 2014.

REFERENCE BOOKS:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.

2. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, Wiley, 2nd Edition, 2012.

SOFTWARE TOOLS:

1. Environment: Google CoLab

2. Programming Language: Python 3.8

3. Machine Learning Library: Scikit-learn, Tensor Flow 2.1 and Keras

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview

2. https://www.youtube.com/watch?v=_M7Km1XZERU

3. https://www.youtube.com/watch?v=UudeDPTtMos&list=PL1xHD4vteKYVpaIiy295pg6_SY5q znc77&index=18

4. https://www.youtube.com/watch?v=OGLxVh1J-xk

5. https://onlinecourses.nptel.ac.in/noc21_cs85/preview

WEB RESOURCES:

1. https://data-flair.training/blogs/machine-learning-tutorial/

2. https://www.w3schools.com/python/python_ml_getting_ started.asp

3. https://www.kaggle.com/dansbecker/learn-machine-learning

4. https://www.youtube.com/watch?v=H9yACitf-KM

5. https://www.youtube.com/watch?v=7oNiqPoKD8

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25CS202001	**MERN STACK DEVELOPMENT**	3	-	3	-	4.5

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on MERN Stack, Building a Webserver with Express JS, Building a Restful API, Building Web Applications with React, MongoDB, Node JS and Managing state with Redux.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on fundamentals of MongoDB and Node JS.

CO2. Build web server using Express JS to configure and customize web applications.

CO3. Apply Restful API with Express JS and Mongoose.

CO4. Apply React to design enterprise web applications.

CO5. Develop web applications through MERN stack and Redux store as per societal needs.

CO6 Work independently or in team to solve problems with effective communications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	-	-	-	-
CO5	3	3	-	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**-**	**-**	**3**	**3**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1: MERN STACK **(08 Periods)**

Introduction to MERN STACK, The Model View Controller (MVC) architectural pattern, Installing and configuring MongoDB, Installing Node.js and Installing npm packages.

Module 2: BUILDING A WEB SERVER WITH EXPRESSJS **(09 Periods)**

Routing in Express JS, Modular route handlers, Writing middleware functions, Writing configurable middleware functions, Writing router-level middleware functions, Writing error-handler middleware functions, Using Express JS' built-in middleware function for serving static as sets, Parsing the HTTP request body, Compressing HTTP responses, Using an HTTP request logger.

Module 3: BUILDING A RESTFUL API **(09 Periods)**

CRUD operations using Express JS' route methods, CRUD operations with Mongoose, Using Mongoose query builders, Defining document instance methods, Defining static model methods, Writing middleware functions for Mongoose, Writing custom validators for Mongoose's schemas, Building a RESTful API to manage users with Express JS and Mongoose.

Module 4: BUILDING WEB APPLICATIONS WITH REACT **(10 Periods)**

Understanding React elements and React components, Composing components, Stateful components and life cycle methods, Working with React. Pure Component, React event handlers, Conditional rendering of components, Rendering lists with React, Understanding refs and how to use them, Understanding React portals, Catching errors with error boundary components, Type checking properties with Prop Types.

Module 5: MANAGING STATE WITH REDUX **(09 Periods)**

Defining actions and action creators, Defining reducer functions, Creating a Redux store, Binding action creators to the dispatch method, Splitting and combining reducers, Writing Redux store enhancers, Time traveling with Redux, Understanding Redux middleware, Dealing with asynchronous data flow.

Total Periods: 45

EXPERIENTIAL LEARNING

Front-end Web Application Library

1. Installing Node.js framework and configuring Visual Studio (VS) Code Integrated Development Environment (IDE), and its dependencies.

2. Create and Run —Hello World‖ Application in VS Code.

3. Build two mini applications using Router that will be served in twodifferent sub-domainsvirtual domains through ExpressJS and Virtual domains.

4. Develop the code for Securing an ExpressJS web application with Helmet.

5. Create a React application that includes simple functional components.

6. Create a React application that includes simple class components.

7. Develop a React application to insert and access props (properties) and state of components.

8. Create a React application to demonstrate event handling.

9. Develop a React application for list rendering.

10. Implement a React application for form handling.

   Hosting Web Applications

11. Choosing a hosting server and selecting a plan for web hosting.

12. Choosing and configuring DNS address.

13. Uploading, configuring and running the website over the internet.

RESOURCES

TEXT BOOKS:

1. Eddy Wilson IriarteKoroliova, MERN Quick Start Guide: Build Web Applications with MongoDB, Express.js, React, and Node, Packt, May 2018.

2. Greg Lim, Beginning MERN Stack Development, First Edition, June 2021.

REFERENCE BOOKS:

1. Brad Dayley, Node.js, MongoDB and Angular Web Development, Pearson, 2ndEdition, 2017.

2. Kogent Learning Solutions Inc, HTML 5 Black Book: Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP and JQuery, Dream tech Press, Second Edition, 2016.

SOFTWARE/TOOLS:

1. Software: Node.js, MongoDB and Visual Studio Code; Express and React modules.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=E-GA9GKJWuE

2. https://www.youtube.com/watch?v=Oe421EPjeBE

3. https://www.youtube.com/watch?v=KNZZZ3pbqco

4. https://www.youtube.com/watch?v=bbkBuqC1rU4

WEB RESOURCES:

1. Node.js Tutorial - https://www.w3schools.com/nodejs/

2. Express.js Tutorial - https://www.javatpoint.com/expressjs-tutorial

3. MongoDB Tutorial - https://www.tutorialspoint.com/mongodb/index.htm

4. Learn React JS Tutorial - https://www.javatpoint.com/reactjs-tutorial

5. Redux Tutorial - https://www.tutorialspoint.com/redux/index.htm

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25AI202004	**CLOUD PRACTITIONER**	3	-	3	-	4.5

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This Course provides a detailed discussion on Fundamentals of Cloud and AWS Environment, AWS Resources along with various services of core computing, Database, and Networking of AWS adopting EC2 Pricing Models. Also, Automation of AWS Workloads with the Imperative Approach and the Declarative Approach with launch Configurations and Launch Templates, Auto Scaling Groups, Scaling Actions and Configuration Management are also focused.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the concepts of Cloud and AWS Environment, Cloud Architectures to work with AWS in Virtual Private Cloud.

CO2. Apply AWS resources to work with AWS Management Console for AWS Console Mobile Application.

CO3. Analyze core compute services, EC2 pricing models, core storage and database services for AWS Implementation.

CO4. Identify and use core networking services for automating AWS Workload with AWS CLI, EC2 in cloud.

CO5. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	-
CO4	2	3	1	-	-	-
CO5	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**1**	**-**	**3**	**3**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1:   FUNDAMENTAL OF CLOUD AND AWS ENVIRONMENT   (08 Periods)

Fundamental of Cloud: Concepts of Cloud Computing, Highly Available and Scalable Resources, Professionally Secured Infrastructure, Metered Payment Model.

AWS Environment: AWS Global Infrastructure: AWS Regions, Regionally Based Services, Globally Based Services, Service Endpoint, AWS Global Infrastructure: Availability Zones, Availability Zone Designations, Availability Zone Networking, Availability Zones and High Availability, AWS Global Infrastructure: Edge Locations, Edge Locations and Cloud Front, Regional Edge Cache Locations, The AWS Shared Responsibility Model, Managed Resources, Unmanaged Resources, Service Health Status, AWS Acceptable Use Policy.

Module 2:   WORKING WITH AWS RESOURCES   (09 Periods)

The AWS Management Console, Accessing the AWS Management Console, Opening a Service Console, Working with Shortcuts, Selecting a Region, The Account Name Menu, Resource Groups, Tag Editor, Tagging Strategies, The AWS Console Mobile Application, The AWS Command Line Interface, Requirements, Installation, Software Development Kits, Mobile Software Development Kits, Internet of Things Device Software Development Kits , Cloud Watch, Cloud Watch Metrics. Cloud Watch Alarms, Cloud Watch Dashboards, Cloud Watch Logs, Cloud Watch Events, API and Non-API Events, Management and Data Events, Event History, Trails, Log File Integrity Validation.

Module 3:   THE CORE COMPUTE SERVICES AND EC2 PRICING   (08 Periods)
**   MODELS**

The Core Compute Services: Deploying Amazon Elastic Compute Cloud Servers, Amazon Machine Images, EC2 Instance Types, Server Storage: Elastic Block Store and Instance, Store Volumes.

EC2 Pricing Models: Simplified Deployments through managed Services, Amazon LightSail, AWS Elastic Beanstalk, Deploying Container and Server less Workloads, Containers, Server less Functions.

Module 4:   THE CORE STORAGE AND DATABASE SERVICES   (10 Periods)

The Core Storage Services: Simple Storage Service, Objects and Buckets, S3 Storage Classes, Access Permissions, Encryption, Object Life Cycle Configurations, S3 Glacier, Archives and Vaults, Retrieval Options, AWS Storage Gateway, File Gateways, Volume Gateways, Tape Gateways, AWS Snowball, Hardware Specifications, Security, Snowball Edge.

The Core Database Services: Database Models, Relational Databases, Structured Query Language, Non-relational (No-SQL) Databases, Amazon Relational Database Service, Database Engines Licensing, Instance Classes, Scaling Vertically, Storage, Scaling Horizontally with Read Replicas, High Availability with Multi-AZ, Backup and Recovery, Determining Your Recovery Point Objective, Dynamo DB, Items and Tables, Scaling Horizontally.

Module 5:   THE CORE NETWORKING SERVICES AND AUTOMATING   (10 Periods)
**   AWS WORKLOADS**

The Core Networking Services: Virtual Private Cloud, VPC CIDR Blocks, Subnets, Internet Access, Security Groups, Network Access Control Lists, VPC Peering, Virtual Private Networks, Direct Connect, Route, Resource Records, Domain Name Registration, Hosted Zones, Routing Policies, Health Checks, Traffic Flow and Traffic Policies, Cloud Front.

Automating AWS Workloads: The Imperative Approach, The Declarative Approach, Infrastructure as Code, Cloud Formation, Templates, Stacks, Cloud Formation vs. the AWS CLI, AWS Developer Tools, Code Commit, Code Build, Code Deploy, Code Pipeline, EC2 Auto Scaling, Launch Configurations and Launch Templates, Auto Scaling Groups, Scaling Actions, Configuration Management, Systems Manager, Ops Works.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Amazon User Account Creation by access URL with account number. Add Security credentials with Enabling Multi-Factor Authentication to Secure Your Access.

2. Create an EC2 instance and invoke Ubuntu operating system with a set of configurations on amazon web services under IaaS.

3. Create New Amazon Elastic Block Store (Amazon EBS) EBS Volume to EC2 Instance for provides persistent block storage volumes for use with Amazon EC2 instances in the AWS Cloud.

4. Creating Amazon Machine Image (AMI) for provides the information required to launch an instance, which is a virtual server in the cloud.

5. Create your First EC2 windows instance

6. Assign Elastic IP Addresses to Instance (Static IP Address)

7. Amazon Elastic File System: Amazon Elastic File System (Amazon EFS) provides simple, scalable file storage for use with Amazon EC2. With Amazon EFS, storage capacity is elastic, growing and shrinking automatically as to add and remove files, to applications to store as they require, when they need it.

8. Launch RDS Instance Amazon Relational Database Service (Amazon RDS) which is a web service that makes it easier to set up, operate, and scale a relational database in the cloud.

9. Accessing MySQL Instance Using Workbench.

10. Create AWS S3 Bucket – (Object Storage) Amazon Simple Storage Service (Amazon S3) which is storage for the Internet. Use Amazon S3 to store and retrieve any amount of data at any time, from anywhere on the web.

    i) AWS S3 Lifecycle Management

    ii) S3 Bucket Replication to Cross-Region

    iii) S3 Bucket Policies to control Access

11. Create VPC – Virtual Private Cloud (isolated Network)

    i) Create subnets

    ii) Create Internet gateway and attach to VPC

    iii) Create Virtual Private Gateway and Attach to VPC

RESOURCES

TEXT BOOKS:

1. Ben Piper and David Clinton, AWS Certified Cloud Practitioner, John Wiley & Sons, Inc., ISBN: 978-1-119-49070-8, 2019.
2. Cloud Practitioner (CLF-C01) Cert Guide, 1/E by Anthony Sequeira, PEARSON INDIA.
3. Aws Certified Cloud Practitioner by Neville Dawson, Dilaber Consulting Ltd.

REFERENCE BOOKS:

1. Dennis Hutten, AWS: The Beginners Guide to Amazon Web Services, ASIN: B0757XM97V, 2017.
2. Gordon Wong, AWS Basics: Beginner's Guide, Createspace Independent Pub, ISBN: 978-1542885751, February 2017.
3. Aurobindo Sarkar and Amit Shah, Learning AWS, ISBN:978-1784394639, Packt Publishing,2015
4. Bernard Golden, Amazon Web Services for Dummies, ISBN: 978-1118571835, Dummies; 1st edition, 2013.
5. Andreas Wittig and Michael Wittig, Amazon Web Services in Action, Manning; 2nd edition, 2018.

SOFTWARE/TOOLS:

1. Amazon EC2
2. Amazon S3
3. Amazon Dynamo DB
4. AWS Aurora

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=SOTamWNgDKc
2. https://www.youtube.com/watch?v=3hLmDS179YE
3. https://www.youtube.com/watch?v=XjPUyGKRjZs

WEB RESOURCES:

1. https://docs.aws.amazon.com/ec2/index.html?nc2=h_ql_doc_ec2
2. https://aws.amazon.com/training/digital/aws-cloud-practitioner-essentials/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25CS202002	**QUANTUM COMPUTING**	3	-	3	-	4.5

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course introduces the theoretical foundations of quantum computing. It focuses on quantum mechanical concepts as applied to information processing, including qubits, quantum gates, circuits, and algorithms. The course also covers quantum error correction techniques and provides a conceptual overview of quantum hardware and. design of quantum computational models.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply quantum mechanical principles to represent and manipulate qubit states, superposition, and entanglement.

CO2. Construct quantum circuits using standard quantum logic gates and analyze their matrix representations and circuit behavior.

CO3. Evaluate the computational efficiency of quantum algorithms and differentiate them from classical approaches.

CO4. Analyze quantum error correction schemes and assess their relevance to quantum noise and DE coherence in quantum systems.

CO5. Interpret quantum programming constructs and outline logical models of algorithm design in quantum frameworks.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	3	-	-
CO4	2	3	-	3	-	-
CO5	2	3	-	3	-	-
Course Correlation Mapping	**3**	**3**	-	**3**	-	-

Correlation Levels: **3: High;** **2: Medium; 1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO QUANTUM COMPUTING   (09 Periods)

Classical bits vs qubits, vector spaces, complex numbers and amplitudes, Dirac notation, basic quantum states, superposition, quantum measurement, entanglement, Bloch sphere, basic linear algebra needed for quantum computation.

Module 2:   QUANTUM GATES AND CIRCUITS   (09 Periods)

Pauli gates (X, Y, Z), Hadamard gate, Phase and T gates, CNOT and Toffoli gates, matrix representation of gates, construction of quantum circuits, reversibility, universal sets of gates, multi-qubit systems, tensor products, identity operations.

Module 3:   QUANTUM ALGORITHMS   (09 Periods)

Deutsch algorithm, Deutsch–Jozsa algorithm, Grover's search algorithm, concept of quantum speedup, oracle model, constructing oracle circuits, problem encoding, analysis of algorithm performance, probabilistic output interpretation.

Module 4:   QUANTUM ERROR CORRECTION AND HARDWARE   (11 Periods)

Quantum DE coherence, quantum noise, bit-flip and phase-flip code, Shor's 9-qubit error correction code, introduction to physical quantum hardware models, superconducting qubits, ion trap systems, D-Wave systems overview.

Module 5:   QUANTUM PROGRAMMING LOGIC   (07 Periods)

Principles of quantum programming, circuit model, gate-level abstraction, QASM concepts, quantum programming logic and design, Qiskit/pyQuil structure (conceptual, not implementation), pseudocode for quantum circuits, logical traceability of quantum programs.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. State Preparation and Verification: Prepare arbitrary single- and multi-qubit states from amplitudes. Verify using statevector fidelity.

2. Quantum Gate Decomposition: Decompose Toffoli and other controlled operations into a universal gate set (H, T, CNOT). Compare circuit depth before and after decomposition.

3. Entanglement Quantification: Generate Bell and GHZ states. Compute entanglement entropy and correlation functions.

4. Deutsch–Jozsa Algorithm (n-qubits): Implement Deutsch–Jozsa for n>3 qubits. Analyze probability distribution and runtime efficiency against classical evaluation.

5. Grover's Algorithm Performance Study: Implement Grover's search on databases of increasing size. Measure success probability and compare with theoretical $\sqrt{N}$ scaling.

6. Quantum Fourier Transform (QFT): Design and simulate QFT circuits. Apply QFT for simple period finding. Evaluate approximation by removing controlled rotations.

7. Error Simulation and Correction: Inject quantum noise (bit-flip, phase-flip, depolarizing channels) into circuits. Implement 3-qubit and 9-qubit (Shor) error correction codes.

8. Quantum Hardware Constraints: Transpile circuits for different IBMQ backends. Analyze gate depth, coupling map constraints, and execution fidelity.

9. Quantum Variational Algorithms: Implement Variational Quantum Eigensolver (VQE) on a small molecule Hamiltonian (e.g., H_2). Compare simulator vs noisy backend results.

10. Quantum Programming Project: Write pseudocode for a quantum program (QASM/Qiskit) that combines state preparation, oracle construction, algorithm execution, and error correction. Demonstrate logical traceability from input to output.

RESOURCES

TEXT BOOKS:

1. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

2. Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, Programming Quantum Computers: Essential Algorithms and Code Samples, O'Reilly, 2019.

REFERENCE BOOKS:

1. Chuck Easttom, Quantum Computing Fundamentals, Pearson, 1st Edition, 2022.

2. Jack D. Hidary's, Quantum Computing: An Applied Approach, Springer, 2019.

3. Robert S. Sutor, Dancing with Qubits: How quantum computing works and how it can change the world, Packt Publishing, 2019.

VIDEO LECTURES:

1. https://www.youtube.com/playlist?list=PL0ojjrEqIyPy-1RRD8cTD_lF1hflo89Iu
2. https://www.youtube.com/playlist?list=PLOFEBzvs-VvqKKMXX4vbi4EB1uaErFMSO
3. www.youtube.com/watch?v=jHoEjvuPoB8
4. www.youtube.com/watch?v=7ecKIAKP2Ck
5. https://www.youtube.com/watch?v=tsbCSkvHhMo
6. https://www.youtube.com/watch?v=Z8GKkgE2840

WEB RESOURCES:

1. https://brilliant.org/courses/quantum-computing/
2. https://www.futurelearn.com/courses/understanding-quantum-computers
3. https://qiskit.org/learn/
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-845-quantum-complexity-theory-fall-2010/
5. http://theory.caltech.edu/~preskill/ph219/index.html
6. https://online.stanford.edu/courses/soe-yeeqmse01-quantum-mechanics-scientists-and-engineers
7. https://quantum.country/
8. https://quantumai.google/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25AI201010	**IOT AND EDGE COMPUTING**	3	-	-	-	3

Pre-Requisite   -

Anti- Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course introduces the core concepts of Natural Language Processing (NLP), covering key approaches such as rule-based, statistical, and neural methods. It explores the use of corpora and empirical techniques for tasks like parsing and word sense disambiguation. The course includes speech recognition, information retrieval, and Natural Language Generation (NLG). Applications in education, healthcare, and data visualization are discussed, highlighting the practical relevance of NLP in modern contexts.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Interpret the global vision, architecture, and foundational technologies of IoT, including protocols, system management, and reference models.

CO2. Analyze various IoT communication technologies, protocols, and their security aspects from a practical and industry perspective.

CO3. Design and implement IoT-based systems using Raspberry Pi, integrating sensors and actuators for real-time applications.

CO4. Explain the role and benefits of edge and fog computing, including containerization, micro services, and real-time edge processing.

CO5. Evaluate cloud-based IoT architectures, web APIs, device management, and data security in industrial applications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	3	3	-
CO2	2	2	-	2	2	-
CO3	3	3	-	3	3	-
CO4	3	3	-	3	3	-
CO5	3	3	-	3	3	-
Course Correlation Mapping	**3**	**3**	-	**3**	**3**	-

Correlation Levels: 3: High; 2: Medium;   1: Low

COURSE CONTENT

Module 1:   FOUNDATIONS OF IOT DESIGN AND MANAGEMENT   (09 Periods)

Introduction - Physical Design - Things in IoT- IoT Protocols, Logical Design - Communication Models and APIs - Difference between IoT and M2M - SDN and NFV for IoT - Software Defined Networking - Network Function Virtualization - System Management with NETCONF- YANG - Need for IoT Systems Management - Network Operator Requirements – NETCONF - YANG. IoT Architecture Reference Models (e.g., IoT-A, IIRA, oneM2M), Overview of Industry Standards (e.g., ISO/IEC, IEEE, ITU, ETSI) for IoT

Module 2:   LAYERS AND PROTOCOLS FOR IOT   (09 Periods)

IoT Access Technologies: Physical and MAC layers - topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT - From 6LoWPAN to 6Lo - Routing over Low Power and Lossy Networks – Application Transport Methods- Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT. Security Protocols for IoT Communication (DTLS, TLS, OSCORE), Bluetooth Low Energy (BLE) and Zigbee for IoT, Time Synchronization and QoS in IoT Protocols

Module 3:   IOT DEVICES AND RASPBERRY PI INTERFACING   (09 Periods)

IoT Physical Devices and Endpoints – Introduction to Raspberry PI - Interfaces (Serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets - Controlling output -Reading input from pins. Integrating Sensors and Actuators (DHT11, PIR, Ultrasonic, etc.), Real-Time Data Logging and Local Storage on Pi.

