SNJB's

Late Sau. Kantabai Bhavarlalji Jain

College of Engineering

(Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

Shri Neminath Jain Brahmacharyashram (SNJB) (Jain Gurukul)

Neminagar, Chandwad - 423101, Dist. Nashik (MS, India).

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ESTD - 1928

Curriculum Structure and Evaluation Scheme for M. Tech. in Computer Engineering

To be implemented for 2024-26 Batch

(With Effect from Academic Year 2024-25)

Vision of the Institute

Transform young aspirant learners towards creativity and professionalism for societal growth through quality technical education.

Mission of the Institute

1. To transfer the suitable technology, particularly for rural development.
2. To enhance diverse career opportunities among students for building a nation.
3. To acquire the environment of learning to bridge the gap between industry and academics.
4. To share values, ideas, beliefs by encouraging faculties and students for welfare of society.

Vision of the Computer Engineering Department

To empower young generations for significant contributions in the field of computer engineering through excellence in knowledge, technical education, and innovation to cater the industrial demands and societal needs.

Mission of the Computer Engineering Department

1. To achieve academic excellence by inculcating basic and latest knowledge in which new ideas flourish.
2. To undertake collaborative training which offers opportunities for long-term interaction with academia and industry.

Program Outcomes (POs) for PG Engineering Program:

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Abbreviations:

Table 1: Abbreviations

Abbreviation	Meaning
ISE	Internal Semester Examination
SEE	Semester End Examination
VSEC	Vocational and Skill Enhancement Courses
VEC	Value Education Course

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Abbreviation	Meaning
PCC	Program Core Courses
PEC	Program Elective Courses
ELC	Research Methodology
	Technical Communication
	Dissertation I
	Dissertation II
	Internship
CCC	Co-Curricular Courses
L	Lecture
PR	Practical
TH	Theory
TW	Term Work
OR	Oral
CS	Computer Engineering

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GENERAL COURSE STRUCTURE

A. Definition of Credit:

Table 2: Definition of Credits

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: (M.Tech. or Equivalent) in Tech. : Two-year Post Graduate degree program in Technology has about 80 credits, the total number of credits proposed for the two-year M.Tech. in **Computer Engineering** is kept as **80**

Table 3: Range of Credits

Course Category		Proposed Credits
Programme Core Course (PCC)	Program Courses	19
Programme Elective Course (PEC)		11
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	4
Value Education Course (VEC)	Humanities Social Science and Management (HSSM)	2*
Research Methodology(RM)	Experiential Learning Courses	2
Technical Communication		2
Dissertation I		16
Seminar I		4
Dissertation II		16
Internship		4
Co-curricular Courses (CC)	Liberal Learning Courses	2
Total Credits		**80**

Note:* –Credits are not to be considered while calculating marks for the declaration of the final result (Pass/Fail)."

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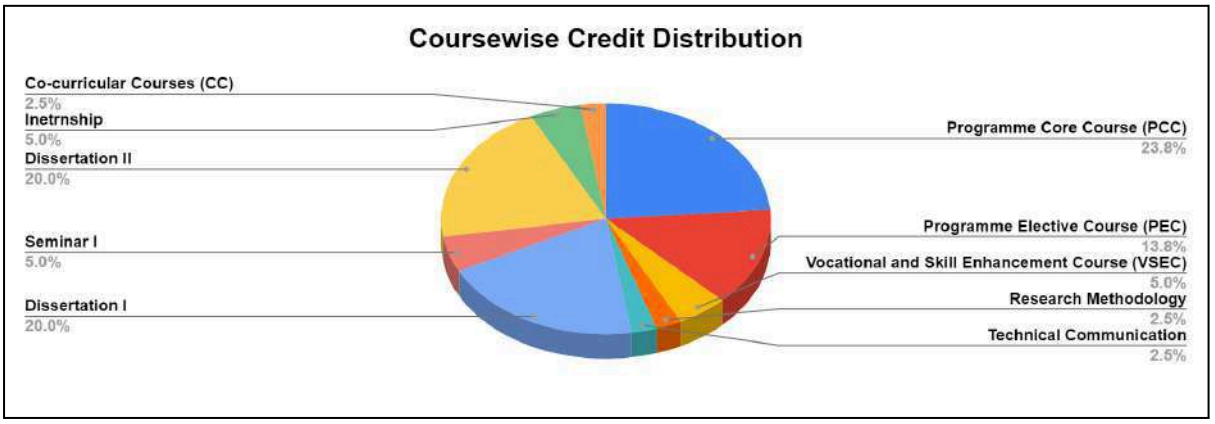
C. Semester wise Credit Distribution Structure for two Year M.Tech in Computer Engineering