Module 4:   BASICS OF EDGE COMPUTING   (09 Periods)

Fog computing vs Edge computing - Need for edge computing - benefits of Edge computing. Lightweight Container Middleware for Edge Cloud Architectures - Clusters for Lightweight Edge Clouds - Architecture Management – Storage and Orchestration - IoT Integration - Security Management for Edge Cloud Architectures. Microservices and Containerization in Edge Devices (Docker, K3s), Real-time Data Processing at the Edge.

Module 5:   WEB SERVERS AND CLOUD STORAGE MODELS IN IOT   (09 Periods)

Physical Servers and Cloud Offerings – Introduction to Cloud Storage models and communication APIs, Cloud IoT Platforms: Overview of AWS IoT, Azure IoT Hub, Google IoT Core, Web Server – Web server for IoT - Cloud for IoT - Python web application framework - Designing a RESTful web API, IoT Device Management in the Cloud (Provisioning, Monitoring, OTA Updates), Data Security and Privacy in Cloud-based IoT Systems.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Analyze a real-world IoT use case (e.g., smart home, industrial automation) and map its components to the IoT-A or oneM2M reference architecture. How would SDN and NFV improve network flexibility and system management in this context?

2. Compare and contrast any two IoT communication protocols (e.g., MQTT vs. CoAP) based on their architectural layers, message formats, and security mechanisms. Explain how these differences impact constrained network environments.

3. Discuss the importance of GPIO interfaces (Serial, SPI, I2C) in Raspberry Pi for IoT projects. How would you theoretically plan a system that reads from a temperature sensor and sends alerts based on thresholds? Include logical flow.

4. Explain how micro services and containerization (e.g., using Docker) contribute to the flexibility and scalability of edge computing in IoT systems. In theory, how would you design a lightweight edge cluster to process video data locally?

5. Examine the role of RESTful APIs in IoT cloud integration. Theoretically design a simple architecture where sensor data is collected, processed, and visualized using a cloud platform like AWS IoT or Google IoT Core. Describe the data flow.

RESOURCES

TEXT BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", VPT, First edition, 2014.

2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, Second Edition, 2012.

3. Rajkumar Buyya, Satish Narayana Srirama "Fog and Edge Computing: Principles and Paradigms", Wiley-Blackwell, First Edition, 2019.

4. Arshdeep Bahga and Vijay Madisetti, "Internet of Things – A Hands-on Approach", Universities Press, 2015

5. Matt Richardson & Shawn Wallace, "Getting Started with Raspberry Pi", O'Reilly (SPD), Third Edition, 2016

REFERENCE BOOKS:

1. Jonathan Follett, "Designing for Emerging - UX for Genomics, Robotics, and the Internet of Things Technologies", O'Reilly, First Edition, 2014.

2. Charalampos Doukas, "Building Internet of Things with the Arduino", Create space Publishers, 2012

3. Donald Norris, "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone
Black", Mc.Graw Hill, First Edition, 2015.
Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan

4. Avesand. David Boyle, "From Machine to-Machine to the Internet of Thing – Introduction to a New Age of Intelligence", Elsevier, 2014.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=fBUElwY3yrs

2. https://www.youtube.com/watch?v=DEBmpVPnZb0

3. https://www.bristolwatch.com/rpi/ads1115.html

WEB RESOURCES:

1. https://www.wired.co.uk/article/internet-of-things-what-is-explained-iot

2. https://www.ibm.com/blogs/internet-of-things/what-is-the-iot/

3. https://www.geeksforgeeks.org/edge-computing/

4. https://www.i-scoop.eu/internet-of-things-guide/edge-computing-iot/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CB201008	**MACHINE LEARNING FOR CYBER SECURITY**	3	-	-	-	3

Pre-Requisite   Machine Learning

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion on Machine Learning concepts, quick way to detect anomalies, malware analysis and network traffic analysis by extracting used information, Examining how attackers exploit consumer-facing websites and app functionality and building machine learning based models to create a production system.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on cyber security and machine learning Concepts.

CO2. Analyze Anomaly Detection methods for building secure system.

CO3. Select and apply to Perform malware and Network Traffic Analysis to build robust cyber system.

CO4. Apply Security mechanisms for protecting consumer web.

CO5. Apply Machine techniques for building secured validate production system

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

**Module 1: CONVERGENCE OF MACHINE LEARNING AND CYBER (09 Periods)
            SECURITY**

Cyber Threat Landscape, The Cyber Attacker's Economy, Overview of Machine Learning, Real-World Uses of Machine Learning in Security, Spam Fighting: An Iterative Approach.
Classifying and Clustering: Training Algorithms to Learn, Supervised Classification Algorithms: Logistic Regression, Decision Trees, Decision Forests, Support Vector Machines, Naive Bayes ,k-Nearest Neighbors ,Neural Networks

Module 2: ANOMALY DETECTION   (07 Periods)

Detection: Anomaly Detection Versus Supervised Learning, Intrusion Detection with Heuristics, Data-Driven Methods, Feature Engineering for Anomaly Detection, Anomaly Detection with Data and Algorithms, Challenges of Using Machine Learning in Anomaly Detection.

**Module 3: MALWARE ANALYSIS AND NETWORK TRAFFIC   (11 Periods)
            ANALYSIS**

Malware Analysis: Understanding Malware, Feature Generation, From Features to Classification, Live malware analysis, dead malware analysis, Android Malware Analysis.
Network Traffic Analysis: Theory of Network Defense, Machine Learning and Network Security, Building a Predictive Model to Classify Network Attacks

Module 4: PROTECTING THE CONSUMER WEB   (09 Periods)

Monetizing the Consumer Web, Types of Abuse and the Data That Can Stop Them, Supervised Learning for Abuse Problems, Clustering Abuse.

Module 5: PRODUCTION SYSTEMS   (09 Periods)

Defining Machine Learning System Maturity and Scalability, Data Quality, Model Quality, Performance, Maintainability, Monitoring and Alerting, Security and Reliability.

Total Periods: 45

EXPERIENTIAL LEARNING

1.   Anomaly detection using supervised learning algorithm like LOF(Local Outlier factor)
2.   Study and implement intrusion detection system using SVM(Support Vector Machines)
3.   Live malware analysis using unsupervised learning algorithm
4.   Study and implement clustering abuse using K-Means Algorithm

RESOURCES

TEXT BOOKS:

1. Clarence Chio, David Freeman "Machine Learning and Security", O'Reilly Media, Inc. ISBN: 9781491979907
2. SumeetDua, Xian Du. "Data Mining and Machine Learning in Cyber security", CRC Press, ISBN:978-1439839423

REFERENCE BOOKS:

1. Learning Nessus for Penetration Testing, by Himanshu Kumar
2. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2ed.
3. Mastering Modern Web Penetration Testing by Prakhar Prasad

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=cpCKhhV1wQU
2. https://www.youtube.com/watch?v=oBdB61A8Yt8

WEB RESOURCES:

1. Machine Learning for Cyber Security: Machine Learning and Security Protecting Systems with Data and Algorithms (Clarence Chio David Freeman) (z-lib.org)
2. https://cset.georgetown.edu/wp-content/uploads/Machine-Learning-and-Cybersecurity.pdf
3. https://www.geeksforgeeks.org/machine-learning-for-anomaly-detection/
4. https://www.malware-traffic-analysis.net/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CB202003	**COMPUTER SYSTEM SECURITY**	3	-	3	-	4.5

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: Introduction to computer security; Operating System Security Models, Unix Security, Windows Security, Storage & Database Security, Wireless Network Security

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply cryptographic technique and network protocols for securing administration.

CO2. Understand security mechanisms in various operating systems.

CO3. Apply mechanisms for securing data and applications.

CO4. Analyze security mechanisms for wireless intrusion detection and prevention.

CO5. Apply infrastructure services for securing E-mail, web servers, DNS servers and Proxy servers.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	-	-	-
CO2	3	-	-	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	-	-	-	-
CO5	3	3	3	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT
Module 1:   **INTRODUCTION**   **(09 Periods)**

Computer Security, Threats, Administrative Security, Overall Planning and Administration, Day to Day Administration, About the Internet, Network Protocols,

Encryption: DES, AES, RSA.

Module 2:   **COMPUTER SECURITY**   **(08 Periods)**

Operating System Security Models: Operating System Models, Classic Security Models, Reference Monitor, Trustworthy Computing, International Standards for Operating System Security.

Unix Security: Securing a Unix System, Place Servers into Network Zones, Authentication Processes, Limit the Number of Administrators and Privileges, Back Up the System, Security Lists.

Windows Security: Securing Windows Systems, Active Directory Domain Architecture.

Module 3:   **DATA SECURITY**   **(08 Periods)**

Storage Security: Storage Security Evolution, Modern Storage Security, Risk Remediation.

Database Security: General Database Security Concepts, Understanding Database Security Layers, Understanding Database-Level Security, Application Security, Database Backup and Recovery, Keeping servers Up to Date, Database Auditing and Monitoring.

Module 4:   **WIRELESS NETWORK SECURITY**   **(10 Periods)**

Radio Frequency Security Basics, Data-Link Layer Wireless Security Features, Flaws, and Threats, Wireless Vulnerabilities and Mitigations, Wireless Network Hardening Practices and Recommendations, Wireless Intrusion Detection and Prevention, Wireless Network Positioning and Secure Gateways.

Module 5:   **SECURING INFRASTRUCTURE SERVICES**   **(10 Periods)**

E-Mail: Protocols Their Vulnerabilities and Counter measures, Spam and Spam Control

Web Servers: Types of Attacks, Web Server Protection

DNS Servers: Prevent Unauthorized Zone Transfers, DNS Cache Poisoning

Proxy Servers: HTTP, FTP, Direct Mapping, POP3, Reverse Proxy

                                                         Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:
1.   a.   Implement DES algorithm for the given input parameters

      b.   Implement AES algorithm for the given input parameters

2.   a.   Implement RSA algorithm for the given input parameters.

      b.   Using RSA asymmetric cryptographic algorithm demonstrate values for Private and Public Keys in cryptographic systems
3.   Implement Firewall Configuration and generate Assessment-iptables using command arguments.
4.   Configure and use SSH software to establish and experiment with secure connection and detect MITM attacks (impostors) with PuTTY.
5.   Write a program to Demonstrate DNS Message format for resolver library routine
6.   Simulate buffer overflow attack and protect against SQL injection attack.
7.   Implement Brute force and dictionary attacks to generate passwords and hashes for files created in system.

8. a. Demonstrate installation and working of Intrusion detection System (IDS)using Snort Tool
   b. Detect and record anomalous traffic and analyze Snort alert file using SNORT Tool

9. a. Configure Snort as detection engine detecting attacks based on signatures defined by rulesets.
   b. Create simple Snort rules.
10. a. Install, configure, and experiment with a honeypot to detect, capture, and analyze attacks.
   b. Create simple honeypot scenarios and alerts, and test them with test attacks

SOFTWARE/TOOLS

1.   JAVA/PYTHON

2.   SNORT Tool

RESOURCES

TEXT BOOKS:

1.   Rick Lehtinen, " Computer Security Basics ",O'Reilly Media, Second Edition , 2006.

2.   Mark Rhodes-Ousley, "Information Security ", McGraw-Hill Obsorne Media, Second Edition, 2013.

REFERENCE BOOKS:

1.   Craighead, Geoff. High-Rise Security and Fire Life Safety. Butterworth-Heinemann, 2003.

2.   Fennelly, Lawrence J. Effective Physical Security. Butterworth-Heinemann, 1997.

3.   Matchett, Alan R. CCTV for Security Professionals. Butterworth-Heinemann, 2003.

VIDEO LECTURES:

1.   Computer Systems Security, https://css.csail.mit.edu/6.858/2022/

2.   Introduction to information Security,
      https://archive.nptel.ac.in/courses/106/106/106106129/

WEB RESOURCES:

1.   https://onlinecourses.nptel.ac.in/noc22_cs36/preview

2.   https://ocw.mit.edu/courses/6-858-computer-systems-security-fall-2014/

3.   https://www.csa.iisc.ac.in/~vg/teaching/SecurityLectures/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CB201013	**BLOCKCHAIN TECHNOLOGIES**	3	-	-	-	3

Pre-Requisite   Computer System Security

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to Block chain Technologies and its decentralization concepts, Digital Currencies, Smart Contracts, Ethereum, Hyper ledger, Alternative Block chains, Current Challenges and Scope of Research.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the concepts of Distributed Systems, Decentralization & Block chains in the Block chain Ecosystem.

CO2. Devise suitable Block chain Platforms for scalable applications.

CO3. Assess the Challenges and Trending technologies for understanding the research scope in Block chain Technologies.

CO4. Pertain to ethical and legal usage of Block chain applications.

CO5. Formulate secured and sustainable Block chains for healthy and safe society.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	-	-
CO2	3	2	-	-	-	-
CO3	-	-	-	2	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**2**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO BLOCK CHAIN DECENTRALIZATION   (09 Periods)

Introduction to Block chain: Distributed systems, History of Block chain, Introduction to Block chain - Definitions, Generic elements, Features, Applications, Tiers; Types of Block chain, CAP theorem and Block chain, Benefits and limitations of Block chain technology.
Decentralization: Decentralization using Block chain, Decentralization methods and routes, Full ecosystem decentralization, Smart contract, Decentralized organizations, Decentralized autonomous organizations, corporations and societies, Applications and platforms for decentralization.

Module 2:   DIGITAL CURRENCY – BITCOIN   (09 Periods)

Definitions, Transactions – Life cycle, Structure, Types; Block chain – Structure of block and block header, Genesis block, Bitcoin network, Wallets; Bitcoin Payments – Investment and buying and selling bitcoins, Installation; Bitcoin Limitations, Name coin.

Module 3:   SMART CONTRACTS AND ETHEREUM   (11 Periods)

Smart Contracts: History & definition, Ricardian contracts - Smart contract templates, Oracles, Smart Oracles, Deployment of smart contracts on Block chain.
Ethereum: Introduction, Ethereum Block chain, Elements of Ethereum Block chain, Precompiled contracts, Accounts, Block, Ether, Messages, Mining – Ethash, CPU and GPU mining; Clients and wallets, Ethereum Network, Applications developed on Ethereum, Scalability and security issues.

Module 4:   HYPERLEDGERS AND ALTERNATIVE BLOCKCHAINS   (08 Periods)

Hyper ledgers: Projects; Hyper ledger as protocol; Fabric; Hyper ledger Fabric; Saw tooth Lake; Corda.
Alternative Block chains: Block chains: Kadena, Stellar, Rootstock, Quorum, Tezos, Storj, Maid safe, Big Chain DB, Multi chain, Tender mint; Platforms: Block Apps, Eris.

Module 5:   INDUSTRY TRENDS AND REAL-WORLD CHALLENGES   (08 Periods)

Enterprise-Grade Block chain Architectures, Real-World Scalability Solutions, Advanced Privacy Techniques, Green Block chain and Sustainable Consensus, Block chain Security in Production, Decentralized Identity and Self-Sovereign Identity (SSI), Web3, DAOs and Token Economies, Block chain in Industry: Use Cases and Trends.

Total Periods: 45

EXPERIENTIAL LEARNING

1.   Prepare a report on the application of Block chain technology for Healthcare.

2.   Demonstrate the usage of Block chain Technologies for Supply Chain Management.

3.   Prepare a report on Block Chain Technology for Copyrights.

4.   Demonstrate how Security is ensured in IoT with Block chain Technology

RESOURCES

TEXT BOOKS:

1. Imran Bashir, Mastering Block chain: Deeper Insights into Decentralization, Cryptography, Bitcoin, and Popular Block chain Frameworks, Packt Publishing, 1st Edition, 2017.

REFERENCE BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, Block chain Applications: A Hands-On Approach, VPT Books, 2017.

2. Josh Thompson, Block chain: The Block chain for Beginnings, Guild to Block chain Technology and Block chain Programming, Create Space Independent Publishing Platform, 2017.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105184/

2. https://www.coursera.org/lecture/introduction-blockchain-technologies/

WEB RESOURCES:

1. https://medium.com/moatcoin/part-6-blockchain-simplified-notes-nptel-892f13875555

2. http://www.hands-on-books-series.com/assets/Bahga-Madisetti-Blockchain-Book-Code.zip

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CB201009	**WIRELESS AND MOBILE NETWORK SECURITY**	3	-	-	-	3

Pre-Requisite   Computer System Security

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion on wireless networks and mobile communication systems. It introduces new wireless designs, algorithms, protocols and applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the security issues at different levels in mobile communication.

CO2. Identify Threats and vulnerabilities in cellular and Wireless Networks.

CO3. Analyze internal and external threats for MANET applications by applying suitable protocols to provide security solutions.

CO4. Analyze ubiquitous & heterogeneous wireless networks security challenges and develop secure systems.

CO5. Understand the security challenges and attacks in mobile commerce applications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	-	-	-	-
CO5	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   SECURITY ISSUES IN MOBILE COMMUNICATION   (10 Periods)

Mobile Communication History, Security-Wired vs Wireless, Security Issues and Requirements in Wireless Mobile Communications, Security for Mobile Applications, Advantages and Disadvantages of Application-level Security

Security of Device, Network, and Server Levels: Mobile Devices Security Requirements, Mobile Wireless network level Security, Server Level Security.

Module 2:   APPLICATION   LEVEL   SECURITY   IN   WIRELESS (09 Periods)
**   NETWORKS AND CELLULAR NETWORKS**

Application of WLANs, Wireless Threats, Some Vulnerabilities and Attack Methods over WLANs, Security for 1G & 2G Wi-Fi Applications, Generations of Cellular Networks, Security Issues and attacks in cellular networks, GSM, GPRS and UMTS security for applications, 3G security for applications, Security Enhancements in 4G LTE and 5G Networks, Wi-Fi Protected Access 3 (WPA3).

Module 3:   APPLICATION LEVEL SECURITY IN MANETS   (08 Periods)

MANETs, applications of MANETs, MANET Features, Security Challenges in MANETs, Security Attacks on MANETs, External Threats for MANET Applications, Internal Threats for MANET Applications, Some of the Security Solutions, , Key Management Techniques in MANETs, Intrusion Detection in MANETs.

Module 4:   APPLICATION LEVEL SECURITY IN UBIQUITOUS   (10 Periods)
**   NETWORKS AND HETEROGENEOUS WIRELESS**
**   NETWORKS**

Ubiquitous Computing, Need for Novel Security Schemes for UC, Security Challenges for UC, Security Attacks on UC Networks, Some of the Security Solutions for UC, Heterogeneous Wireless network architecture, Heterogeneous network application in disaster management, Security problems and solutions in heterogeneous wireless networks

Module 5:   SECURITY FOR MOBILE COMMERCE APPLICATION   (08 Periods)

M-commerce Applications, M-commerce Initiatives, Security Challenges in Mobile E-commerce, Types of Attacks on Mobile E-commerce, A Secure M-commerce Model Based on Wireless Local Area Network, Some of M-Commerce Security Solutions, Tokenization in Mobile Payments, Biometric Authentication in M-Commerce.

**   Total Periods: 45**

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1.   Study of various Security Issues in Mobile Communication

2.   Simulate Security Attacks in MANETs using NS2 or NS3

3.   Implement Secure Communication in a Wi-Fi Network using WPA2/WPA3

4.   Study on Security Issues and attacks in cellular networks

5.   Design and Analyze a Token-Based Mobile Payment Flow

6.   Study on Application Level Security in various networks

7.   Study how to Develop an M-Commerce App and Maintain its Security

8.   Case Study on Security Solutions in Heterogeneous Wireless Networks

RESOURCES

TEXT BOOKS:

1. Pallapa Venkataram, B. Satish Babu, Wireless and Mobile Network Security, First Edition, Tata McGraw Hill, 2010.

REFERENCE BOOKS:

1. Hakima Chaouchi, Maryline Laurent-Maknavicius, Wireless and Mobile Network Security Security Basics, Security in On-the-shelf and Emerging Technologies, Wiley, 2009.

2. Tara M. Swaminathan and Charles R. Eldon, Wireless Security and Privacy- Best Practices and Design Techniques, Addison Wesley, 2002.

VIDEO RESOURCES:

1. https://www.youtube.com/watch?v=fasXvwixO4I

2. https://nptel.ac.in/courses/117102062

WEB RESOURCES:

1. https://study.com/academy/course/computer-science-323-wireless-mobile-networking.html

2. https://www.digimat.in/nptel/courses/video/106106167/L01.html

3. https://www.coursera.org/lecture/security-awareness-training/mobile-devices-and-security-EMjmM

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CB202008	**NETWORK OPERATIONS AND SECURITY**	3	-	3	-	4.5

Pre-Requisite   Advanced Computer Networks

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This Course provides a detailed discussion on host and user management. It provides the policies and methods for Configuration and maintenance of system and also network tools and methods for monitoring the performance networks and provides the authentication, Mitigation and access control for both wired and wireless networks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply mechanisms for Host and User management tasks.