Table 4: Semester wise Credit Distribution Structure

Semester		I	II	III	IV	Total Credits
Programme Core Course (PCC)	Program Courses	13	6	-	-	**19**
Programme Elective Course (PEC)		3	8	-	-	**11**
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	-	-	**4**
Value Education Course (VEC)	Humanities Social Science and Management (HSSM)			2*		**-**
Research Methodology	Experiential Learning Courses	2	-	-	-	**2**
Technical Communication		-	2	-	-	**2**
Dissertation I		-	-	16	-	**16**
Seminar I		-	-	4	-	**4**
Dissertation II		-	-	-	16	**16**
Internship		-	-	-	4	**4**
Co-curricular Courses (CCC)	Liberal Learning Courses	-	2	-	-	**2**
Total		20	20	20	20	**80**

Note:* –Credits are not to be considered while calculating marks for the declaration of the final result (Pass/Fail)."



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In accordance with the NHEQF, the levels for the PG programme are given in the given Table

Table 5: Levels for the PG programme

Level	Qualification Title	Credit Requirements	Semester	Year
6.5	1-Year PG after a 4-year UG	20	I	1
		20	II	1
7	2-Year PG after a 4-year UG such as B.E., B. Tech. etc.	20	III	2
		20	IV	2

TEACHING AND EVALUATION SCHEME FOR FIRST YEAR M-TECH

Semester – I

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/OR	
1	PCC	24-PCC-CS-5-01	Mathematics for Computer Science	4	-	-	4	4	40	60	100	-	-	100
2	PCC	24-PCC-CS-5-02	Security in Computing	4	-	-	4	4	40	60	100	-	-	100
3	PCC	24-PCC-CS-5-03	Advanced Algorithms	3	-	-	3	3	40	60	100	-	-	100
4	PCC	24-PCC-CS-5-04	Laboratory Practice -I	-	-	4	4	2	-	-	-	50	50	100
5	PEC	24-PEC-CS-5-01	Programme Elective Course – I	3	-	-	3	3	40	60	100	-	-	100
6	VSEC	24-VSEC-CS-5-01	Instructional Design and Development	-	-	4	4	2	-	-	-	50	-	50
7	ELC	24-ELC-CS-5-01	Research Methodology	2	-	-	2	2	50	-	50	-	-	50
Total				**16**	**-**	**8**	**24**	**20**	**210**	**240**	**450**	**100**	**50**	**600**

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Table 6: Program Elective Course-I

	Course Code-TH	Name of the Elective Course- TH
A	24-PEC-CS-5-01A	AI Driven Problem Solving
B	24-PEC-CS-5-01B	Digital Image Processing
C	24-PEC-CS-5-01C	Virtual Reality and Augmented Reality
D	24-PEC-CS-5-01D	Soft Computing

Semester – II

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/OR	
1	PCC	24-PCC-CS-5-05	Advance Cloud Computing	4	-	-	4	4	40	60	100	-	-	100
2	PCC	24-PCC-CS-5-06	Laboratory Practice - II	-	-	4	4	2	-	-	-	50	50	100
3	PEC	24-PEC-CS-5-02	Programme Elective Course – II	4	-	-	4	4	40	60	100	-	-	100
4	PEC	24-PEC-CS-5-03	Programme Elective Course – III	4	-	-	4	4	40	60	100	-	-	100
5	VSEC	24-VSEC-CS-5-02	Drone Technology and Applications	-	-	4	4	2	-	-	-	50	50	100
6	CCC	24-CCC-CS-5-01	Scientific studies of Mind,Matter and Consciousness	2	-	-	2	2	-	-	-	50	-	50
7	ELC	24-ELC-CS-5-02	Technical Communication	-	-	4	4	2	-	-	-	50	-	50
8	VEC	24-VEC-CS-5-01	Introduction to human rights and duties **	1	-	-	1	1*	-	-	-	25*	-	25*
9	VEC	24-VEC-CS-5-02	Human rights of vulnerable and Disadvantaged groups **	1	-	-	1	1*	-	-	-	25*	-	25*
Total				**16**	**-**	**12**	**28**	**20**	**120**	**180**	**300**	**200**	**100**	**600**

Note: * - Credits not to be considered while Calculation of Marks for Declaration of Final Result (Pass/Fail)

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** - Inclusion of Courses 24-VEC-CS-5-01 and 24-VEC-CS-5-02 is done as per the Note (41AC-Note-01) dated 4 Feb 2025

Table 7: Program Elective Course-II

	Course Code-TH	Name of the Elective Course- TH
A	24-PEC-CS-5-02A	AI-Powered IoT Applications
B	24-PEC-CS-5-02B	Advance Data Visualization and Storytelling
C	24-PEC-CS-5-02C	Application Development using Augmented reality
D	24-PEC-CS-5-02D	Computer Vision and Pattern Recognition

Table 8: Program Elective Course-III

	Course Code-TH	Name of the Elective Course- TH
A	24-PEC-CS-5-03A	Industrial IOT
B	24-PEC-CS-5-03B	Social Network Analytics
C	24-PEC-CS-5-03C	Ethical Hacking
D	24-PEC-CS-5-03D	Business Analytics

Level 6.5 Exit Criteria:
Students who exit at the end of 1st year with the completion of 40 credits shall be awarded a Postgraduate Diploma.