CO2. Apply policies and methods for system Configuration and maintenance.

CO3. Analyze and monitor network performance and remote file access using Network tools.

CO4. Apply Authentication and Access Control methods for network security.

CO5. Apply Mitigation Techniques for Wireless Network security.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT
Module 1:   HOST AND USER MANAGEMENT **(09 Periods)**

Host Management - Global view, local action, Physical considerations of server, Computer startup and shutdown, Configuring and personalizing workstations, installing a Unix disk, Installation of the operating system, Software installation, Kernel customization.
User Management – Issues, User registration, Account policy, Login environment, User support services, Controlling user resources, online user services, User well-being, Ethical conduct of administrators and users, Computer usage policy.

Module 2:   CONFIGURATION AND MAINTENANCE **(09 Periods)**

System configuration policy, Methods: controlling causes and symptoms, Change management, Declarative languages, Policy configuration and its ethical usage, Common assumptions: clock synchronization, Human–computer job scheduling, Automation of host configuration, Preventative host maintenance, SNMP tools, Cfengine, Database configuration management

Module 3:   MONITORING NETWORK PERFORMANCE AND REMOTE   (09 Periods) ACCESS

Common Reasons to Monitor Networks, SNMP Monitors, Packet Sniffers, Throughput Testing, Port Scanners, Vulnerability Scanners, Network Performance, Load, and Stress Testing, Tracking Event Logs.
Remote File Access, VPNs, Site-to-Site and Client-to-Site, HTTPS/Management URL, Out-of-Band Management.

Module 4:   NETWORK SECURITY **(09 Periods)**

Physical Security and Device Hardening - Adding Physical Security to the Mix, Two-Factor and Multifactor Authentication, Secured Versus Unsecured Protocols, Additional Device Hardening.
Authentication and Access Controls - Mandatory Access Control, Discretionary Access Control, Rule-Based Access Control, Role-Based Access Control, RADIUS and TACACS+, Kerberos Authentication, Local Authentication, Lightweight Directory Access Protocol, Using Certificates, Auditing and Logging, Multifactor Authentication Factors, Access Control.

Module 5:   SECURING WIRELESS NETWORKS AND MITIGATION   (09 Periods) TECHNIQUES

Securing Wireless Networks - WPA, WPA2, TKIP-RC4, and CCMP-AES, Wireless Authentication and Authorization, Shared, Preshared, and Open Keys
Mitigation Techniques - Signature Management, Device Hardening, Change Native VLAN, Switch and Port Protection, Demilitarized Zones (Perimeter Network), VLAN Network Segmentation, Privileged User Account, File Integrity Monitoring, Role Separation, Using ACLs to Restrict Access, Honeypots and Honey nets, Penetration Testing

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Configure the following servers using cisco packet tracer
    A. HTTP   B. DNS   C. SMTP   D. FTP

2. Implement cisco router configuration command list using packet tracer
    A. Change router configuration
    B. Enabling Password
    C. Set Telnet Password
    D. Set IP Address to cisco interface
    E. Enable a port interface.

3. Configure SSH on cisco routers and switches using cisco packet tracer.

4. Configuring VLAN and VTP on a small network of 4 switches using Packet Tracer.

5. Building a topology with spanning tree and static routing network protocols.

6. Implement the following routing protocols using cisco packet tracer.
    A. OSPF   B.RIP

7. Installation of Virtual box and kali Linux for SNMP Monitoring.

8. Analyze the packet/Traffic using Wireshark.

9. Identify the network vulnerabilities by scanning the network using Nmap.

10. Identify the network vulnerable ports by port scanning using Nmap.

RESOURCES
TEXT BOOKS:

1. Mark Burgess, "Principles of Network and System Administration", Second Edition, John Wiley & Sons, Ltd, 2004.

2. Donald Childers and Scott Miller, "Probability and Random Processes", Second Edition, Elsevier,2012

REFERENCE BOOKS:

1. Jesin A, "Packet tracer network simulator", PACT Publishing, 2014.

2. Angela Ore Baugh, Gilbert Ramirez, Josh Burke, Larry Pesce, Joshua Wright, Greg Morris, "Wireshark and ethereal Network protocol and analyzer toolkit", Syngress Publishing. In 2007.

3. Himanshu Sharma, "Kali Linux - An Ethical Hacker's Cookbook," Packt Publishing Limited

VIDEO RESOURCES:

1. Network and Computer Security, https://ocw.mit.edu/courses/6-857-network-and-computer-security-spring-2014/

WEB RESOURCES:

1. https://alison.com/courses?query=networking
2. https://www.infosecinstitute.com/skills/learning-paths/comptia-network/
3. https://www.koenig-solutions.com/wireshark-network-analyst-certification-training-course
4. https://www.youtube.com/watch?v=pq3yV3qpBkw

1.

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201001	**ARTIFICIAL INTELLIGENCE**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course provides an over view on the foundation blocks of AI, concepts of agents and its realization. It discusses on the problem-solving approach using searching technique up to search in terms of reasoning and also discusses on distributed AI and its applications along with brief knowledge on expert systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Architect intelligent agents using artificial intelligence techniques and principles.

CO2. Analyze and interpret the problem, identify suitable solutions using heuristic functions, optimization algorithms and search algorithms.

CO3. Select and apply appropriate knowledge representation to build Bayesian network models to reason under uncertainty.

CO4. Demonstrate the knowledge on the diverse concepts of parallel and distributed AI and in reasoning of Expert system and ethical implications of intelligent machines for providing privacy, trust, security and safety.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1:   INTRODUCTION TO ARTIFICIAL INTELLIGENCE   (09 Periods)

Foundations of artificial intelligence, History of artificial intelligence, State of the art, Risks and benefits of AI, Intelligent agents – Agents and environments, The concept of rationality, Structure of agents.

Module 2:   PROBLEM SOLVING BY SEARCHING   (09 Periods)

Problem solving agents, Search algorithms, Uninformed search strategies, Informed search strategies–Greedy best-first search, A* search; Heuristic functions.

Module 3:   SEARCH IN COMPLEX ENVIRONMENTS   (09 Periods)

Local search algorithms and optimization problems – Hill-climbing search, Simulated annealing, Local beam search, Evolutionary algorithms; Optimal decisions in games–The minimax search algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning, Move ordering; Monte Carlo tree search.

Module 4:   PROBABILISTIC REASONING   (10 Periods)

Representing Knowledge in an uncertain domain, Semantics of Bayesian networks, Probabilistic reasoning over time – Time and uncertainty, Inference in temporal models, Hidden Markov models.

Module 5:   EXPERT SYSTEM AND REASONING   (08 Periods)

Parallel and Distributed AI: Psychological Modelling, Parallelism in Reasoning system. Distributed Reasoning System.
Expert System: Representing and using domain knowledge, Expert System shells, Explanations, Knowledge Acquisition.
Ethics and Safety in AI: Limits of AI, Ethics of AI – Surveillance, security and privacy, Fairness and bias, Trust and transparency, AI safety.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Compare and contrast the rational agent model with the concept of human intelligence. Identify two real-world systems and classify the type of agents they use (e.g., reflex, model-based, goal-based, utility-based).

2. List three real-world applications of intelligent agents (e.g., self-driving cars, virtual assistants). For each, identify the environment, the agent's perception inputs, possible actions, and the definition of rational behavior.

3. Implement a game-tree decision-making approach (e.g., Tic-Tac-Toe or Chess) using the minimax algorithm with alpha-beta pruning. Evaluate the performance when the depth of search is limited and suggest how move ordering improves efficiency.

4. Using any tool like Python's pgmpy or pomegranate, design a simple Bayesian network for a medical diagnosis problem. Show how probability inference can be used to predict disease presence based on observed symptoms.

5. Analyze how the performance of Breadth-First Search and Depth-First Search differs when solving a maze or tree-structured problem. Describe the scenarios where each is most appropriate.

RESOURCES

TEXT BOOKS:

1. Stuart Russel, Peter Norvig, Artificial Intelligence A Modern Approach, 4th Edition, Pearson Education, 2020.

2. Elaine Rich, Kevin Knight and Shiv Shankar B. Nair, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2009.

REFERENCE BOOKS:

1. Ela Kumar, "Artificial Intelligence", I.K. International Publishing House Pvt. Ltd, 2008.

2. Wolfgang Ertel," Introduction to Artificial Intelligence", Second Edition, Springer, 2017.

3. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education, 2017.

4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2011.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105077

2. https://nptel.ac.in/courses/106105078

3. https://nptel.ac.in/courses/106106182

4. https://www.youtube.com/watch?time_continue=1&v=zx_oMonGdK4

5. https://www.youtube.com/watch?v=dtGRmhZ6Cuo&list=PLEdmaLOtiZFswiGRQAr9iVV ucY3L 3jvgA&index=9&t=70s

6. https://www.youtube.com/watch?v=yMcZvZayJUA&t=4s

WEB RESOURCES:

1. http://cs.wwc.edu/~cs_dept/KU/PR/Prolog.html

2. http://www.cs.may.ie/~jpower/Courses/PROLOG/

3. http://www.csupomona.edu/~jrfisher/www/prolog_tutorial/contents.html

4. https://www.coursera.org/learn/python-for-applied-data-science-ai

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201002	**REINFORCEMENT LEARNING**	3	-	-	-	3

Pre-Requisite — Machine Learning

Anti-Requisite — -

Co-Requisite — -

COURSE DESCRIPTION: This course provides an overview on the concepts of Reinforcement learning, a very active research sub-field of Machine Learning. This course also deals with Tabular solution methods, Planning and Learning with Tabular Methods, Approximate solution methods, Applications and case studies related to reinforcement learning.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the basic concepts of Reinforcement learning and Multi-arm Bandits.

CO2. Formalize problems as Markov Decision Process and solve using dynamic programming.

CO3. Analyze Monte Carlo method, Temporal difference learning for prediction and control.

CO4. Utilize planning and control to perform Trajectory sampling and Heuristic search.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

**Module 1:   INTRODUCTION TO REINFORCEMENT LEARNING   (09 Periods)
                AND MULTI-ARM BANDITS**

Reinforcement Learning: Introduction, Elements of Reinforcement Learning, Limitations and Scope, Tic-Tac-Toe, History of Reinforcement Learning

Multi-Arm Bandits : An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper Confidence Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits), Real-world examples of Contextual Bandits (e.g., News Recommendation).

Module 2:   FINITE MARKOV DECISION PROCESS   (09 Periods)

The Agent– Environment Interface, Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality, and Approximation, Partial Observability (POMDP), Environment Modeling Tools (Gym, Petting Zoo)

Module 3:   DYNAMIC PROGRAMMING   (09 Periods)

Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming Generalized Policy Iteration, Efficiency of Dynamic Programming, Real-world constraints in DP (e.g., limited memory, computational cost).

**Module 4:   MONTE CARLO METHODS AND TEMPORAL-   (09 Periods)
                DIFFERENCE LEARNING**

Monte-Carlo Methods: Monte Carlo Prediction - Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns

Temporal-Difference Learning: TD Prediction - Advantages of TD Prediction Methods, Optimality on TD (0), Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control.

Module 5:   PLANNING AND LEARNING   (09 Periods)

Models and Planning, Integrating Planning, Acting, and Learning, Model Incorrectness, Prioritized Sweeping, Full vs. Sample Backups, Trajectory Sampling, Heuristic Search, Monte Carlo Tree Search. Deep Reinforcement Learning (DRL) - Multi-Agent and Meta-Reinforcement Learning.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Write a report explaining how a news or product recommendation system can be formulated using the multi-armed bandit model. Discuss different action-selection strategies (e.g., ε-greedy, UCB, gradient bandits), and provide a comparative theoretical analysis of their performance in non-stationary environments. Include real-life use cases like content personalization in YouTube, Netflix, or Flipkart.

2. Model a real-world scenario such as a self-driving car navigating intersections or a drone delivering packages. Define the MDP components (states, actions, transitions, rewards), and explain how partial observability affects decision-making. Propose how POMDPs and tools like Open AI Gym or Petting Zoo can support simulation and testing.

3. Choose a business or logistics problem (e.g., warehouse inventory control, elevator scheduling). Frame it as a reinforcement learning problem and discuss how dynamic programming methods like policy iteration or value iteration can solve it. Highlight limitations due to memory or compute constraints and propose theoretical strategies for approximation.

4. Select a simple game like Blackjack, Tic-Tac-Toe, or Maze navigation. Theoretically explain how Monte Carlo methods differ from TD methods (e.g., SARSA, Q-Learning) in learning value functions. Discuss the trade-offs between on-policy and off-policy methods, and propose when each would be most effective. Include pseudocode if possible.

5. Research and write about how planning methods (e.g., Monte Carlo Tree Search, Prioritized Sweeping) are used alongside Deep RL in high-dimensional tasks like robotics or strategy games. Explain how model-based planning improves sample efficiency and decision-making. Extend the discussion to meta-RL and multi-agent environments with practical examples.

RESOURCES

TEXT BOOKS:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning an Introduction, The MIT Press Cambridge, Massachusetts London, England, 2nd edition 2018.

REFERENCE BOOKS:

1. Phil Winder, Reinforcement Learning Industrial Applications of Intelligent Agents, O'Reilly Media, Inc., First Edition, 2020.
2. Aske Plat, Learning to Play: Reinforcement Learning and Games, Springer, 2020.
3. A, Taweh Beysolow, Applied Reinforcement Learning with Python: With Open AI Gym, Tensor flow, and Keras, 2019.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106/106/106106143/
2. https://onlinecourses.nptel.ac.in/noc19_cs55/preview
3. https://www.coursera.org/specializations/reinforcementlearning?utm_source=bg& utm_med ium=sem & utm
4. https://www.youtube.com/watch?v=LzaWrmKL1Z4

WEB RESOURCES:

1. https://neptune.ai/blog/how-to-structure-organize-track-and-manage-reinforcement- learning-rl-projects
2. https://livetalent.org/elearning-course/reinforcement-learning/
3. https://www.guru99.com/reinforcement-learning-tutorial.html
4. https://enjeeneer.io/sutton_and_barto/rl_notes.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201005	**TEXT ANALYTICS**	3	-	-	-	3

Pre-Requisite	Machine Learning
Anti- Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: Text Analytics are the methods and techniques used to extract useful knowledge from text to support decision making. This field includes a collection of research from the natural language processing, databases, data mining, and machine learning communities. The aim of this course is to be a primer for text analytics theory. Topics discussed in the course include: Text tokenization, Text normalization, Text syntax and structure, Text classification, Feature extraction, Classification algorithms, Text summarization, Key phrase extraction, Topic modeling, Text similarity and clustering, Document clustering, Automated document summarization, Semantic analysis, Sentiment analysis.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on preprocessing techniques for text data.

CO2. Apply various computational, language processing, machine learning techniques to classify and cluster text.

CO3. Build manual and automated text summarizers for getting more insights from the given text data.

CO4. Apply various distance or similarity measures to estimate the degree of similarity between two text documents.

CO5. Design machine learning models using supervised learning approaches and perform sentiment analysis.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1:   TEXT PROCESSING   **(10 Periods)**

Text tokenization – Sentence tokenization, Word tokenization; Text normalization – Cleaning, Tokenizing, Removing special characters, Expanding contractions, Case conversions, Removing stop words, Correcting words, Stemming, Lemmatization; Text syntax and structure– Parts of Speech tagging, Text parsing, Spell Correction using Contextual Models (e.g., BERT-based spell correctors), Dependency Parsing and Named Entity Recognition (NER) using spa Cy

Module 2:   TEXT CLASSIFICATION   **(09 Periods)**

Text classification, Automated text classification, Blueprint of text classification, Feature extraction – Bag of Words model, TF-IDF model, Averaged word vectors, TF-IDF weighted averaged word vectors; Classification algorithms – Naïve Bayes, Support vector machines, Evaluating classification models, Building a multi-class classification system.

Module 3:   TEXT SUMMARIZATION   **(08 Periods)**

Text summarization and information extraction, Singular value decomposition, Key phrase extraction – Weighted tag–based phrase extraction; Topic modeling – Latent semantic indexing, Latent Dirichlet allocation, Non-negative matrix factorization, Abstractive Summarization using Transformers (e.g., BART, T5).

Module 4:   TEXT SIMILARITY AND CLUSTERING   **(09 Periods)**

Text Similarity, Analyzing Term Similarity, Cosine Distance and Similarity, Analyzing Document Similarity, Hellinger-Bhattacharya Distance, Okapi BM25 Ranking, Document Clustering-K Means, Affinity Propagation, Ward's Agglomerative Hierarchical Clustering.

Module 5:   AUTOMATED DOCUMENT SUMMARIZATION,   **(09 Periods)**
**   SEMANTIC ANALYSIS**

Extraction-based techniques, Abstraction-based techniques, Latent semantic analysis, Text rank, Semantic analysis - Word sense disambiguation, Named entity recognition; Sentiment analysis of movie reviews – Getting and formatting data, Text normalization, Feature extraction, Model performance evaluation, Preparing datasets, Supervised machine learning technique.

**   Total Periods: 45**

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1.   Select a news article or a product review. Describe how you would theoretically apply each stage of text preprocessing (tokenization, stop word removal, stemming, lemmatization, etc.) to prepare this text for further analysis. Justify why each step is necessary in the chosen context.
2.   Compare and contrast extractive and abstractive summarization methods. Choose a use case such as legal document summarization or news article condensation, and theoretically explain which approach would be more suitable and why. Include relevant models and summarization techniques.
3.   Summarize long-form articles using Hugging Face Transformers (BART or T5) and compare with extractive methods.
4.   Implement key phrase extraction on news articles using SVD and TF-IDF scoring.
5.   Implement document similarity using both TF-IDF (Cosine) and Okapi BM25 for a set of research papers.

RESOURCES

TEXT BOOKS:

1. Dipanjan Sarkar, Text Analytics with Python, APRESS, 2016.

REFERENCE BOOKS:

1. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly, 2018.
2. Charu C. Aggarwal, Machine Learning for Text, Springer, 2018.
3. Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda, Applied Text Analysis with Python, O'Reilly, 2018.

VIDEO LECTURES:

1. http://nptel.ac.in/courses/110107129
2. https://freevideolectures.com/course/4135/nptel-business-analytics-text-mining- modeling-using-python/38
3. https://freevideolectures.com/course/4135/nptel-business-analytics-text-mining- modeling-using-python/39
4. https://freevideolectures.com/course/4135/nptel-business-analytics-text-mining- modeling-using-python/40
5. https://www.youtube.com/watch?v=FtGBzBi51mQ

WEB RESOURCES:

1. https://www.lexalytics.com/technology/text-analytics
2. https://download.e-bookshelf.de/download/0008/3870/64/L-G-0008387064- 0017200370.pdf-
3. https://www.linguamatics.com/what-text-mining-text-analytics-and-natural-language-processing
4. https://www.coursera.org/learn/text-mining
5. https://onlinecourses.nptel.ac.in/noc19_mg47/preview

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202006	**DEEP LEARNING**	3	-	3	-	4.5

Pre-Requisite	Machine Learning
Anti- Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides an overview of deep learning, a field of machine learning that deals with the creation and implementation of modern neural networks such as Recurrent Neural Networks, Convolutional Neural Networks. This course also deals with advanced deep learning models like Convolutional auto encoders, Attention mechanisms for machine translation; Generative adversarial networks (GANs).

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Acquire working knowledge with deeper theoretical understanding of neural networks and explore the different parameters of the network.

CO2. Construct a generative model for learning probability distribution using Restricted Boltzmann Machines.

CO3. Analyze temporal sequential input data using gated memory based neural units.

CO4. Utilize Convolutional Neural Network for analyzing visual imagery and utilize transfer learning approaches for reducing the training efforts.

CO5. Apply encoder-decoder architecture for image denoising, and learning representation of a set of data.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**2**	**3**	**-**	**3**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO NEURAL NETWORKS **(09 Periods)**

Basic architecture of neural networks, Training a neural network with backpropagation, Practical issues in neural network training- Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious optima, Computational challenges.

Module 2: RESTRICTED BOLTZMANN MACHINES **(09 Periods)**

Hopfield networks, Boltzmann machine, Restricted Boltzmann machines- Training the RBM, contrastive divergence algorithm, Practical issues and improvisations; Stacking restricted Boltzmann machines- Deep Boltzmann machines and deep belief networks;.

Module 3: RECURRENT NEURAL NETWORKS **(09 Periods)**

Architecture of recurrent neural networks, Challenges of training recurrent networks- Layer normalization; Echo-state networks, Long short-term memory (LSTM), Gated recurrent units (GRUs).

Module 4: CONVOLUTIONAL NEURAL NETWORKS **(09 Periods)**

Structure of a convolutional network, Training a convolutional network, Case studies of convolutional architectures- Alex Net, ZFNet, VGG, Google Net, ResNet, Effects of depth, Pretrained models.

Module 5: ADVANCED TOPICS IN DEEP LEARNING **(09 Periods)**

Convolutional auto encoders, Attention mechanisms- Recurrent models of visual attention, Attention mechanisms for machine translation; Generative adversarial networks (GANs)- Applications of GANs; Deep Reinforcement Learning (DRL)-Value-based methods, Policy-based methods, Actor Critic methods – DRL Models.

Total Periods: 45

EXPERIENTIAL LEARNING
LIST OF EXERCISES:

1. Perform splitting of data for training, testing, and validation using k-fold cross validation.

2. Construct and implement multi-layer feed forward neural network for hand written digit classification problem.

3. Solve the overfitting problem in a neural architecture using Drop Out technique.

4. Implement image reconstruction using Restricted Boltzmann machines (RBM).

5. Solve a time series forecasting (stock prediction) using LSTM RNN.

6. Solve a seq2seq problem (machine translation) using LSTM Recurrent Neural Architecture.

7. Implement a binary and multi class image classification using Convolution Neural Network.

8. Perform hyper parameter tuning using Bayesian optimization technique for a Convolution Neural Network.

9. Study the efficiency of the transfer learning approach for a classification problem on the following architectures; VGG-16, Alex net, and Inception-V3.

10. Implement the image dimensionality reduction problem using a AutoEncoder architecture.

11. Development of a Reinforcement Learning-Based Clinical Decision Support System for Optimizing Treatment Policies in Chronic Disease Management

RESOURCES

TEXT BOOKS:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018.

REFERENCE BOOKS:

1. Ian Good fellow, Yoshua Bengio, Aaron Courville, Deep Learning, 4th Edition, MIT Press, 2016.
2. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.

SOFTWARE/TOOLS:

1. Environment: Google Co Lab
2. Programming Language: Python 3.8
3. Machine Learning Library: Tensor Flow 2.1 and Keras

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106184
2. https://www.coursera.org/specializations/deep-learning?utm_source=deeplearningai&utm_medium=institutions&utm_campaign=Website courses DLS Top Button
3. https://www.simplilearn.com/tutorials/deep-learning-tutorial/what-is-deep-learning
4. https://www.udemy.com/course/data-science-logistic-regression-in-python/
5. https://www.udemy.com/course/data-science-deep-learning-in-python/

WEB RESOURCES:

1. https://www.youtube.com/watch?v=aPfkYu_qiF4
2. https://www.guru99.com/deep-learning-tutorial.html
3. https://www.coursera.org/professional-certificates/tensorflow-in-practice
4. https://www.mathworks.com/discovery/deep-learning.html
5. https://www.techtarget.com/searchenterpriseai/definition/deep-learning-deep-neural-network#:~: text=Deep%20learning%20is%20a%20type,includes%20statistics%20and%20predictive%20modeling.

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202007	**COMPUTER VISION**	3	-	3	-	4.5

Pre-Requisite	Machine Learning
Anti- Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides an introduction to computer vision including fundamentals of image formation, camera models and geometry, stereo, object tracking, image clustering, classification and scene understanding. Methods for depth recovery from stereo images, camera calibration, automated alignment, tracking, boundary detection, and recognition are explored in detail.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on various image representation and transformation techniques suited for digital image processing tasks.

CO2. Analyze stereo images, and apply camera calibration methods for estimation of disparity maps.

CO3. Design image retrieval systems or search engines using image indexing and visual words as image representations.

CO4. Apply various image clustering, classifications and segmentation methods for solving real world problems such as OCR, face recognition, and image understanding.

CO5. Utilize advanced techniques and algorithms for processing video frames and provide solutions for object tracking problems.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**3**

Correlation Levels: **3: High;**   **2: Medium; 1: Low**

COURSE CONTENT

Module 1: IMAGE DESCRIPTORS AND IMAGE MAPPING (09 Periods)

Image Descriptors – Harris Corner Detector, SIFT (Scale-Invariant Feature Transform), Matching Geotagged Images; Image Mapping - Homographies, Warping Images, Creating Panoramas.

Module 2: CAMERA MODELS AND MULTIPLE VIEW GEOMETRY (09 Periods)

Camera Models - Pin-hole Camera Model, Camera Calibration, Pose Estimation, Augmented Reality; Multiple View Geometry - Epipolar Geometry, Computing with cameras and 3D structure, Multiple view reconstruction, Stereo Images.

Module 3: CLUSTERING AND IMAGE SEARCHING (09 Periods)

Clustering Images - K-means clustering, Hierarchical clustering, Spectral clustering; Searching Images - Image Retrieval, Visual Words, Indexing Images, Ranking results using Geometry.

Module 4: CLASSIFICATION OF IMAGES (09 Periods)

Classifying Image Content - K-Nearest Neighbors, Bayes Classifier, Support Vector Machines, Optical Character Recognition.

Module 5: IMAGE SEGMENTATION AND OBJECT TRACKING (09 Periods)

Graph Cuts, Segmentation using Clustering, Variational Methods - Processing Video, Object Tracking- Optical Flow, Lucas-Kanade algorithm.

Vision Transformers and Self-Attention Models - Vision Transformers (ViT), Self-attention in Image Analysis. Advanced Video Analytics and Human Action Recognition - Temporal CNNs, 3D Conv Nets.

Total Periods: 45

EXPERIENTIAL LEARNING:

LIST OF EXERCISES:

1. Identify the internal corners of an image using the Harris corner detector algorithm.
2. Execute feature matching using Scale Invariant Feature Transform Technique.
3. Estimate the homographies between the images (using RANSAC) and then warp all images to a common image plane.
4. Compute disparity maps from a stereo image pair with normalized cross-correlation.
5. Reconstruct a 3D scene using two images taken with a camera with known calibration.
6. Place a computer graphics model on an object present in a scene using camera parameters computed from feature matches.
7. Solve the problem of recognizing numbers in images of printed Sudoku's.
8. Implement image segmentation using the normalized cuts algorithm.
9. Compute image gradients on the first normalized cuts eigenvectors. Combine these gradient images to detect image contours of objects.
10. Track an object present in the video frames using Lucas-Kanade Optical flow algorithm.
11. Perform image classification using Naive Bayes Classifier.
12. Cluster images using features extracted from PCA, and Hog using an unsupervised learning approach.
13. Fine-tune a pre-trained ViT on the Stanford Dogs dataset.
14. Action classification using UCF101 dataset or custom video dataset.

RESOURCES

TEXT BOOKS:

1. Jan Eric Solem, "Programming Computer Vision with Python, O'Reilly Media", 2012.

REFERENCE BOOKS:

1. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision‖", Acade mic Press, 3$^{r\,d}$ Edition, 2012.
2. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference" Cambridge University Press, 2012.

SOFTWARE/TOOLS:

1. Python
2. Open CV

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=715uLCHt4jE
2. https://nptel.ac.in/courses/108103174
3. https://www.youtube.com/watch?v=Z_YNkw65gp8
4. https://www.youtube.com/playlist?list=PL7v9EfkjLswLfjcI-qia-Z-e3ntl9l6vp

WEB RESOURCES:

1. https://nptel.ac.in/courses/108103174
2. https://github.com/jbhuang0604/awesome-computer-vision#books
3. https://medium.com/readers-writers-digest/beginners-guide-to-computer-vision-23606224b720
4. https://doc.lagout.org/science/0_Computer%20Science/2_Algorithms/An%20Introduction%20to%203D%20Computer%20Vision%20Techniques%20and%20Algorithms%20%5BCyg anek%20%26%20Siebert%202009-02-09%5D.pdf
5. https://www.udacity.com/course/introduction-to-computer-vision--ud810

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201011	**GENERATIVE AI**	3	-	-	-	3

Pre-Requisite	Artificial Intelligence
Anti- Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides a comprehensive exploration of large language models (LLMs) and their applications. The training of LLMs is examined in-depth, including data collection, bidirectional token prediction, and fine-tuning, along with emergent properties and biases. The course also addresses data privacy and safety, covering post-processing, reinforcement learning, and best practices. Finally, it explores the workings, security, and ethical considerations of major AI chat bots such as Chat GPT, Microsoft Copilot, etc.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the Fundamentals of Large Language Models

CO2. Demonstrate the methodologies used in training LLMs, including data collection, Fine-tuning LLMs, and bidirectional token prediction.

CO3. Implement safety-focused improvements for LLM-generated content, including post-processing detection algorithms and content filtering.

CO4. Apply emotional attachment and social penetration theories to human-chat bot interactions.

CO5. Develop and utilize simple prompts to effectively interact with AI chat bots, and critically assess their reasoning, summarizing capabilities, and truthfulness.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
Course Correlation Mapping	3	3	3	-	-	-

Correlation Levels: 3: High;   2: Medium; 1: Low

COURSE CONTENT

Module 1:   LARGE LANGUAGE MODELS   (09 Periods)

Introduction, Large language models: The power of AI, Evolution of natural language processing, Conversational LLMs, Open AI's ChatGPT Google's Bard/La MDA Microsoft's Bing AI, Meta's LLa Ma/Stanford's Alpaca

Module 2:   TRAINING LARGE LANGUAGE MODELS   (09 Periods)

Introduction, Training LLMs, Exploring open web data collection, Demystifying auto regression and bidirectional token prediction, Fine-tuning LLMs, The unexpected: Emergent properties of LLMs, Learning with few examples Is emergence an illusion, What's in the training data?, Encoding bias, Sensitive information.

Module 3:   DATA PRIVACY AND SAFETY WITH LLMS   (09 Periods)

Safety-focused improvements for LLM generations, Post-processing detection algorithms Content filtering or conditional pre-training, Reinforcement learning from human feedback Reinforcement learning from AI feedback, Navigating user privacy and commercial risks, Inadvertent data leakage, Best practices when interacting with chatbots

Module 4:   MAKING SOCIAL CONNECTIONS WITH CHATBOTS   (09 Periods)

Chatbots for social interaction, The loneliness epidemic, Emotional attachment theory and chatbots, Attachment Theory, The good and bad of human-chatbot relationships, Social Penetration Theory, Charting a path for beneficial chatbot interaction.

Module 5: CHATGPT AND AI CHATBOTS   (09 Periods)

Introduction, The 'Big Three' AI Chat bots, Chat GPT, Microsoft Copilot, Google Bard, How AI Chatbots Work, Security and privacy, Simple Prompts, Reasoning and Summarising, Truthiness and Chatbots.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Compare responses from ChatGPT, Google Bard, and Microsoft Bing AI to the same set of prompts (e.g., summarize a news article or explain a scientific concept). Analyze differences in tone, detail, factual accuracy, and fluency. Reflect on how each model handles the same information.

2. Using a small text dataset (e.g., movie reviews or product descriptions), train a basic language model using a library like Hugging Face's Transformers. Experiment with fine-tuning using new sample data. Document how performance changes and what trade-offs arise in fine-tuning.

3. Interact with a chatbot and analyze whether it reveals potentially sensitive or biased outputs. Then explore existing content filtering tools or RLHF frameworks (e.g., Open AI moderation API or Detoxify) to detect and reduce harmful outputs in generated content.

4. Conduct a simulated conversation with ChatGPT or another chatbot over several turns, mimicking a social or emotional support context. Analyze the chatbot's responses using Attachment Theory and Social Penetration Theory to evaluate emotional depth, empathy, and appropriateness.

5. Craft different styles of prompts (e.g., creative writing, summarizing a scientific paper, answering a math problem) and evaluate ChatGPT's response accuracy and clarity. Then assess the privacy/security risks of sharing sensitive information in these prompts, identifying safe prompt engineering practices.

RESOURCES

TEXT BOOKS:

1. Numa Dhamani and Maggie Engler, "Introduction to Generative AI ", Manning Publications Co.,2024
2. Mark Pesce, "Getting Started with ChatGPT and AI Chatbots: An Introduction to Generative AI Tools", O'Reilly Media, 2024

REFERENCE BOOKS:

1. Ian Good fellow, Yoshua Bengio, and Aaron Courville, " Deep Learning", MIT Press, 2016

2. Kai-Fu Lee, "AI Superpowers: China, Silicon Valley, and the New World Order", Houghton Mifflin Harcourt, 2018.

VIDEO LECTURES:

1. https://www.coursera.org/learn/nlp-sequence-models

2. https://www.youtube.com/watch?v=K47kS1deTE4

WEB RESOURCES:

1. https://news.microsoft.com/source/topics/ai/

2. https://platform.openai.com/docs/overview

3. https://www.affectiva.com/product/in-cabin-sensing-ai/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CS201005	**DATA SCIENCE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to Data science, Using python for data science, Exploratory data analysis - Probability and distributions, Predictive modelling - Time series analysis, Data extraction - Feature selection, Single value decomposition, Principal component analysis, Data visualization - Using visualization for data science, Visualization tools.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze data by recognizing data science process and develop applications using relevant python libraries.

CO2. Develop distribution functions to analyze and interpret data to extract meaningful statistics.

CO3. Develop methods to extract meaning from data using feature selection techniques.

CO4. Create data visualizations using charts to identify trends, patterns and outliers in data.

CO5. Design and develop predictive models for a given problem to support forecasting.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	-	-	-
CO2	3	2	-	-	-	-
CO3	3	2	-	-	-	-
CO4	1	3	-	-	-	-
CO5	2	3	2	-	-	-
Course Correlation Mapping	**3**	**2**	**2**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1:   INTRODUCTION TO DATA SCIENCE   (09 Periods)

Data science history, Data science project life cycle, Managing a data science project, Using python for data science - Understanding the basic concepts of python, Essential python libraries; Numpy, Pandas, Matplotlib, IPython, Scipy, Scikitlearn, Stats Models, Using python to analyze data.

Module 2:   STATISTICAL THINKING FOR PROGRAMMERS   (11 Periods)

Exploratory Data Analysis: Distributions - Representing and plotting histograms, Outliers, Summarizing distributions, Variance, Reporting results; Probability mass function - Plotting PMFs, Other visualizations, The class size paradox Data frame indexing; Cumulative distribution functions - Limits of PMFs, Representing CDFs, Percentile based statistics, Random numbers, Comparing percentile ranks; Modeling distributions - Exponential distribution, Normal distribution, Lognormal distribution.

Module 3:   DATA EXTRACTION   (09 Periods)

Extracting meaning from data - Feature selection, User retention, Filters, Wrappers, Entropy, Decision tree algorithm; Random forests, The dimensionality problem, Single value decomposition, Principal component analysis.

Module 4:   DATA VISUALIZATION   (07 Periods)

Need for data visualization, Creating visualizations - Comparison charts, Composition charts, Distribution charts, Relationship charts; Using visualization for data science – Popular visualization tools.

Module 5:   PREDICTIVE MODELING   (09 Periods)

Time series Analysis - Importing and cleaning, Plotting, Moving averages, Missing values, Serial correlation, Autocorrelation; Predictive modeling - Overview, Evaluating predictive models, Building predictive model solutions, Sentiment analysis.

Total Periods: 45

EXPERIENTIAL LEARNING

1. **Stock Market Prediction:** Build a Stock Market Forecasting system by implementing Machine learning algorithms on the Euro Stock Market Dataset which is a time series dataset. The dataset has closing prices of major European Stock Indices: Germany DAX (Ibis), Switzerland SMI, France CAC, and UK FTSE, for all business days. Analyze the trends in a time series dataset, Visualize the time series data and build stock market prediction model using techniques like Holt Exponential Smoothing, FB Prophet, LSTM etc. Dataset can be downloaded from the url: https://github.com/ vincentarelbundock/Datasets/ blob/master/csv/datasets/EuStockMarkets.csv

2. Build a Data Science Web App with Stream lit and Python:

    Build a data analysis code to analyze Motor Vehicle Collisions Data, then train a model using Linear Regression, and finally use the model to make predictions. Then, adapt this code to convert it into a web app using Stream lit. The web app shall display text, data frames, and plots. Add interactivity to your app, allowing your user to upload his/her files.

    Dataset can be downloaded from the url: https://data.cityofnewyork.us/Public-Safety/Motor-Vehicle-Collisions-Crashes/h9gi-nx95

RESOURCES

TEXT BOOKS:

1. Ofer Mendelevitch, Casey Stella, Douglas Eadline, Practical Data science with Hadoop and Spark: Designing and Building Effective Analytics at Scale, Addison Wesley (Data & Analytics Series), 2017.

2. Alen B. Downey, Think Stats: Exploratory Data Analysis, O'Reilly Publications, 2nd Edition, 2014.

REFERENCE BOOKS:

1. Jacob T. VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Publications, 2016.

2. Cathy O'Neil, Rachell Schutt, Doing Data Science: Straight Talk from the Frontline, O'Reilly Publications, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=MTjOuCbdBCo

2. https://www.youtube.com/watch?v=8LgR42WCRl0

3. https://www.youtube.com/watch?v=eRgeKID7Er8

4. https://www.youtube.com/watch?v=FPM6it4v8MY

5. https://www.youtube.com/watch?v=WSANiPbatHc

6. https://www.youtube.com/watch?v=_0EmqA97lr8

7. https://www.youtube.com/watch?v=FPM6it4v8MY

8. https://www.youtube.com/watch?v=j_qnIatT3k4

9. https://www.youtube.com/watch?v=QtYOI-9R1vo

WEB RESOURCES:

1. Data Science for Engineers, IIT Madras, NPTEL Course e-book: https://drive.google.com/file/d/1Kia3XhbJugl8YYnKQIrelNriWdmX7tvW/view

2. https://www.simplilearn.com/resources-to-learn-data-science-online-article

3. https://people.smp.uq.edu.au/DirkKroese/DSML/DSML.pdf

4. https://intellipaat.com/blog/free-resources-to-learn-data-science-online/#no3

5. https://www.netsuite.com/portal/resource/articles/financial-management/predictive-modeling.shtml

6. https://dzone.com/articles/what-is-data extraction#:~:text=Data%20Extraction%20Defined,or%20to%20further%20analyze%20it.

7. https://www.analyticsvidhya.com/blog/2021/08/effective-data-visualization-techniques-in-data-science-using-python/

8. https://www.techtarget.com/searchenterpriseai/definition/predictive-modeling

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201006	**DATA ANALYTICS**	3	-	-	-	3

Pre-Requisite ‾

Anti-Requisite ‾

Co-Requisite ‾

COURSE DESCRIPTION: The course provides Introduction to Data Analytics and its Life Cycle, Review of Basic Data Analytic Methods Using R, Advanced Analytical Theory and Methods, Advanced Analytics-Technology and Tools: In-Database Analytics and Communicating and Operationalizing an Analytics Project

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on the foundations of Analytics and Data Analytics Life Cycle.

CO2. Import, Export Data and perform descriptive statistics using R programming to make inferences.

CO3. Identify trends and patterns in data using Data Exploration and Statistical Methods.

CO4. Apply Advanced Analytical Methods to perform Text Analysis and Time–Series Analysis.

CO5. Develop and Operationalize Analytics project creating suitable product deliverables and portray data using visual representation.

CO6. Analyze and Design Data Analytics Applications to solve societal problems.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
CO6	3	3	2	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1:   INTRODUCTION TO DATA ANALYTICS and R   (09 Periods)

Practice in Analytics: BI versus Data Science, Current Analytical Architecture, Emerging Big Data Ecosystem and a New Approach to Analytics, An overview of Big Data tools.

Data Analytics Life Cycle: Key Roles for a Successful Analytics Project Background and Overview of Data Analytics Lifecycle Phases - Discovery Phase, Data Preparation Phase, Model Planning, Model Building, Communicate Results, Operationalize. Data Cleaning and Preprocessing Techniques

Introduction to R: R Graphical User Interfaces, Data Import and Export, Attribute and Data Types, Descriptive Statistics.

Module 2:   BASIC DATA ANALYTICAL METHODS   (09 Periods)

Exploratory Data Analysis: Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation.

Statistical Methods for Evaluation: Hypothesis Testing, Difference of Means, Wilcoxon Rank- Sum Test, Type I and Type II Errors, Power and Sample Size, ANOVA, Decision Trees in R, Naïve Bayes in R. Correlation vs. Causation, Chi-Square Test**,** Basic Regression Models.

Module 3:   ADVANCED ANALYTICAL TECHNOLOGY AND METHODS   (09 Periods)

Time Series Analysis: Overview of Time Series Analysis, Box-Jenkins Methodology, ARIMA Model, Autocorrelation Function (ACF),Autoregressive Models, Moving Average Models , ARMA and ARIMA Models ,Building and Evaluating an ARIMA Model, Reasons to Choose and Cautions.

Text Analysis: Basic NLP techniques – Stop word removal, Lemmatization, Text Analysis Steps, A Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency— Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights.

Module 4:   FINAL DELIVERABLES AND VISUALIZATION   (09 Periods)

Communicating and Operationalizing an Analytics Project, Creating the Final Deliverables: Developing Core Material for Multiple Audiences, Project Goals, Main Findings, Approach, Model Description, Key Points Supported with Data, Model Details Recommendations, Additional Tips on Final Presentation, Providing Technical Specifications and Code, Data Visualization. Dash boarding and Interactive Visualization

Module 5:   DATA ANALYTICS APPLICATIONS   (09 Periods)

Text and Web: Data Acquisition, Feature Extraction, Tokenization, Stemming, Conversion to Structured Data, Sentiment Analysis, Web Mining.

Recommender Systems: Feedback, Recommendation Tasks, Recommendation Techniques, Final Remarks.

Social Network Analysis: Representing Social Networks, Basic Properties of Nodes, Basic and Structural Properties of Networks.