Guidelines for Program Elective Course
Students may choose any course or NPTEL MOOCs course* from the department's recommended list. The total credits earned through MOOCs must match the allocated credits for the respective elective. (One credit is awarded for each four-week MOOCs course).

* Online NPTEL MOOCs courses will be offered as per availability on the portal of NPTEL/SWAYAM

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TEACHING AND EVALUATION SCHEME FOR SECOND-YEAR M-TECH

Semester – III

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/OR	
1	ELC	24-ELC-CS-6-01	Dissertation I	-	-	32	32	16	-	-	-	150	150	300
2	ELC	24-ELC-CS-6-02	Seminar I	-	-	8	8	4	-	-	-	50	50	100
Total				-	-	**40**	**40**	**20**	-	-	-	**200**	**200**	**400**

Note: Inclusion of Courses Cyber Security and Skill Development-I will be proposed as per the Note (41AC-Note-01) dated 4 Feb 2025

Semester – IV

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/OR	
1	ELC	24-ELC-CS-6-03	Dissertation II	-	-	32	32	16	-	-	-	150	150	300
2	ELC	24-ELC-CS-6-04	Internship	-	-	8	8	4	-	-	-	50	50	100
Total				-	-	**40**	**40**	**20**	-	-	-	**200**	**200**	**400**

Note: Inclusion of Course Skill Development-II will be proposed as per the Note (41AC-Note-01) dated 4 Feb 2025

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24-PCC-CS-5-01 : Mathematics for Computer Science		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60

Prerequisites Courses: Discrete Mathematics , Data Science

Course Objectives:

- Apply statistical techniques and probability modeling for effective decision-making.
- Implement coding theory and numerical optimization for efficient data handling and algorithm enhancement.
- Utilize matrix operations in machine learning for data manipulation and integrate Bayesian theory for uncertainty management.
- Develop skills in applying fuzzy logic and Bayesian inference to improve decision-making in complex scenarios.

Course Outcomes:

After completion of the course, learners should be able to

1. Explore and Understand advanced mathematical foundations to solve computational problems.
2. Apply statistical techniques and probability models to analyze data and make informed decisions.
3. Utilize coding theory and numerical optimization techniques to optimize data processing
4. Understand matrix operations in machine learning algorithms to manipulate data effectively and integrate Bayesian theory for managing uncertainty.
5. To apply fuzzy logic and Bayesian inference to optimize decision-making in complex scenarios.

Course Contents

Unit I	**Descriptive and Inferential Statistical Techniques**	**8 Hours**

Measures of central tendency: mean, median, mode ; Measures of variability: range, variance, standard deviation, interquartile range; Confidence intervals for means and proportions; Hypothesis testing: formulation, significance tests, p-values, and error types; Analysis of variance (ANOVA) and regression analysis.

#Exemplar: A study using ANOVA investigates differences in mean daily calcium intake among adults aged 60 years with normal bone density, osteopenia, and osteoporosis. Participants are randomly selected from hospital records and categorized based on bone density. Daily calcium intake, including food and supplements, is measured to assess variations among the groups.

Unit II	**Probability Distribution and Estimation Theory**	**9 Hours**

Introduction of probability distributions, Discrete distributions (Binomial, Poisson), Continuous distributions (Normal, Exponential), Probability density function (PDF) and Cumulative distribution function (CDF); Introduction to estimation theory, Point estimation and interval estimation; Properties of estimators: unbiasedness, consistency, efficiency; Methods of estimation: Method of moments, Maximum Likelihood Estimation (MLE).