<div align="right">**Total Periods: 45**</div>

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Use R to import a real-world dataset (e.g., from Kaggle or UCI) and perform data cleaning and preprocessing (e.g., handling missing values, encoding categorical variables). Then generate descriptive statistics and create basic visualizations (e.g., histograms, boxplots) to summarize the data.
2. Conduct an exploratory data analysis (EDA) in R for a dataset with multiple variables (e.g., sales or health data). Use visualizations such as pair plots, heat maps, and facet grids, and then apply hypothesis testing (e.g., t-test or ANOVA) to draw statistical conclusions. Finally, build a simple Naïve Bayes classifier and interpret its accuracy.
3. Use R to analyze a time series dataset (e.g., monthly airline passenger data). Decompose it into trend, seasonality, and residuals, then build an ARIMA model and forecast future values. Additionally, perform basic text analysis on a corpus of tweets or customer reviews, applying TF-IDF and basic sentiment analysis.
4. Create a mini-project report in R Mark down that presents a complete analysis workflow—problem definition, EDA, model building, and results—with visualizations and commentary tailored to a non-technical audience. Build an interactive dashboard using Shiny or Plotly to showcase real-time insights.
5. Using R, extract and preprocess web data or online reviews (e.g., from Amazon or IMDb), convert it into structured format, and build a sentiment analysis model. Then develop a simple recommender system (e.g., user-item collaborative filtering) and visualize the social network structure using an SNA library such as igraph, showing node centrality and clustering.

RESOURCES

TEXT BOOKS:

1. EMC Education Services, Data Science and Big Data Analytics – Discovering, Analyzing, Visualizing and Presenting Data, John Wiley and Sons, 2015.

2. Joao Moreira, Andre Carvalho, André Carlos Ponce de Leon Ferreira Carvalho, Tomás Horvath - A General Introduction to Data Analytics - John Wiley and Sons, 1st Edition,2019·

REFERENCE BOOKS:

1. Anil Mahesh Wari, Data Analytics Made Accessible, Lake Union Publishing, 1st Edition, 2017

2. Richard Dorsey, Data Analytics: Become a Master in Data Analytics, Create Space Independent Publishing Platform, 2017.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106/107/106107220/

2. https://nptel.ac.in/courses/106/104/106104021/

3. https://nptel.ac.in/courses/106/106/106106093/

4. https://nptel.ac.in/courses/106/106/106106095/

5. https://nptel.ac.in/courses/106/104/106104135/

WEB RESOURCES:

1. https://extension.harvard.edu/academics/programs/data-science-graduate-certificate/

2. https://www.simplilearn.com/pgp-data-science-certification-bootcamp-program

3. https://ischoolonline.berkeley.edu/data-science/

4. https://developers.google.com/machine-learning/crash-course/

5. https://www.mastersindatascience.org/learning/what-is-data-analytics/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201009	**MALWARE ANALYSIS**	3	-	-	-	3

Pre-Requisite	Machine Learning
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: The course provides theoretical and conceptual knowledge about the various aspects of the computer system, particularly MS Windows. Introduction to malware, behaviours of malware, mitigating with malware and understanding anti-techniques to prevent influence of malware.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge about the prevalence of malware in the systems.

CO2. Develop ideas for reverse-engineering and elucidate the internals of registry.

CO3. Apply debugging in dynamic analysis using tools.

CO4. Explore methods for counter measures to prevent influence of malware.

CO5. Analyze anti-techniques for extended analysis and prevention of malware.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium;   1: Low

COURSE CONTENT

Module 1:   BASIC ANALYSIS   **(09 Periods)**

Basic Static Techniques - Finding Strings, Packed and Obfuscated Malware, Portable Executable File Format, Linked Libraries and Functions; Malware Analysis in Virtual Machines
- Structure of a Virtual Machine, Creating and Using Malware Analysis Machine - Risks of Using VMware for Malware Analysis; Basic Dynamic Analysis - Sandboxes - Running and Monitoring Malware - Comparing Registries, Introduction to File less Malware Concepts.

Module 2:   ADVANCED STATIC ANALYSIS   **(09 Periods)**

The x86 Architecture - Reverse Engineering - General Registers, Flags, Stack; Recognizing C Code in Assembly - Global vs. Local Variables - Disassembling Arithmetic Operations - Recognizing if, switch and loop statements; Recognizing function call conventions, structures, Windows API, Registry, Networking APIs, Kernel vs. User Mode, Native APIs.

Module 3:   ADVANCED DYNAMIC ANALYSIS   **(09 Periods)**

Debugging - Source level vs. Assembly level debugging, Kernel vs. User-mode debugging; Exceptions - Modifying Execution with a Debugger, Program Execution; Olly Dbg - The OllyDbg Interface, Loading Malware, Memory Map, Viewing Threads and Stacks, Executing Code, Loading DLLs, Exception Handling, Scriptable Debugging. API Hooking and Tracing Tools, Behavioral Analysis Techniques.

Module 4:   MALWARE ANALYSIS   **(09 Periods)**

Malware Functionality - Downloaders, Launchers Backdoors, Privilege Escalation, Process Injection, Hook Injection; Data Encoding - Ciphers, Simple Cryptographic Algorithms, Encodings; Malware Focused Network Signatures - Network Counter Measures, Content-Based Network Countermeasure, Combining Dynamic and Static Analysis Techniques.

Module 5:   ANTI-TECHNIQUES   **(09 Periods)**

Anti-Reverse-Engineering - Anti-Disassembly, Defeating Disassembly Algorithms, Anti-Disassembly Techniques, Obscuring Flow Control, Brief topics on Anti-debugging, Anti- Virtual Machines. Code Obfuscation Techniques, Code Injection & Evasion Techniques, Detection Evasion Techniques, Case Studies on Real-world Malware Families.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. **Static Analysis Using PE Studio and Strings:** Analyze a given PE file and extract readable strings, imported functions, and compiler metadata. Use strings utility to extract human-readable strings; Open the sample in PE Studio to analyze imports, exports, and suspicious indicators.
2. **Debugging Malware with OllyDbg:** Step through malware execution to locate the decryption routine. Load malware into OllyDbg; Set breakpoint at Get Proc Address or suspicious function; Observe changes in memory/registers.
3. **Analyze a Downloader Malware:** Use dynamic + static analysis to analyze a downloader sample. Capture network traffic using Wireshark; Disassemble to find C2 URLs or hardcoded IPs; Observe dropped files or created processes.
4. **Detect Custom Cipher or Encoding:** Decrypt data encoded using simple XOR or substitution. Identify and reverse XOR/ROT13 encoded strings; Write a Python script to decode embedded payload.
5. **Detect and Analyze Anti-Debugging and Anti-VM Techniques:** Observe malware behavior under a debugger and virtual machine. Analyze how malware checks for debugger (e.g., Is Debugger Present, timing checks); Simulate VM evasion using tools like Pafish.

RESOURCES

TEXT BOOKS:

1. Michael Sikorski and Andrew Honig, Practical Malware Analysis, no starch press, 2012.

2. Monnappa K. A., Learning Malware Analysis, Packt Publishing, 2018.

REFERENCE BOOKS:

1. Alexey Kleymenov and Amr Thabet, Mastering Malware Analysis: The complete malware analyst's guide to combating malicious software, APT, cybercrime, and IoT attacks, Packt Publisher, 2019.

2. Michael Ligh, Steven Stair, Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code, Wiley, 2011.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=D4pc63SeHxI
2. https://www.youtube.com/watch?v=yorvgUhbEbI
3. https://www.youtube.com/watch?v=JLh1xBv7GVQ
4. https://www.youtube.com/watch?v=VYROU-ZwZX8
5. https://www.youtube.com/watch?v=j3lgxdylktM

WEB RESOURCES:

1. https://github.com/surajr/Machine-Learning-approach-for-Malware-Detection
2. https://github.com/Pyran1/MalwareCollection
3. https://github.com/imamitsingh/Classification-of-malwares-using-machine-learning-algorithms
4. https://towardsdatascience.com/malware-classification-using-machine-learning-7c648fb1da79
5. https://ieeexplore.ieee.org/document/9368268

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202009	**DATA VISUALIZATION**	3	-	3	-	4.5

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Introduction to data visualization, Data exploration and plots, Numpy, Pandas, Introduction to Matplotlib, Simplifying visualizations using Seaborn and Geoplotlib, Making things interactive with Plotly, Folium and Bokeh.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on data visualization methods to identify suitable factors for the adoption of data visualization.

CO2. Apply data exploration using Numpy, Pandas and Plots to perform data presentation.

CO3. Design layouts using Matplotlib forT image presentation of data.

CO4. Construct effective data visualizations using Seaborn, Geoplotlib to perform statistical graphics.

CO5. Develop interactive applications using Plotly, Folium, Bokeh to explore diverse data like COVID-19 dataset analysis, Newyork City, Stock Price and Airbnb.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	2	3	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**3**

Correlation Levels: 3: High;   2: Medium; 1: Low

COURSE CONTENT

Module 1: DATA VISUALIZATION, DATA EXPLORATION AND PLOTS (09 Periods)

Data Visualization: What is data visualization, Key elements, Importance, The power of visual storytelling, Examples, Benefits, Types of charts and graphs used in data visualization.
Data Exploration: NumPy, NumPy operations, Pandas, Advantages of Pandas over NumPy, Disadvantages of Pandas, Operations of Pandas, Series.
Plots: Comparison plots, Relation plots, Composition plots, Distribution plots, Geo plots, Aspects of good visualization, Outlier and Anomaly Detection via Visualization, Auto-generating data reports for rapid exploration.

Module 2: VISUALIZATION USING MATPLOTLIB (09 Periods)

Overview of plots in Matplotlib, Pyplot basics, Basic text and legend functions, Basic plots – Bar chart, Pie chart, Stacked bar chart, Stacked area chart, Histogram, Box plot, Scatter plot, Bubble plot; Layouts, Images – Basic image operations, Plotting multiple images in a grid. Customizing Themes and Styles, Animation with Matplotlib.

Module 3: VISUALIZATION USING SEABORN AND GEOPLOTLIB (09 Periods)

Seaborn: Advantages of Seaborn, Controlling figure aesthetics, Color palettes, Bar plots, Kernel density estimation, Plotting bivariate distributions, Visualizing pairwise relationships, Violin plots, Multi-plots in Seaborn, Regression plots, Squarify.
Plotting Geospatial Data: Geopandas Basics, Design principles of Geoplotlib, Geospatial visualizations, Tile providers, Custom layers.

Module 4: VISUALIZATION USING PLOTLY, FOLIUM (09 Periods)

Types of visualizations using Plotly, Plotly chart types, Bar charts, 3D scatter chart, 3D line chart, Plotly for COVID-19 dataset analysis, Plotly animation, Scatter matrix, Treemap, Geographic visualizations using Folium.

Module 5: VISUALIZATION USING BOKEH (09 Periods)

Bokeh: Concepts of Bokeh, Interfaces in Bokeh, Bokeh server, Presentation, Integrating, Adding widgets, Embedding Plots in HTML and Web Pages.
Case Studies: Implementing Matplotlib and Seaborn on New York city database, Visualizing Bokeh stock prices, Analyzing Airbnb data with geoplotlib.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES

1. **DATA EXPLORATION USING NUMPY AND PANDAS:**
   a) Compute arithmetic mean, median, standard deviation and variance using statistical functions in NumPy.
   b) Perform operations indexing, slicing, splitting, iterating, computing mean of elements by loading any online dataset in delimited format (CSV) using genfromtxt method in NumPy.
   c) Compute mean of elements for each column and for complete dataset by loading any online dataset in delimited format (CSV) using read_csv method in Pandas.
   d) Perform operations filtering, sorting, combining and reshaping with any online dataset using NumPy and Pandas.

2. **VISUALIZATION BASICS WITH MATPLOTLIB:**
   a) Plot the data pairs (x, y) as circles connected with line segments (1,1), (2,3), (4,4). Visualize and save the plot using plt. savefig method.

b) Insert axis labels, title, text, annotations and legends for the created plot.

c) Create a bar plot setting the title, axis labels and legends loading any online dataset.

d) Create a pie chart to visualize water usage with title and labels. Consider online water usage dataset for processing.

3. **DATA VISUALIZATION USING MATPLOTLIB:**

a) Create stacked bar Plot and stacked area chart setting the title, axis labels and legends considering any online dataset for processing.

b) Use histogram and box plot with title and labels to visualize the intelligence quotient by considering online IQ Scores dataset for processing.

c) Create scatter plot and examine the relationship between variables in the data set. Consider any online dataset for processing.

4. **IMAGE OPERATIONS USING MATPLOTLIB:**

a) Create a scatter plot with marginal histograms including labels and title. consider any online dataset for processing.

b) Import necessary modules and load sample images. Visualize the images in a 2x2 grid and represent the image in array. Remove the axes and give each image a label.

5. **SIMPLIFIED VISUALIZATION USING SEABORN:**

a) Create box plot and violin plot using Seaborn to compare intelligence quotient (IQ) Scores for different test groups by considering online IQ Scores dataset for processing.

b) Use bar plot to compare the movie scores of five different movies. Consider online movie scores dataset for processing.

c) Implement linear regression by visualizing linear relationship between maximum longevity and body mass in the regression plot using the replot() function in Seaborn. Consider online animal dataset for processing.

6. **PLOTTING GEOSPATIAL DATA USING SEABORN:**

a) Plot the geospatial data on a map and find the densely populated areas for cities in Europe that have a population of more than 100k, Display using dot-density visualization. Consider online world cities population dataset for processing.

b) Create a custom layer that will allow to display geospatial data and animate the data points over time.

c) Create a choropleth plot with Geo JSON Data.

7. **DATA VISUALIZATION USING PLOTLY:**

a) Perform COVID-19 dataset analysis using Plotly.

8. **DATA VISUALIZATION USING FOLIUM:**

a) Create a New Delhi map using feature group, layer control, and marker configuration in Folium to visualize key attractions in New Delhi, India and around.

b) Create a Folium heat map with time animation.

9. **INTERACTIVE VISUALIZATION WITH BOKEH:**

a) Import necessary modules and load word population dataset using pandas. Extract the required data and create a plot using Bokeh figure method with labels and title.

b) Use grid plot to display the country plots next to each other and arrange the visualizations vertically.

c) Create line plots to compare the global mean population density with that of Japan.

d) Create models interface-based plot to display the lines and axes.

e) Create a basic visualization with stock price dataset. Include interactive visualization using widgets to dynamically change the stock that is displayed in graph.

10.   **DATA VISUALIZATION ON NEW YORK CITY DATABASE:**

a) Import necessary modules and load datasets "New York Population Records" and "New York Housing Unit Records". The first dataset contains information about the New York population and the second dataset contains information about housing units. Understand the structure of the dataset by looking at the features.

b) Perform data wrangling for median housing income, wage by gender for different occupation categories, wage distribution.

c) Create a plot containing multiple subplots that visualize information with regard to New York City wages.

- Visualize the median household income for the US, New York, New York City, and its districts.
- Visualize the average wage by gender for the given occupation categories for the population of New York City.
- Visualize the wage distribution for New York and New York City. Use the yearly wage intervals: 10k steps between 0 and 100k, 50k steps between 100k and 200k, and >200k.

d) Use a tree map to visualize the percentage for the given occupation subcategories and for the population of New York City.

11.   **INTERACTIVE VISUALIZATION OF STOCK PRICES USING BOKEH:**

a) Import necessary modules and load stock prices data. Understand the structure of the dataset by looking at the features.

b) Create a new column that holds the formatted short version of the date value and update the dataset.

c) Create an interactive visualization that displays a Candlestick Plot to handle stock price data.

d) Compare two stocks to each other by selecting them from dropdowns. Use Range Slider to restrict the displayed date range in the requested year.

e) Display the volume of the selected stock based on the selection of visualization either Candlestick or Line Plot.

12.   **DATA ANALYSIS ON AIRBNB DATA USING GEOPLOTLIB:**

a) Import necessary modules and load Airbnb data. Understand the structure of the dataset by looking at the features.

b) Create a simple dot map from the points to get a glance of the data.

c) Create a custom layer and plot each point on the map with a color that is defined by the currently selected attribute, either price or rating.

d) Display the hotspots for the most expensive and best-rated accommodation across New York.

RESOURCES

TEXT BOOKS:

1. Mario Dobler, Tim Grobmann, Data Visualization with Python, Packt Publishing, 2019.

2. Kalilur Rahman, Python Data Visualization Essentials Guide, bpb Publications, 2021.

REFERENCE BOOKS:

1. Abha Belorkar, Sharath Chandra Guntuku, Shubhangi Hora, Anshu Kumar, Interactive Data Visualization with Python, 2nd Edition, Packt Publishing, 2020.

2. Claus O.Wilke, Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, O'Reilly, 2019.

3. Danyel Fisher, Miriah Meyer, Making Data Visual: A Practical Guide to Using Visualization for Insight, O'Reilly, 2017.

SOFTWARE/TOOLS:

1. Python 3.9, Python Libraries – NumPy, Pandas, Matplotlib, Seaborn, Plotly, Folium, Bokeh.

2. IDLE/Jupyter Notebook/JupyterLab/Pycharm/Google Colab.

VIDEO LECTURES:

1. https://youtu.be/eFByJkA3ti4

2. https://youtu.be/JhK2qVi5dC4

3. https://www.youtube.com/watch?v=qdnM8Fpvdqc

4. https://www.youtube.com/watch?v=MUP2m46uw8I

5. https://www.youtube.com/watch?v=7kPqESo1vRw

6. https://www.youtube.com/watch?v=Nt84_TzRkbo

WEB RESOURCES:

1. https://plotly.com/python/

2. https://datavizcatalogue.com/

3. https://www.tableau.com/learn/articles/data-visualization

4. https://www.analyticsvidhya.com/blog/2021/10/interactive -plots-in-python-with-plotly-a- complete-guide/

5. https://www.digitalvidya.com/blog/python-visualization/

6. https://d3js.org/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202010	**BUSINESS INTELLIGENCE TOOLS**	3	-	3	-	4.5

Pre-Requisite	Data Visualization
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on business intelligence tools and concepts like foundations of BI, Decision Making, Data Modelling for BI Tools, ETL Basics and Optimizations, Business Reporting, and Business Performance Management, Moving BI Process to Product Environment.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on the foundations of Business Intelligence and decision making to improve operational efficiency.

CO2. Create Data Model exploring different possibilities using Power BI to provide Business intelligence solutions.

CO3. Connect to different data sources and extract data using ETL operations to handle queries and extract meaningful insights for efficient business operations.

CO4. Create Business reports and visualize using Power BI to provide useful insights about business and improve decision making.

CO5. Deploy Business Intelligence process in a product environment on Cloud.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FOUNDATIONS OF BUSINESS INTELLIGENCE   **(10 Periods)**
**   AND DECISION MAKING**

Foundations of Business Intelligence: What Is business intelligence?, BI Characteristics, Benefits of BI, BI Platform Components, BI Platform Location, BI Concepts, BI Approaches, BI Capabilities, Types of Business Intelligence (Strategic, Tactical, Operational).

Decision Making: Introduction and Definitions, Phases of the Decision-Making Process, The Intelligence Phase, The Design Phase, The Choice Phase, The Implementation Phase, Support for various phases, Data-Driven vs Intuition-Based Decision Making. Decision Support Systems: Capabilities, DSS Classifications, Components of Decision Support Systems.

Module 2: DATA MODELING FOR BI SOLUTIONS   **(08 Periods)**

Modeling steps- Business Model, Logical Model, Dimensional Model, Physical Model; Defining our Model-Sales Dimension, Status Table, Currency Dimension, Customer Dimension, Employee Dimension¸ Product Dimension, and Time Dimension; Exploring Data Modeling Possibilities, Data Modeling Tools: Preparing the ETL- Source Systems, Source Tables, Source Fields.

Module 3: ETL BASICS AND OPTIMIZATIONS   **(09 Periods)**

Details of the Solution, Open Source ETL Suites, Downloading and Installing Pentaho Data Integration. Understanding ETL Concepts- Repositories and Connections, Transformations, How to Organize a Set of Transformations in a Workflow, Create and Share a Connection, The Global Picture, The Product Parent Category Tables, The Customer and Customer Country Tables, The Employee and Employee Category and Employee Department Tables, The Fact Table, Creating the Time Dimension, Connecting All of It Up, Designing the Job Open Source Alternatives to PDI;ETL Optimizations, Error Handling and Logging in ETL Workflows.

Module 4: BUSINESS REPORTING, AND   **(10 Periods)**
**   PERFORMANCE MANAGEMENT**

Business Reporting: Business Reporting Definitions and Concepts, Data and Information Visualization, Different Types of Charts and Graphs, The Emergence of Data Visualization and Visual Analytics, BI Tools: Micro strategy Desktop-Tableau, Microsoft Power BI, Qlik Sense.

Performance Management: Performance Dashboards, Closed-Loop BPM Cycle, Performance Measurement, Key Performance Indicator, Balanced Scorecards, Six Sigma as a Performance Measurement System.

Module 5: MOVING BI PROCESS TO PRODUCT ENVIRONMENT   **(08 Periods)**

Multi environment Scenario-Deploying a Productive Environment, Adding Environments, Isolation of Environments, Multi environment Recommendations; Maintaining Your Environment, Security, Auditing, Moving BI Processes to the Cloud- Deciding our Cloud Provider, Choosing the Right Cloud Provider: Amazon Web Services (AWS), Microsoft Azure, Google Cloud, Vendor-Based Cloud Solutions, Data Governance and Compliance in BI (GDPR, HIPAA)

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. a) Install the Power BI desktop using the link specified below:
    b) https://powerbi.microsoft.com/en-us/downloads/
    c) Analyze the functionalities available in Power BI desktop to connect to the data, edit
    d) Query, create relationships, and build reports.

2. **Load and Transform:**
    a) Load the database tables and explore the different options available in Query editor.
    b) Perform data transformation tasks such as group by, transpose, changing data types, splitting columns and review the data model.
    c) Perform Loading of data from an Excel file.
    d) Perform loading multiple CSV files from a folder.

3. a) Create a static table, enter data and relate with other tables and queries in the model. Review the data model.
    b) Load data from web and display in Power BI reports.

4. **Data Model:**
    a) Combine the queries using the merge queries option in Query Editor. Use Merge Query option in Power BI to implement different types of SQL types such as Left outer Join, Right outer Join, Full outer join, Inner join.
    b) Combine queries using Append Queries to implement Union operation in SQL and review the data model.

5. **Data Analysis Expressions (DAX):**
    a) Create new columns and measures using the various DAX functions.
    b) Create the Date Dimension using DAX.
    c) Use the variables to simplify the calculations.

6. a) Apply Information functions and login functions in DAX.
    b) Create dynamic calculations using filter functions in DAX to work on Table and Relationship.

7. **Visualizations in Power BI:**
    Analyse the components of Report Development Interface and list of visualization in Power BI.

8. a) Create visualizations using different types of Bar chart such as horizontal, vertical and stacked to compare the values of unique categories.
    b) Apply Filters and slicers, both are used to limit the data in the visualizations

9. a) Create Line chart to display the trends of data over a period of time.
    b) Standardize the visual design of the report pages using report themes in Power BI

10. a) Create multi-page reports using visualization
    b) Display the total value of a measure using card.

11. a) Display which data category has the highest rank, that is, the largest value using ribbon chart.
    b) Visualize the relationship between 2 measures using scatter chart.
    c) Display the percentage of total using Donut and Piechatr.

12. **Q&A using Power BI:**
    Explore the data based on the available data set. Create questions in natural language. Use Power BI to provide suggestion on the question raised and to select best visualization to answer the question. Select bar chart to display the Information.

RESOURCES

TEXT BOOKS:

1. Albert Nogus, Juan Valladaraes, Business Intelligence Tools for Small Companies, Apress, Tenth Edition 2017.
2. Chandraish Sinha, Mastering Power BI, BpB Publications, 2022.

REFERENCE BOOKS:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, Business Intelligence and Analytics, Pearson, 10th Edition, 2014.
2. Hancoc ; Toren, Practical Business Intelligence with SQL Server 2005, Pearson,2022.

SOFTWARE/TOOLS:

1. Power BI Tool.

VIDEO LECTURES:

1. https://www.coursera.org/courses?query=power%20bi
2. https://nptel.ac.in/courses/110107092
3. https://www.udemy.com/topic/business-intelligence/
4. https://www.edx.org/learn/power-bi
5. https://www.ed2go.com/careers/information-technology/business-intelligence-analyst
6. https://www.udacity.com/blog/search/label/business-intelligence
7. https://mindmajix.com/search?searchString=business%20intelligence&type=course

WEB RESOURCES:

1. www.pentaho.com/
2. https://www.ibm.com/developerworks/library/os-weka2/
3. http://www.saedsayad.com/
4. http://www.cs.ccsu.edu/~markov/ccsu_courses/datamining-3.html
5. https://cognitiveclass.ai/
6. https://data-flair.training/blogs/business-intelligence/
7. https://www.tutorialspoint.com/power_bi/index.htm
8. https://www.educba.com/business-intelligence-tool/
9. https://chartio.com/learn/business-intelligence/10-business-intelligence-tools-to- visualize-and-analyze-your-data

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201007	**DATA MINING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on the concepts, principles, methods and applications of data mining with the focus on major data mining techniques such as Association pattern mining, Clustering, Classification and Outlier analysis. The course will also cover algorithms and methods related to data preprocessing, Frequent pattern mining, Clustering and Classification with relevant case studies.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on Data Mining and Data Preparation process to gather, combine and organize data to make informed decision.

CO2. Identify frequent patterns, associations using frequent Item set Mining algorithms for further analysis of data mining tasks and to support business decision-making process.

CO3. Select and Apply appropriate Clustering and Classification methods to solve real-life problems.

CO4. Analyze and Apply suitable Outlier detection methods in diverse domains such as Quality Control, Fault detection, Financial Fraud and Intrusion detection.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO DATA MINING AND DATA PREPARATION **(09 Periods)**

Introduction: The Data Mining Process, The Basic Data Types, The Major building blocks, Scalability Issues and the Streaming Scenario.

Data Preparation: Feature Extraction, Data Type Portability, Data Cleaning, Data Reduction and Transformation – Sampling, Feature Subset Selection, Dimensionality Reduction with Axis Rotation.

Module 2: ASSOCIATION PATTERN MINING **(09 Periods)**

The Frequent Pattern Mining Model, Association Rule Generation Framework, Frequent Item set Mining Algorithms, Alternative Models: Interesting Patterns, Meta-algorithms, Pattern Summarization, Pattern Querying.

Applications: Classification, Clustering, Outlier detection, Market Basket Analysis, Recommendations and Collaborative Filtering, Web log analysis.

Module 3: CLUSTER ANALYSIS **(09 Periods)**

Feature selection for Clustering, Representative based algorithm-k-Means algorithm; Hierarchical Clustering algorithm- Agglomerative Methods; Probabilistic model based algorithm-Relationship of EM to k-Means and other representative methods, Grid and Density based methods-DBSCAN, DENCLUE, CLIQUE; Cluster Validation, Clustering Categorical Data, Cluster Ensembles.

Applications: Applications to other Data Mining problems, Text Applications, Multimedia Applications, Social Network Analysis.

Module 4: DATA CLASSIFICATION **(09 Periods)**

Feature selection for Classification, Decision Trees, Rule based Classifiers, Probabilistic Classifier, Support Vector Machines, Instance based Learning**,** Classifier Evaluation, Ensemble Methods.

Module 5: OUTLIER ANALYSIS **(09 Periods)**

Extreme Value Analysis, Probabilistic Models, Clustering for Outlier detection, Distance based Outlier Detection, Density-Based Methods, Information-Theoretic Models, Outlier Validity, Outlier Detection with Categorical Data, High-Dimensional Outlier Detection, Outlier Ensembles.

Applications: Quality Control and Fault detection, Financial Fraud and Anomalous Events, Intrusion Detection Application.

Total Periods: 45

EXPERIENTIAL LEARNING

1. **Prediction of Adult Income based on Census Data available in kaggle:**
   Apply classification algorithm to predict the income level of an individual that exceeds 50K based on the census data available at the online repository. The dataset consists of variables such as age, type of work, working hours, sex and many more. Perform data analysis to understand the standard of living of the city, benefit of setting up the business or bank loan eligibility. Also, to understand the real estate preferences by average income of the people residing in the area, figure out the type of tourist places that people from other countries would like to travel.
2. **Product and Price Comparing tool**:
   With the increase in popularity of e-commerce portals, shopping websites are magnifying to a great extent to enable online shoppers to purchase anything with just one click and get it delivered at your doorstep. To purchase an item, people tend to spend quite a lot of time in searching a product and comparing it with other websites by themselves. Automate the task of comparing product and price of a product to help customer buy cheap and best deal available. Also, track the consumer demand and inform when the commodity price is lowest and notify consumers proactively.

3. **Comparative Study of Clustering Algorithms:**
   Implement clustering algorithms k-means , hierarchical clustering   and Expectation Maximization algorithm using python and compare based on the metrics :
   - number of clusters
   - size of dataset
   - performance of the algorithm
   - accuracy of the algorithm

RESOURCES

TEXT BOOKS:

1. Charu C.Aggarwal, Data Mining, The Text book, Springer, 2015.
2. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012.

REFERENCE BOOKS:

1. Alex Berson and Stephen J.Smith, —Data Warehousing, Data Mining & OLAP‖, Tata McGraw – Hill Edition, 35th Reprint 2016.
2. K.P. Soman, Shyam Diwakar and V. Ajay, — Insight into Data Mining Theory and Practice, Eastern Economy Edition, Prentice Hall of India, 2006.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105174
2. https://nptel.ac.in/courses/110107092
3. https://freevideolectures.com/course/4566/nptel-data-mining/9
4. https://www.youtube.com/channel/UCdaj0DjWHoy7hFLtZtjtZ7g
5. https://www.youtube.com/watch?v=pBAbMbgaBAk
6. https://www.youtube.com/watch?v=esmzYhuFnds&t=6s
7. https://www.youtube.com/watch?v=qg_M37WGKG8

WEB RESOURCES:

1. https://www.tutorialandexample.com/outlier-analysis-in-data-mining
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/data-mining1
3. https://www.researchgate.net/publication/49616224_Data_mining_techniques_and_appli cations
4. https://www.geeksforgeeks.org/data-mining/
5. https://www.tutorialspoint.com/data_mining/dm_pdf_version.htm
6. https://www.coursera.org/specializations/data-mining

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202003	**BIG DATA FRAMEWORKS**	3	-	3	-	4.5

Pre-Requisite   -
Anti- Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion and Hands-On- Experience on HDFS Concepts, Hadoop File System, Hadoop Operations, Develop a MapReduce Application, Yarn Architecture, Mesos Setup, Spark Standalone Architecture, Spark Execution Model, Spark Cache, Job Execution and Fault Tolerance.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate Knowledge on big data frameworks and Hadoop Distributed File System.

CO2. Develop data processing and analytics applications using Map Reduce Workflows and spark streaming

CO3. Build a spark cluster and manage resources dynamically using YARN or Mesos

CO4. Apply several techniques such as shuffling, partitioning, and caching mechanisms to improve the performance of Spark jobs

CO5. Explore various job scheduling methods and use recommended configurations to build a fault tolerant application.

CO6. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
CO6	-	-	-	-	3	3
Course Correlation Mapping	**3**	**2**	**3**	**-**	**3**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1:   INTRODUCTION TO HADOOP   **(09 Periods)**

Data, Data Storage and Analysis, Querying all your data, Beyond Batch, Comparison with Other Systems, The Design of HDFS, HDFS Concepts, The Command-Line Interface, Hadoop File Systems, The Java Interface, Data Flow, Parallel Copying with distcp.

Module 2:   HADOOP OPERATIONS AND DEVELOPING A MAP   **(11 Periods)**
                  REDUCE APPLICATION

Hadoop Operations: Cluster Specification, Cluster Setup and Installation, Hadoop Configuration, Security, Benchmarking a Hadoop Cluster.

MapReduce Application: The Configuration API, Setting up the Development Environment, Writing a Unit Test With MR Unit, Running Locally on Test Data, Running on a Cluster, Tuning a Job, MapReduce Workflows.

Module 3:   CLUSTER MANAGEMENT   **(08 Periods)**

Background, Spark Components-Driver, Workers and Executors, Configuration; Spark Standalone-Architecture, Single-Node Setup scenario, Multi Node Setup; YARN-Architecture, Dynamic Resource Allocation, Scenario; Mesos-Setup, Architecture, Dynamic Resource Allocation, Basic Setup Scenario.

Module 4:   PERFORMANCE TUNING   **(08 Periods)**

Spark Execution Model, Partitioning, Shuffling Data – Shuffling and Data Partitioning, Operators and Shuffling; Serialization, Spark Cache, Memory Management, Shared Variables, Broadcast Variable, Accumulators; Data Locality.

Module 5:   JOB EXECUTION AND FAULT TOLERANCE   **(09 Periods)**

Job Execution: Life Cycle of a Spark Job-Spark Master, Spark Driver, Spark Worker, Job Life Cycle; Job Scheduling- Scheduling Within an Application, Scheduling with External Utilities.

Fault Tolerance: Fault Tolerance-Internal and External Fault Tolerance, Service Level

Agreements, Resilient Distributed Datasets, Batch versus Streaming, Testing Strategies, Recommend Configurations.

                                                          Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Build and set up Hadoop framework to run in single-node and multi-node setup.

2. Write and implement a text file processing program using MapReduce model.

3. Implement a MapReduce program suing pySpark for identifying potential customers.

4. Consider the dataset (attached Ex.4.txt) and write a mapper and reducer program for finding the cost of the item that is most expensive, for each location.

   Link to download dataset:

   https://drive.google.com/file/d/109Lp4_BgQPilDNDduO7638YCDCd7MGY2/view?usp=sharing

5. Install Apache Spark and configure it to run on a single machine. Create workers on different machines and configure a multi-node setup.

6. Install Mesos and configure Spark to run with Mesos and perform dynamic resource allocation.

7. Using pySpark in an interactive mode, perform the following tasks:
   i. load data from a CSV file (CRAN package download logs http://cran-logs.rstudio.com/)

   ii. display the first n rows of the data

   iii. transform each row of data into an array

   iv. use count by key method to find the number of downloads for a package

8. Implement the following Spark Data frame and SQL operations;
   i. Create a spark data frame from python list and RDD

   ii. Change the data frame properties

   iii. filter and aggregate the data
   iv. transform a data frame column v. build a view with the Spark Data Frame

9. Write a pySpark program to count the number of occurrences of words in a text and use explicit caching.

10. Analyze the impact of number of worker cores on a parallelized operation and use Caching to reduce computation time.

11. Perform image classification using Spark Deep Learning.

12. Build a linear regression model using Apache spark's spark.ml for stock price prediction.

RESOURCES

TEXT BOOKS:

1. Tom White, Hadoop: The Definitive Guide, O'Reilly, 4th Edition,2015.

2. Llya Ganelin, Ema Or. hian, Kai Sasaki, Brennon York, Spark: Big Data Cluster Computing in Production,1st Edition,2016.

REFERENCE BOOKS:

1. Nick Pentreath,Machine Learning with Spark,PacktPublishing,2015.

2. Mohammed Guller, Big Data Analytics with Spark, Apress, 2015.

3. Donald Miner, Adam Shook, Map Reduce Design Pattern, O'Reilly, 2012

4. Frank J. Ohlhorst, Big Data Analytics: Turning Big Data into Big Money, Wiley Publication, December, 2012.

5. Kevin Roebuck, Big Data: High-Impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Tebbo Publisher, 2011.

6. Alex Holmes, Hadoop in Practice, Manning Publications Publisher, 2012.

SOFTWARE/TOOLS:

1. APACHE HADOOP, APACHE SPARK, JDK

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc20_cs92/preview

2. https://archive.nptel.ac.in/courses/106/104/106104189/

3. https://www.youtube.com/watch?v=g7Qpnmi0Q-s

4. https://www.youtube.com/watch?v=cYL42BBL3Fo

5. https://www.youtube.com/watch?v=x-PCNX4prLA

6. https://www.youtube.com/watch?v=QaoJNXW6SQo

7. https://www.youtube.com/watch?v=mafw2-CVYnA

WEB RESOURCES:

1. https://github.com/rshah204/MapReduce -Implementation-in-Python/blob/master/MapReduce. ipynb

2. https://github.com/rshah204/MapReduce-Implementation-in-PySpark

3. https://github.com/XD-DENG/Spark-practice#load-data

4. https://github.com/XD-DENG/Spark-practice/blob/master/Spark%20DataFrames%20%26%20SQL%20 -%20Basics.ipynb

5. https://github.com/tirthajyoti/Spark-with-Python/blob/master/Word_Count.ipynb

6. https://github.com/tirthajyoti/Spark-with- Python/blob/master/Spark Context Workers Lazy Evaluations. ipynb

7. https://medium.com/linagora -engineering/making-image-classification-simple-with- spark-deep-learning-f654a8b876b8

8. https://drive.google.com/file/d/109Lp4_BgQPilDNDduO7638YCDCd7MGY2/view?usp= sharing

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI202008	**DATA ENGINEERING**	3	-	3	-	4.5

Pre-Requisite	Big Data Frameworks
Anti- Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Modern data Engineering tools, data pipelines, data collection stage, data curation stage, data aggregation stage, data engineering challenges and effective deployment strategies. The course focuses on building databases and processing systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze Modern data engineering and tools, storage and compute data lakes to store and retrieve data efficiently on Cloud.

CO2. Create and run data pipelines for organizing large volumes of data on Cloud.

CO3. Perform data collection, data curation, data aggregation and demonstrate their use in storage systems on Cloud.

CO4. Deploy and monitor pipelines in production on Cloud and solve data engineering challenges.

CO5. Work independently to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	-	-	-	-	3	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**3**

Correlation Levels: **3: High;**   **2: Medium; 1: Low**

COURSE CONTENT

Module 1:   MODERN DATA ENGINEERING AND TOOLS   (10 Periods)

Data Engineering and Analytics: Core capabilities of storage and compute resources, Availability of varying datasets, Computing Adoption of cloud computing, Data storytelling, The monetary power of data.

Discovering Storage and Compute Data Lakes: Exploring the benefits of data lakes, Adhering to compliance frameworks, Segregating storage and compute in a data lake, Discovering data lake Architectures, Data Mesh vs Data Lakehouse, The CAP theorem.

Module 2:   DATA PIPELINES AND DATA COLLECTION STAGE   (08 Periods)

Understanding Data Pipelines: Components of a data pipeline, Process of creating a data pipeline, Running a data pipeline

Data Collection Stage: Architecting the Electroniz data lake, Understanding the bronze layer, Configuring data sources, Configuring data destinations, Building the ingestion pipelines.

Module 3:   DATA CURATION STAGE   (09 Periods)

Understanding Delta Lake: Understanding Delta Lake, Creating a Delta Lake table, Changing data in an existing Delta Lake table, Performing time travel, Performing upserts of data, Understanding isolation levels, Understanding concurrency control. ACID Transactions in Data Lakes

Data Curation Stage: The need for curating raw data, The process of curating raw data, Developing a data curation pipeline, Running the pipeline for the silver layer, Verifying curated data in the silver layer.

Module 4:   DATA AGGREGATION STAGE   (09 Periods)

The need to aggregate data, The process of aggregating data, Developing a data aggregation pipeline, Running the aggregation pipeline, Understanding data consumption, Verifying aggregated data in the gold layer. Data Modeling Techniques, Batch vs Incremental Aggregation

**Module 5:   DATA ENGINEERING CHALLENGES AND   (09 Periods)
                    EFFECTIVE DEPLOYMENT STRATEGIES**

Deploying and Monitoring Pipelines in Production: The deployment strategy, Developing the master pipeline, Testing the master pipeline, Scheduling the master pipeline, Monitoring pipelines.

Solving Data Engineering Challenges: Schema evolution, Sharing data, Data governance.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Use an Azure Data bricks workspace and perform Structured Streaming with batch jobs by using Delta Lake. You need to complete the exercise within a Data bricks Notebook. To begin, you need to have access to an Azure Data bricks workspace.

2. Demonstrates the experience of working with Apache Spark in Azure Synapse Analytics. Learn how to use libraries like Hyperspace and MSS park Util to optimize the experience of working with Data Lake storage accounts from Spark notebooks.

3. a) Query Parquet data with server less SQL pools
   b) Create external tables for Parquet and CSV files
   c) Create views with server less SQL pools
   d) Secure access to data in a data lake when using server less SQL pools
   e) Configure data lake security using Role-Based Access Control (RBAC) and Access Control Lists (ACLs)

4. a) Use some Data bricks notebooks to learn fundamentals concepts and techniques for working with Data Frames.
   b) Build the Azure Data bricks Data Frames concepts learned in the previous lab above by exploring some advanced methods data engineers can use to read, write, and transform data using Data Frames.

5. a) Perform Data Exploration in Synapse Studio
   b) Ingest data with Spark notebooks in Azure Synapse Analytics
   c) Transform data with Data Frames in Spark pools in Azure Synapse Analytics
   d) Integrate SQL and Spark pools in Azure Synapse Analytics

6. a) Perform petabyte-scale ingestion with Azure Synapse Pipelines
   b) Import data with Poly Base and COPY using T-SQL
   c) Use data loading best practices in Azure Synapse Analytics

7. a) Execute code-free transformations at scale with Azure Synapse Pipelines
   b) Create data pipeline to import poorly formatted CSV files
   c) Create Mapping Data Flows

8. Create linked services, and orchestrate data movement and transformation in Azure Synapse Pipelines.

9. a) Secure Azure Synapse Analytics supporting infrastructure
   b) Secure the Azure Synapse Analytics workspace and managed services
   c) Secure Azure Synapse Analytics workspace data

10. a) Configure Azure Synapse Link with Azure Cosmos DB
    b) Query Azure Cosmos DB with Apache Spark for Synapse Analytics
    c) Query Azure Cosmos DB with server less SQL pool for Azure Synapse Analytics

11. a) Use Stream Analytics to process real-time data from Event Hubs
    b) Use Stream Analytics windowing functions to build aggregates and output to Synapse Analytics
    c) Scale the Azure Stream Analytics job to increase throughput through partitioning
    d) Repartition the stream input to optimize parallelization

12. a) Learn the key features and uses of Structured Streaming
    b) Stream data from a file and write it out to a distributed file system
    c) Use sliding windows to aggregate over chunks of data rather than all data
    d) Apply watermarking to remove stale data
    e) Connect to Event Hubs read and write streams

RESOURCES

TEXT BOOKS:

1. Manoj Kukreja, Danil Zburivsky, Data Engineering with Apache Spark, Delta Lake, and Lakehouse: Create Scalable Pipelines that Ingest, Curate, and Aggregate Complex Data in a Timely and Secure Way, Packt Publishing, 2021.
2. Crickard, Paul, Data Engineering with Python: Work with Massive Datasets to Design Data Models and Automate Data Pipelines Using Python, Packt Publishing, 2020.

REFERENCE BOOKS:

1. Eagar, G, Data Engineering with AWS: Learn how to Design and Build Cloud-based Data Transformation Pipelines Using AWS, Packt Publishing, 2021.

2. Housley, Matt, and Reis, Joe, Fundamentals of Data Engineering: Plan and Build Robust Data Systems, O'Reilly Media, Incorporated, 2022.

SOFTWARE/TOOLS:

1. Microsoft Azure, Windows PowerShell
2. Apache Spark, Delta Lake, JSON

VIDEO LECTURES:

1. http://nptel.ac.in/courses/ 106104189
2. http://nptel.ac.in/courses/ 106106179
3. https://www.youtube.com/watch?v=TScSdIJ-_Oo
4. https://www.youtube.com/watch?v=IPkQpBdde5Y&t=1s
5. https://www.youtube.com/watch?time_continue=22&v=cbobqI3ZGuA

WEB RESOURCES:

1. https://github.com/MicrosoftLearning/DP-203-Data-Engineer/tree/master/Instructions/Labs
2. https://docs.microsoft.com/en-us/azure/synapse-analytics/spark/apache-spark- overview
3. https://github.com/PacktPublishing/Data -Engineering-with-Apache-Spark-Delta- Lake-and-Lakehouse
4. https://github.com/PacktPublishing/Data-Engineering-with-Python
5. https://blog.claydesk.com/azure-data-lake-tutorial/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201004	**PREDICTIVE ANALYTICS**	3	-	-	-	3

Pre-Requisite	Machine Learning
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides a detailed discussion on the concepts of predictive analytics and modelling with few case studies such as Recovering Lapsed Donors Fraud Detection and help desk operations. This course also focuses on the importance of Data Understanding, Data Preparation, Association Rules, Descriptive Modelling, Model assessment and deployment in decision making.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on the basics of Predictive Analytics and Modelling to predict future outcomes.

CO2. Analyse the insights of data using data visualization and preparation methods for improved decision making.

CO3. Identify patterns in categorical data and build descriptive models using Association rules, Principal Component Analysis and Clustering algorithms.

CO4. Assess and Deploy Predictive Models using batch approach, Regression and Ensemble Models to improve corporate operations.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1:   INTRODUCTION   **(09 Periods)**

Overview of Predictive Analytics: Analytics, Predictive Analytics, Business Intelligence, Predictive Analytics vs. Statistics, Predictive Analytics vs. Data Mining, Challenges in Using Predictive Analytics, Educational Background. Setting up the Problem: Predictive Analytics Processing Steps, Defining Data for Predictive Modelling, Defining the Target Variable, Defining Measures of Success for Predictive Models, Doing Predictive Modelling Out of Order, and Case Study: Recovering Lapsed Donors and Fraud Detection. Real-world Applications of Predictive Analytics.

Module 2:   DATA UNDERSTANDING   **(08 Periods)**

What the Data Looks Like, Single Variable Summaries, Data Visualization in One Dimension, Histograms, Multiple Variable Summaries, Data Visualization, Two or Higher Dimensions, The Value of Statistical Significance, Pulling It All Together into a Data Audit. Correlation and Covariance Analysis - Identifying Data Leakage and Data Drift.

Module 3:   DATA PREPARATION   **(08 Periods)**

Variable Cleaning: Incorrect Values, Consistency in Data Formats, Outliers, Multidimensional Outliers, Missing Values, Fixing Missing Data. Feature Creation: Simple Variable Transformations, Fixing Skew, Binning Continuous Variables, Numeric Variable Scaling, Nominal Variable Transformation, Ordinal Variable Transformations, Date and Time Variable Features, ZIP Code Features, Multidimensional Features, Variable Selection Prior to Modelling, Sampling.

Module 4:   ASSOCIATION RULES AND DESCRIPTIVE MODELING   **(10 periods)**

Item sets and Association Rules: Terminology, Condition, Left-Hand-Side, Antecedent, Right-Hand-Side, Consequent, Output, Conclusion, Rule (Item Set), Support, Antecedent Support, Confidence, Accuracy, Lift. Parameter Settings, How the Data Is Organized, Measures of Interesting Rules, Deploying Association Rules, Problems with Association Rules, Building Classification Rules from Association Rules.

Descriptive Modelling: Data Preparation Issues with Descriptive Modelling, Principal Component Analysis, Clustering Algorithms.

Module 5:   PREDICTIVE MODELING   **(10 Periods)**

Predictive Modelling and Assessing Predictive Models: Batch Approach to Model Assessment, Assessing Regression Models. Model Ensembles: Motivation for Ensembles, Bagging, Boosting, Improvements to Bagging and Boosting, Model Ensembles and Occam's razor, Interpreting Model Ensembles. Model Deployment, Help Desk Case Study. Model Interpretation Techniques: SHAP, LIME - Hyperparameter Tuning: Grid Search, Random Search, Bayesian Optimization - Model Monitoring & Performance Tracking.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. You are a data analyst at a non-profit organization. The management wants to re-engage donors who have stopped donating. Explain how you would define the problem using predictive analytics principles. Discuss how you would define the target variable, choose success measures, and differentiate this task from traditional statistics or business intelligence.

2. Imagine you are auditing a dataset for an online retail store. The dataset contains customer demographics and purchase histories. Describe the steps you would take to explore the data both statistically and visually. How would you detect potential data leakage or drift that could affect your future model performance?

3. You are working with a dataset containing salary details, job titles, and years of experience. Discuss how you would handle missing values, identify and treat outliers, and create meaningful features. What are the key considerations when transforming and selecting variables before modeling?

4. A retail chain wants to understand buying patterns from their transaction logs. Describe how you would theoretically apply association rule mining to uncover these patterns. Also explain how clustering or PCA could help in segmenting customers for targeted marketing.

5. You are building a predictive model to forecast support ticket resolution times for a help desk. Describe the types of models you would use, how you'd evaluate them, and what techniques you would use for improving and interpreting model performance (e.g., SHAP, hyper parameter tuning).

RESOURCES

TEXT BOOKS:

1. Dean Abbott - Applied Predictive Analytics_ Principles and Techniques for the Professional Data Analyst-Wiley, 2014.

REFERENCE BOOKS:

1. Siegel, Eric, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2016.
2. Theobald, Oliver, Data Analytics for Absolute Beginners Cengage Learning, 2nd Edition, 2019.
3. Bari, A., Chaouchi, M., Jung, T. Analytics for Dummies, 2nd Edition, 2016.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_mg86
2. http://www.nitttrc.edu.in/nptel/courses/video/110104086/L08.html
3. https://nptel.ac.in/courses/110104086
4. https://onlinecourses.swayam2.ac.in/imb20_mg19
5. https://nptel.ac.in/courses/110105089

WEB RESOURCES:

1. https://www.futurelearn.com/courses/predictive-analytics
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/predictive- modeling-and-analytics-regression
3. https://ecm.elearningcurve.com/Fundamentals_of_Predictive_Analytics_Class_p
4. https://www.edx.org/learn/predictive-analytics
5. https://www.kaggle.com/code/aks2411/auto-mpg-prediction/log
6. https://www.ibm.com/in-en/analytics/predictive-analytics

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201008	**STREAM PROCESSING AND ANALYTICS**	3	-	-	-	3

Pre-Requisite	Big Data Frameworks
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course covers the fundamental concepts of stream processing the general blueprints of architectures that implements streaming with spark. This course also focuses on structured streaming, it's programming model and in similar organization spark streaming, creation of streaming applications, monitoring and performance tuning.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on the fundamental concepts of stream processing model and architectures to enable efficient data streaming.

CO2. Create custom sinks to write data to systems not supported by the default implementations.

CO3. Process data in a scalable and resource constrained way using time-based stream processing.

CO4. Apply D Streams, execution model in combination with a functional programming model to develop and execute stream applications.

CO5. Investigate several performance tuning strategies and apply an optimal method to tune the overall performance of a job.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	-	-
CO2	3	2	3	-	-	-
CO3	2	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	3	2	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1:   STREAM PROCESSING MODEL AND ARCHITECTURES   (09 Periods)

Stream Processing Model: Introducing Stream Processing-What is Stream processing? Examples of Stream processing, Scaling Up data processing, Distributed Stream processing, Apache Spark; Sources and Sinks, Transformations and Aggregations, Window Aggregations, Stateless and Stateful Processing, Stateful streams, Example: Local stateful computation in Scala, The effect of time.

Streaming Architectures: Components of a data platform, Architectural models, Use of batch processing component in Streaming application, Lambda Architecture, Kappa Architecture, Streaming Algorithms, Batch Algorithms. Event-Driven Architecture (EDA).

Module 2:   STRUCTURED STREAMING   (09 Periods)

Steps with Structured Streaming, Batch Analytics, Streaming, Analytics, Initializing Spark, Sources: Acquiring Streaming Data, Transforming Streaming Data, Sinks: Output the Resulting Data, Structured Streaming in Action, Structured Streaming sources-Understanding sources, File Source, Kafka Source, Socket Source.

Module 3:   SINKS AND EVENT TIME-BASED STREAM PROCESSING   (09 Periods)

Structured Streaming Sinks: Understanding Sinks, Sink API, File Sink, Kafka Sink, Memory Sink, Console Sink, For each Sink.

Event Time-Based Stream Processing: Understanding Event Time in Structured Streaming, Time-Based Window Aggregations; Monitoring Structured Streaming Applications, Continuous Processing, Event Time vs Processing Time vs Ingestion Time.

Module 4:   SPARK STREAMING   (09 Periods)

Need for Spark Streaming, The D Stream Abstraction, The Structure of a Spark Streaming Application, Simple Streaming Application using D Stream, Limitations of D Streams vs Structured Streaming, The Spark Streaming Programming Model, The Spark Streaming Execution Model- The Bulk-Synchronous Architecture, The Receiver Model; Spark Streaming Sources, Spark Streaming Sinks, Time-Based Stream Processing, Working with Spark SQL-Accessing Spark SQL Functions from Spark Streaming, Dealing with Data at Rest, Join Optimizations, Updating Reference Datasets in a Streaming Application.

Module 5:   MONITORING AND PERFORMANCE TUNING   (09 Periods)

Monitoring Spark Streaming: The Streaming UI, Understanding Job Performance Using the Streaming UI, The Monitoring REST API, The Metrics Subsystem, The Internal Event Bus, Interacting with the Event Bus, Security in Streaming Systems.

Performance Tuning: The Performance Balance of Spark Streaming, External Factors that Influence the Job's Performance, How to Improve Performance? Tweaking the Batch Interval, Backpressure, Dynamic Throttling, Caching, Speculative Execution, Streaming Classification with Naive Bayes.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Build a simple event-driven streaming pipeline using Apache Spark that reads from a simulated real-time source (like socket or Kafka), performs a basic stateful aggregation (e.g., running average), and demonstrates the difference between stateless vs stateful stream processing. Visualize how the system handles time-based events using Scala or Python.
2. Implement a Structured Streaming application in PySpark that reads real-time data from a Kafka topic, performs a transformation (e.g., word count or sentiment score), and writes the output to a console or file sink. Track how Spark handles mini-batches internally.
3. Using a dataset with timestamps, develop a Structured Streaming application that compares event time vs ingestion time using time-based window aggregations. Use different sinks (e.g., Kafka, memory, file) to store results and interpret how each affects system performance and latency.
4. Create a Spark Streaming application using D Streams to process simulated IoT data in real time. Compare its structure and performance with an equivalent Structured Streaming version. Highlight differences in execution model, batch handling, and joining with static datasets using Spark SQL.
5. Deploy a sample Spark Structured Streaming job and monitor its behavior using the Spark Streaming UI and REST API. Introduce intentional performance bottlenecks (e.g., high data rate or insufficient batch interval) and apply performance tuning techniques like backpressure, caching, or speculative execution. Measure and report the improvements.

RESOURCES

TEXT BOOKS:

1. Gerard Maas, François Garillot, Stream Processing with Apache Spark, O'Reilly, 2019.
2. Tomasz Drabas, Denny Lee, Learning PySpark, Packt Publishing, 2017.

REFERENCE BOOKS:

1. Anindita Basak, Krishna Venkataraman, Ryan Murphy, Manpreet Singh, Stream Analytics with Microsoft Azure: Real -time data processing for quick insights using Azure Stream Analytics,Packt Publishing,2017.
2. Henrique, Andrade, Buğra Gedik, Deepak S. Turaga, Fundamentals of Stream Processing: Application Design, Systems, and Analytics, Cambridge University Press, 2014.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=Rw9OCYhxzwI
2. https://www.youtube.com/watch?v=vFshGQ2ndeg&t=15s
3. https://www.youtube.com/watch?v=A3Mvy8WMk04&t=6s
4. https://www.youtube.com/watch?v=9B7-z0HW058&list=PL9sbKmQTkW076JzfKvnUpGoKVocjkl1S5&index=6
5. https://www.youtube.com/watch?v=Kb08RTmjnkw&t=12s

WEB RESOURCES:

1. https://github.com/stream-processing-with-spark
2. https://github.com/spark-notebook/spark-notebook
3. https://spark-notebook.io/
4. https://spark.apache.org/docs/latest/streaming-programming-guide.html
5. https://spark.apache.org/docs/3.2.0/api/java/org/apache/spark/mllib/classification/NaiveBayes.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201701	**BUSINESS ANALYTICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course emphasizes on the basic concepts of Business Analytics. It covers the basic excel skills, Excel look up functions for database queries in business analytics. By the end of this course students will acquire basic knowledge to implement statistical methods for performing descriptive, predictive and prescriptive analytics.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic concepts and models of Business Analytics

CO2. Select Suitable basic excel function to perform analytics on spread sheets.

CO3. Apply different statistical techniques and distributions for modeling the data

CO4. Develop user-friendly Excel applications by using statistical models for effectiveness decision making.

CO5. Analyze the performance of different optimization models used in prescriptive analytics on Binary and Categorical data.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	-	-	-
CO2	2	3	-	-	-	-
CO3	2	2	-	-	3	-
CO4	1	1	-	-	-	-
CO5	-	-	-	-	-	-
Course Correlation Mapping	**2**	**2**	**-**	**-**	**3**	**-**

Correlation Levels:　　　**3: High;**　　**2: Medium;**　　**1: Low**

COURSE CONTENT

Module 1:   FOUNDATIONS OF BUSINESS ANALYTICS   (09 Periods)

Introduction, What is Business Analytics, Evolution of Business Analytics, Scope of Business Analytics, Data for Business Analytics, Applications of Business Analytics, Models in Business Analytics, Problem Solving with Analytics.

Module 2:   ANALYTICS ON SPREADSHEETS   (09 Periods)

Basic Excel Skills, Excel Functions, Using Excel Lookup Functions for Database Queries, Spreadsheet Add-Ins for Business Analytics.
Visualizing and Exploring Data: Data Visualization, Creating Charts In Microsoft Excel, Other Excel Data Visualization, Statistical Methods For Summarizing Data, Exploring Data Using Pivot tables.

Module 3:   DATA MODELING   (09 Periods)

Basic concepts of Probability, Random Variables and Probability Distributions, Continuous Probability Distributions.
Statistical Sampling, Estimation population parameters, Sampling Error, Sampling Distributions, Hypothesis Testing, ANOVA, Chi Square Test.

Module 4:   PREDICTIVE ANALYTICS   (09 Periods)

Trend lines And Regression Analysis, Modelling Relationships And Trends In Data, Simple Linear Regression, Multiple Linear Regression, Building Good Regression Models,
Strategies for predictive decision modelling implementing models on spreadsheets, spreadsheet applications in business analytics, developing user-friendly excel applications, analysing uncertainty and model assumptions, model analysis using analytic solver platform

Module 5:   PRESCRIPTIVE ANALYTICS   (09 Periods)

Linear Models: Building Linear Models, Implementing Linear Optimization Models On Spreadsheets, Graphical Interpretation Of Linear Optimization, Linear Optimization Models for prediction and Insight.
Integer Models: Solving models with Integer Variables, Integer Optimization Models with Binary Numbers
Decision Analysis: Formulating Decision Problems, Decision Strategies Without Outcome Probabilities, Decision Trees With Outcome Probabilities, Decision Trees.

Total Periods: 45

EXPERIENTIAL LEARNING

1. **Diabetic Prediction:**
   The National Institute of Diabetes and Digestive and Kidney Diseases has a created a dataset. The objective of the dataset is to diagnostically predict whether or not a patient has diabetes, based on certain diagnostic measurements included in the dataset. Several constraints were placed on the selection of these instances from a larger database. In particular, all patients here are females at least 21 years old of Pima Indian heritage. The datasets consists of several medical predictor variables and one target variable, Outcome. Predictor variables includes the number of pregnancies the patient has had, their BMI, insulin level, age, and so on. Build a machine learning model to accurately predict whether or not the patients in the dataset have diabetes or not?

2. Solve the house price prediction problem using **Linear regression analysis** method. Optimize the parameters of the regression function using gradient descent method.

3. Visualize the decision tree built for solving Heart disease prediction problem and measure the impurity of nodes created via **Decision Tree Analysis**.
   Dataset:https://www.kaggle.com/arviinndn/heart-disease-prediction-uci dataset/data

4. The data set baby boom (Using R) contains data on the births of 44 children in a one-day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed?

5. Visualize the **Distribution of data** with different feature scaling methods on online news popularity dataset for article word count.
   Dataset:https://www.kaggle.com/datasets/deepakshende/onlinenewspopularity

6. **Human Activity Recognition System:**
   The human activity recognition system is a classifier model that can identify human fitness activities. To develop this system, you have to use a smart phone dataset, which contains the fitness activity of 30 people which is captured through smart phones. This system will help you to understand the solving procedure of the **Multi-classification problem**.

RESOURCES

TEXT BOOKS:

1. James Evans, Business Analytics, Pearson Education, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Marc J. Schniederjans, Business Analytics, Pearson Education,2015

2. Camm, Cochran, Essentials of Business Analytics, Cenage learning, 2015

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105089

2. https://archive.nptel.ac.in/courses/110/107/110107092/

3. https://nptel.ac.in/courses/110106050

WEB RESOURCES:

1. https://www.proschoolonline.com/certification-business-analytics-course/what-is-ba

2. https://michael.hahsler.net/SMU/EMIS3309/slides/Evans_Analytics2e_ppt_01.pdf

3. https://www.guru99.com/business-analyst-tutorial-course.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201702	**ETHICS FOR AI**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Recognize the fundamental ideas and standards of AI ethics. Recognizing fairness and prejudice in artificial intelligence. Obstacles to obtaining explain ability and openness. Frameworks based on ethics and the law that designate accountability. Privacy and security concerns related to AI ethics. Ethics in AI in the future.

COURSE OUTCOMES: At the end of the course, student will be able to:

CO1. Understand the basic concepts of AI Ethics and ethical principles.

CO2. Understanding the concept of bias and fairness in AI.

CO3. Challenges in achieving the transparency and explain ability.

CO4. Legal and ethical frameworks for assigning responsibility.

CO5. Security and privacy issues of AI Ethics. Future of AI ethics.

CO-PO Mapping Table

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	-	-	-	-
CO4	2	3	3	-	-	-
CO5	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

Correlation Levels: **3: High;** **2: Medium;** **1: Low**

COURSE CONTENT

MODULE 1:   INTRODUCTION TO AI ETHICS   **(09 Periods)**

Overview of ethical issues in AI. Historical context and key concepts. Importance of ethical considerations in AI development and deployment.
Ethical Principles and Frameworks:
Utilitarianism, deontology, virtue ethics, and other ethical theories. Ethical principles for AI, such as fairness, transparency, accountability, and privacy.

MODULE 2:   BIAS AND FAIRNESS IN AI   **(09 Periods)**

Understanding bias in AI systems. Types of bias (e.g., algorithmic bias, dataset bias). Approaches to detecting and mitigating bias. Fairness metrics and fairness-aware machine learning algorithms.

MODULE 3:   TRANSPARENCY AND EXPLAINABILITY   **(09 Periods)**

Importance of transparency and explain ability in AI. Techniques for explaining AI decisions. Challenges and trade-offs in achieving transparency and explain ability. Regulatory requirements and guidelines for transparent AI systems.

MODULE 4:   ACCOUNTABILITY AND RESPONISIBILITY   **(09 Periods)**

Holding AI developers, users, and organizations accountable for AI systems' actions. Legal and ethical frameworks for assigning responsibility. Challenges in attributing responsibility in complex AI systems

MODULE 5:   PRIVACY AND DATA PROTECTION   **(09 Periods)**

Privacy issues in AI, including data collection, storage, and sharing. Privacy-preserving AI techniques. Regulatory frameworks (e.g., GDPR) and ethical guidelines for data protection in AI. Ethical considerations in emerging AI technologies.

Total Periods: 45

EXPERENTIAL LEARNING

Case -1: Emergence of Bias and Fairness Interventions

For the problem of Loan Approval and Hiring by AI, specify the steps and practices to the entry of bias and fairness improvement interventions.

Case-2: AI governance with critical thinking, negotiation skills, and a multi-stakeholder perspective
Undertake the study from ethical perspective for the problem of Public response system, Policy making and Contract negotiation.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Müller, Vincent C., Ethics of Artificial Intelligence and Robotics. The Stanford Encyclopedia of Philosophy, 2021.

2. Meredith Broussard, Artificial Unintelligence: How Computers Misunderstand the World, Cambridge, MA: MIT Press, 2018.

REFERENCE BOOKS:

1. Brett Frischmann and Evan Selinger, Re-Engineering Humanity, Cambridge University Press, Cambridge, 2018.

2. Cathy O'Neil, Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy, Crown Publishers, 2016.

3. Shoshana Zub off, The Age of Surveillance Capitalism, Financial Times, 2020.

VIDEO LECTURES:

1. https://rainermuehlhoff.de/en/EoAI2025/

2. https://www.youtube.com/watch?v=qpp1G0iEL_c

3. https://rainermuehlhoff.de/en/EoAI2025/

WEB RESOURCES:

1. https://www.ibm.com/topics/ai-ethics

2. https://www.coursera.org/articles/ai-ethics

3. https://ai.google/responsibility/principles/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CM201701	**COST MANAGEMENT OF ENGINEERING PROJECTS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course will provide an understanding of the cost tools and techniques that can be used throughout a project's design and development. The students will be exposed to the methods, processes, and tools needed to conduct economic analysis, estimation of Project.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the costing concepts and their role in decision-making.

CO2. Understand the project management concepts and their various aspects in selection.

CO3. Interpret costing concepts with project execution.

CO4. Knowledge of costing techniques in the service sector and various budgetary control techniques.

CO5. Become familiar with quantitative techniques in cost management.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	-	-	2
CO2	-	-	-	-	-	2
CO3	-	-	-	-	-	2
CO4	-	-	-	-	-	2
CO5	-	-	-	-	-	2
Course Correlation Level	-	-	-	-	-	**2**

Correlation Levels: **3: High;** **2: Medium;** **1: Low**

COURSE CONTENT

Module 1:   INTRODUCTION TO COSTING CONCEPTS   (05 Periods)

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost, and Opportunity cost; Creation of a Database for operational control.

Module 2:   INTRODUCTION TO PROJECT MANAGEMENT   (10 Periods)

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre-project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

Module 3:   PROJECT EXECUTION AND COSTING CONCEPTS   (10 Periods)

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

Module 4:   COSTING OF SERVICE SECTOR AND BUDGETARY   (10 Periods)
                CONTROL

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets

Module 5:   QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT   (10 Periods)

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare a mini-project report regarding cost control techniques in manufacturing units.
2. Prepare a report on real-life engineering project case studies, especially those that faced cost overruns or successfully managed costs
3. Conduct hands-on budgeting exercises where participants are given a project scope, and they have to create detailed budgets.

RESOURCES

TEXT BOOKS:

1.   John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561

2.   Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCE BOOKS:

1.   Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.

2.   Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.

3.   Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

4.   Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

VIDEO LECTURES:

1.   https://www.youtube.com/watch?v=rck3MnC7OXA

2.   https://www.youtube.com/watch?v=QWD1LMzStI4

WEB RESOURCES:

1.   https://www.superfastcpa.com/what-are-cost-concepts-in-decision-making

2.   https://www.indeed.com/career-advice/career-development/project-cost-controls

3.   https://www.geeksforgeeks.org/difference-between-pert-and-cpm/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CE201701	**DISASTER MANAGEMENT**	3	-	-	-	3

Pre-Requisite   -

Anti-Requisite   -

Co-Requisite   -

COURSE DESCRIPTION: This course provides a detailed discussion on disaster prone areas in India, repercussions of disasters and hazards, disaster preparedness and management, risk assessment and disaster management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the vulnerability of an area to natural and man-made disasters/hazards as per the guidelines to solve complex problems using appropriate techniques ensuring safety, environment and sustainability.

CO2. Analyze the causes and impacts of disasters using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO3. Suggest the preparedness measures using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO4. Analyze the Risk Assessment using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO5. Design disaster management strategies to solve pre, during and post disaster problems using appropriate tools and techniques following the relevant guidelines and latest developments ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	2	3	-	-	2	-
CO3	2	-	-	-	2	-
CO4	2	-	-	-	-	-
CO5	2	2	-	-	-	-
Course Correlation Level	**2**	**3**	**-**	**-**	**2**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   **DISASTER PRONE AREAS IN INDIA**   **(09 Periods)**

Introduction: Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types And Magnitude. **Disaster Prone Areas:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

Module 2:   **REPERCUSSIONS OF DISASTERS AND HAZARDS**   **(09 Periods)**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Module 3:   **DISASTER PREPAREDNESS AND MANAGEMENT**   **(11 Periods)**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Module 4:   **RISK ASSESSMENT**   **(08 Periods)**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Module 5:   **DISASTER MANAGEMENT**   **(08 Periods)**

Disaster management organization and methodology, Disaster management cycle, Disaster management in India – Typical cases and Cost–benefit analysis, Disaster management programs implemented by NGOs and Government of India, Usage of GIS and Remote sensing techniques in disaster management, Leadership and Coordination in Disaster management, Emerging trends in disaster management.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Perform hazard assessment and vulnerability analysis for any nearby town/city and prepare a detailed report of possible impacts of various disasters on environment, infrastructure and development.

2. Prepare a detailed report on the causes and effects of Tsunami that was occurred in the year 2004. Also discuss various advancements in Tsunami warning systems.

3. Identify the major causes of urban floods in cities like Chennai, Hyderabad & Mumbai. Also list various mitigation strategies to reduce the impact of floods.

4. Prepare a detailed report on how various man-made activities are directly/indirectly related to the occurrence of landslides that occurred in recent days in India.

5. Visit AP State Disaster Response and Fire Services Department and record about various methods used by them in mitigating disasters and their management.

RESOURCES

TEXT BOOKS:

1. Sharma V. K., Disaster Management, Medtech Publishing, 2nd Edition, 2013.
2. Anand S. Arya, Anup Karanth, and Ankush Agarwal, Hazards, Disasters and Your Community: A Primer for Parliamentarians, GOI–UNDP Disaster Risk Management Programme, Government of India, National Disaster Management Division, Ministry of Home Affairs, New Delhi, Version 1.0, 2005

REFERENCE BOOKS:

1. Donald Hyndman and David Hyndman, Natural Hazards and Disasters, Cengage Learning, USA, 5th Edition, 2015.
2. Disaster Management in India, A Status Report, Ministry of Home Affairs, Govt. of India, May 2011.
3. Rajendra Kumar Bhandari, Disaster Education and Management: A Joyride for Students, Teachers, and Disaster Managers, Springer India, 2014.
4. Singh R. B., Natural Hazards and Disaster Management, Rawat Publications, 2009.
5. R. Nishith, Singh AK, Disaster Management in India: Perspectives, issues and strategies, New Royal book Company.
6. Sahni, PardeepEt.Al. (Eds.), Disaster Mitigation Experiences And Reflections, Prentice Hall of India, New Delhi.
7. Goel S. L. , Disaster Administration And Management Text And Case Studies, Deep &Deep Publication Pvt. Ltd., New Delhi

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105104183
2. https://www.digimat.in/nptel/courses/video/124107010/L01.html

WEB RESOURCES:

1. https://egyankosh.ac.in/handle/123456789/25093
2. https://www.egyankosh.ac.in/handle/123456789/25912
3. https://www.nios.ac.in/media/documents/333courseE/12.pdf
4. https://ndmindia.mha.gov.in/images/public-awareness/Primer%20for%20Parliamentarians.pdf

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25SS201701	**VALUE EDUCATION**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course deals with understanding the value of education and self-development, Imbibe good values in students, and making them know about the importance of character.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the knowledge of values and self-development

CO2. Analyze the importance of the cultivation of values.

CO3. Learn suitable aspects of personality and behavioral development

CO4. Function as a member and leader in multi-disciplinary teams by avoiding faulty thinking.

CO5. Develop character and competence for effective studies.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	-	-	-	-
CO2	2	3	-	-	2	-
CO3	2	-	-	-	2	-
CO4	2	-	-	-	-	-
CO5	2	2	-	-	-	-
Course Correlation Mapping	**2**	**3**	**-**	**-**	**2**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: VALUES AND SELF-DEVELOPMENT   (09 Periods)

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements- Case studies

Module 2: IMPORTANCE OF CULTIVATION OF VALUES.   (09 Periods)

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline- Case studies

Module 3:   PERSONALITY AND BEHAVIOR DEVELOPMENT   (09 Periods)

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness - Case studies

Module 4: AVOID FAULTY THINKING.   (09 Periods)

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature - Case studies

Module 5: CHARACTER AND COMPETENCE   (09 Periods)

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and the same message. Mind your Mind, Self-control. Honesty, Studying effectively- Case studies

Total Periods: 45

EXPERIENTIAL LEARNING

1. Demonstrate orally using your experiences of what values are naturally acceptable in a relationship to nurture or exploit others.

2. Prepare a report by identifying and analyzing the importance of cultivation of values.

3. Present a poster on different attitudes and behaviours.

4. Students give a PowerPoint presentation on doing best for nature.

5. Students are encouraged to bring a daily newspaper to class or to access any news related to the need for human values and note down the points.

6. Prepare a case study on how to maintain harmony with different religious people through character and competence.

(It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in the Course Handout)

RESOURCES

TEXTBOOKS:

1. R. Subramanaian, Professional Ethics, Oxford Higher Education, 2013.
2. Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw-Hill, 3rd Edition, 2007.
3. Chakravarthy, S.K.: Values and ethics for Organizations: Theory and Practice, Oxford University Press, NewDelhi, 1999.

REFERENCE BOOKS:

1. M.G. Chitakra: Education and Human Values, A.P.H. Publishing Corporation, New Delhi, 2003
2. Awakening Indians to India, Chinmayananda Mission, 2003
3. Satchidananda, M.K.: Ethics, Education, Indian Unity and Culture, Ajantha Publications, Delhi, 1991

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=90VQPZURN5c
2. https://www.youtube.com/watch?v=6ofPcK0uDaA
3. https://www.youtube.com/watch?v=5_f-7zCi79A
4. https://www.youtube.com/watch?v=2ve49BWAJRE
5. https://www.youtube.com/watch?v=kCOIfnxxQ5U

WEB RESOURCES:

1. https://www.livingvalues.net/
2. https://livingvalues.net/materials-for-schools/
3. https://www.edb.gov.hk/en/curriculum-development/4-key-tasks/moral-civic/index.html

Course Code	Course Title	L	T	P	S	C
25SS201702	**PEDAGOGY STUDIES**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course deals with understanding pedagogical practices that are being used by teachers in formal and informal classrooms, the effectiveness of pedagogical practices, teacher education (curriculum and practicum), and the school curriculum and guidance materials that can best support effective pedagogy.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge of pedagogical methodology

CO2. Analyze the functional knowledge in Pedagogical practices, Curriculum, and Teacher Education

CO3. Learn effective pedagogical practices and apply strategies.

CO4. Function effectively as an individual and as a member of the Professional development.

CO5. Understand research Gaps and provide future Directions.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	-	-	-
CO2	2	3	-	-	3	-
CO3	2	2	-	-	3	-
CO4	1	1	-	-	-	-
CO5	-	-	-	-	-	-
Course Correlation Mapping	**2**	**2**	**-**	**-**	**3**	**-**

Correlation Levels: 3: High;   2: Medium;   1: Low

COURSE CONTENT

Module 1:   INTRODUCTION AND METHODOLOGY   (09 Periods)

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of Methodology and Searching- Case studies

Module 2:   THEMATIC OVERVIEW   (09 Periods)

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher Education- Case studies

Module 3:   EFFECTIVENESS OF PEDAGOGICAL PRACTICES   (09 Periods)

Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality Assessment of included studies, teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' Attitudes and beliefs and Pedagogic strategies- Case studies

Module 4:   PROFESSIONAL DEVELOPMENT   (09 Periods)

Alignment with classroom practices and follow-up support, Peer support, and Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes- Case studies

Module 5:   RESEARCH GAPS AND FUTURE DIRECTIONS   (09 Periods)

Research design, Contexts, Pedagogy, Teacher Education, Curriculum and Assessment, Dissemination and research impact- Case studies

Total Periods: 45

EXPERIENTIAL LEARNING

1. List out the self-improvement in you after going through pedagogical methodologies.
2. Discuss different practices that you would like to adopt in the curriculum.
3. Describe in your own words how can you bring effectiveness to the curriculum.
4. Imagine you are a head teacher and illustrate different barriers to learning.
5. Assume you are a teacher and Interpret different directions that you would bring for the assessment of the students.

   (It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in the Course Handout)

RESOURCES

TEXTBOOK:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.

REFERENCES:

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of
2. Curriculum Studies, 36 (3): 361-379.Oxford and Boston: Blackwell. Educational Development, 33 (3): 272–282.
3. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=WL40UeySag4
2. https://www.youtube.com/watch?v=MMXaXDIHFJ8
3. https://www.youtube.com/watch?v=7uJL1R6M4Iw

WEB RESOURCES:

1. https://acrl.ala.org/IS/instruction-tools-resources-2/pedagogy/a-selected-list-of-journals-on-teaching-learning/
2. https://guides.douglascollege.ca/TLonline/resourcesforonlinepedagogy
3. https://www.refseek.com/directory/teacher_resources.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25LG201701	**PERSONALITY DEVELOPMENT THROUGH ESSENTIAL LIFE SKILLS**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course gives awareness to students about the various dynamics of personality development.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge in Self-Management and Planning Career
CO2. Analyze the functional knowledge in attitudes and thinking strategies
CO3. Learn and apply soft skills for professional success.
CO4. Function effectively as an individual and as a member in diverse teams
CO5. Communicate effectively in public speaking in formal and informal situations.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	-	-	-
CO2	2	3	-	-	-	-
CO3	2	2	-	-	3	-
CO4	1	1	-	-	-	-
CO5	-	-	-	-	-	-
Course Correlation Mapping	**2**	**2**	**-**	**-**	**3**	**-**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1:   SELF-ESTEEM & SELF-IMPROVEMENT   **(09 Periods)**

Concept of personality, significance of personality-Know Yourself – Accept Yourself; Self-Improvement: Plan to Improve - Actively Working to Improve Yourself- SWOT Analysis-Exercises- case studies.

Module 2:   DEVELOPING POSITIVE ATTITUDES   **(09 Periods)**

How Attitudes Develop – Attitudes are Catching – Improve Your Attitudes – Exercises- case studies- Positive attitude and its advantages, negative attitude and its disadvantages-case studies

Module 3:   SELF-MOTIVATION & SELF-MANAGEMENT   **(09 Periods)**

Concept of motivation, significance, factors leading to de-motivation- Show Initiative – Be Responsible - Self-Management; Efficient Work Habits – Stress Management – Employers Want People Who can Think – Thinking Strategies- Exercises- case studies

Module 4:   GETTING ALONG WITH THE SUPERVISOR   **(09 Periods)**

Know your Supervisor – Communicating with your Supervisor – Special Communication with Supervisor – What Should you Expect of Your Supervisor? – What your Supervisor expects of you - Moving Ahead Getting Along with your Supervisor- Exercises- case studies

Module 5:   WORKPLACE SUCCESS   **(09 Periods)**

First Day on the Job – Keeping Your Job – Planning Your Career – Moving Ahead- Essential employability skills, professional attributes, and career development strategies -Exercises-Case studies.

Total Periods: 45

EXPERIENTIAL LEARNING

1.   List out the self-improvements in you on the charts and explain in detail.

2.   Discuss different famous personalities and their attitudes.

3.   Describe different personalities concerning self-motivation and self-management.

4.   Imagine you are a supervisor and illustrate different special communications.

5.   Assume and Interpret different experiences on the first day of your job.

RESOURCES

TEXTBOOK:

1.   Harold R. Wallace and L. Ann Masters, Personal Development for Life and Work, Cengage Learning, Delhi, 10th edition Indian Reprint, 2011. (6th Indian Reprint 2015)

2.   Barun K. Mitra, Personality Development and Soft Skills, Oxford University Press, 2011.

REFERENCE BOOKS:

1.   K. Alex, Soft Skills, S. Chand & Company Ltd, New Delhi, 2nd Revised Edition, 2011.

2.   Stephen P. Robbins and Timothy A. Judge, Organizational Behaviour, Prentice Hall, Delhi, 16th edition, 2014

VIDEO LECTURES:

1.   https://www.youtube.com/watch?v=6Y5VWBLi1es

2.   https://www.youtube.com/watch?v=H9qA3inVMrA

WEB RESOURCES:

1.   https://www.universalclass.com/.../the-process-of-perso

2.   https://www.ncbi.nlm.nih.gov/pubmed/25545842

3.   https://www.youtube.com/watch?v=Tuw8hxrFBH8

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201701	**ENTREPRENEURSHIP AND INNOVATION MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course aims to provide students with a deep understanding of entrepreneurship and innovation. It explores entrepreneurial processes, opportunity identification, business planning, innovation management, intellectual property rights, and venture growth strategies. Students will develop entrepreneurial thinking, creativity, and problem-solving abilities to create and manage innovative ventures that contribute to economic and societal development.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Explain the fundamentals of entrepreneurship and its role in economic development.

CO2. Analyze opportunities and prepare business plans for entrepreneurial ventures.

CO3. Apply creativity and innovation techniques to business problems.

CO4. Demonstrate knowledge of technology management, IPR, and startup ecosystem.

CO5. Evaluate financing options, marketing strategies, and growth models for ventures.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	1	-	-
CO2	3	3	2	2	2	-
CO3	2	3	3	2	2	1
CO4	2	2	2	2	2	1
CO5	3	3	2	2	3	1
Course Correlation Mapping	**3**	**3**	**2**	**2**	**2**	**1**

Correlation Levels: **3: High;**   **2: Medium;**   **1: Low**

COURSE CONTENT

Module 1: INTRODUCTION TO ENTREPRENEURSHIP   (09 Periods)

Concept, meaning and importance of entrepreneurship – Characteristics and skills of entrepreneurs – Types of entrepreneurs: social, women, corporate, rural, technology-based – Intrapreneurship vs. entrepreneurship – Entrepreneurial ecosystem and its components.

Module 2: ENTREPRENEURIAL   PROCESS   AND   BUSINESS   (09 Periods)
PLANNING

Stages of entrepreneurial process: Idea, Feasibility, Startup, Growth – Opportunity identification and evaluation – Market research and environmental scanning – Structure and components of a business plan – Case studies of successful entrepreneurs.

Module 3: INNOVATION MANAGEMENT   (09 Periods)

Meaning, scope and significance of innovation – Types of innovation: product, process, business model, disruptive, frugal – Creativity techniques: brainstorming, lateral thinking, design thinking, TRIZ – Managing innovation in organizations – Innovation as a competitive advantage.

Module 4: TECHNOLOGY, IPR AND STARTUP ECOSYSTEM   (09 Periods)

Technology management and commercialization – Intellectual Property Rights (IPR): patents, copyrights, trademarks, designs, trade secrets – Technology transfer and licensing – Startup India, Atal Innovation Mission, MSME policies – Role of incubators, accelerators and innovation hubs.

Module 5: FINANCING AND GROWTH OF VENTURES   (09 Periods)

Sources of finance: bootstrapping, angel investors, venture capital, crowdfunding, government support – Entrepreneurial marketing strategies – Financial planning for startups – Scaling up ventures: challenges and strategies – Exit strategies: mergers, acquisitions, IPO.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare a mini-business plan for a startup idea.

2. Visit a nearby incubation/innovation center and prepare a report.

3. Conduct a creativity workshop (brainstorming/design thinking session).

4. Prepare a case study presentation on a successful entrepreneur/startup.

RESOURCES

TEXT BOOKS:

1.   Hisrich, R.D., Peters, M.P., & Shepherd, D.A. (2017), Entrepreneurship, McGraw-Hill Education.

2.   Drucker, P. (2007), Innovation and Entrepreneurship, Harper Business.

3.   Kuratko, D.F. (2020), Entrepreneurship: Theory, Process and Practice, Cengage Learning.

REFERENCE BOOKS:

1.   Timmons, J.A., & Spinelli, S. (2019), New Venture Creation: Entrepreneurship for the 21st Century, McGraw-Hill Education.

2.   Schilling, M.A. (2020), Strategic Management of Technological Innovation, McGraw-Hill Education.

3.   Scarborough, N.M. (2018), Essentials of Entrepreneurship and Small Business Management, Pearson.

VIDEO LECTURES:

1.   https://www.youtube.com/watch?v=rA4uKIy5gO0&list=PLsh2FvSr3n7fQlIDbfKutmSL26TsWitGQ

2.   https://www.youtube.com/watch?v=itRVzjk9mkg

WEB RESOURCES:

1.   https://nacosadsu.org.ng/main/docs/300L/ENT%20301.pdf?utm_source=chatgpt.com

2.   https://www.measiim.edu.in/myweb/uploads/2022/05/PMFEA-IE-1.pdf?utm_source=chatgpt.com

3.   https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/pages/lecture-notes/?utm_source=chatgpt.com