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#Case Study: To design and conduct a case study that evaluates the properties of different estimators—unbiasedness, consistency, and efficiency—using real-world data, and to identify applications for each property.		
Unit III	**Information and Coding Theory**	**9 Hours**
Entropy, Joint and Conditional entropy, Relation between, entropy and Mutual information ; Huffman codes, Shannon-Fano coding; Error correcting codes: minimum distance principles, Hamming bound, general binary code, group code, linear group code Convolution encoding: algebraic structure, Gilbert bound, Threshold decoding: threshold decoding for block codes, Cyclic binary codes: BCH codes, generalized BCH code and decoding, optimum codes, concepts of non-cyclic codes.		
#Case Study: Explore the encoding and decoding process of BCH codes, focusing on properties like error correction, using real-world parameters and examples.		
Unit IV	**Numerical Optimization**	**8 Hours**
Mathematical Formulation for optimization, Continuous and Discrete Optimization, constrained and Unconstrained Optimization, Global and Local Optimization, Stochastic and Deterministic Optimization, Overview of Optimization algorithms.		
#Case Study: Analyze and compare optimization algorithms used in machine learning and engineering applications, examining their efficiency, convergence properties, and practical implementations		
Unit V	**Matrices in Machine Learning Algorithms**	**8 Hours**
Projection transformation; orthogonal decomposition; singular value decomposition; principal component analysis and linear discriminant analysis, Gradient Calculus: Basic concepts of calculus: partial derivatives, gradient, directional derivatives, Jacobian, Hessian matrix.		
#Exemplar: Explore application of handwriting recognition using Principal Component Analysis (PCA) and demonstrate how this technique retains crucial information while significantly reducing computational demands.		
Unit VI	**Bayesian theory and Fuzzy logic**	**7 Hours**
The Bayesian Paradigm , Bayesian Inference, Bayesian modeling; Basics of Fuzzy sets and Fuzzy Logic, Extracting Fuzzy models from data, Fuzzy Decision trees.		
#Exemplar/Case Studies: To explore the application of fuzzy logic in various engineering disciplines through real-world scenarios, illustrating its effectiveness in solving complex engineering problems where traditional methods may fall short.		
Learning Resources		
Text Books		
T1. Kathleen F. Weaver, Vanessa C. Morales, Sarah L. Dunn, Kanya Godde, Pablo F. Weaver "An Introduction to Statistical Analysis in Research" , willey, First published:28 July 2017, Print ISBN:9781119299684 |Online ISBN:9781119454205, DOI:10.1002/9781119454205 https://onlinelibrary.wiley.com/doi/book/10.1002/9781119454205		
T2.Andrew N O'Connor, "Probability Distributions Used in Reliability Engineering", RIAC, 2011,ISBN: 1933904062,		

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https://crr.umd.edu/sites/crr.umd.edu/files/Free%20Ebook%20Probability%20Distributions%20Used%20in%20Reliability%20Engineering.pdf

T3. J. Nocedal and S. J. Wright, " Numerical Optimization". New York: Springer Science & Business Media,2006, ISBN0387400656, 9780387400655 https://www.math.uci.edu/~qnie/Publications/NumericalOptimization.pdf

T4. Thomas M. Cover, Joy A. Thomas: Elements of information theory, Second Edition John Wiley and Sons, 2012. ISBN1118585771, 9781118585771 https://onlinelibrary.wiley.com/doi/book/10.1002/047174882X

T5. J. H. van Lint, Introduction to coding theory, Springer Science & Business Media, 2013, ISBN3662079984, 9783662079980 . Unit Information and Coding

T6 Michael R. Berthold, David J Hand Intelligent Data Analysis: An Introduction, Springer, 2007 ISBN 3540486259, 9783540486251 Unit Bayesian theory and Fuzzy logic

T7 Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020, ISBN 1108470041, 9781108470049 UNIT MATRIX

Reference Books :

R1. Ben Lambert, "A Student's Guide to Bayesian Statistics" , SAGE Publications Ltd, First published 2018, ISBN 978-1-4739-1635-7

R2. Rohatgi, V.K., and Saleh, A.K.Md. Ehsanes (2009). An introduction to probability and statistics. Second Edition, Wiley India.

R3. Singiresu S. Rao, Engineering Optimization: Theory and Practice, 4th edition, John Wiley & Sons, 2009, ISBN 978-0-470-18352-6

R4. Roberto Rivera, " Principles of Managerial Statistics and Data Science" , Wiley, ISBN: 9781119486411

Additional Resources: (Books, e-Resources)

A1. https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_hypothesistesting-anova/bs704_hypothesistesting-anova_print.html
A2.https://uotechnology.edu.iq/dep-eee/lectures/4th/Communication/Information%20theory/2.pdf
A3. https://ejournal.csol.or.id/index.php/csol/article/view/69
A4.https://epubs.siam.org/doi/abs/10.1137/16M1080173
A5. https://songxia-sophia.medium.com/principle-components-analysis-pca-essence-and-case-study-with-python-43556234d321
A6 .https://rizkia.staff.telkomuniversity.ac.id/files/2017/11/Fuzzy-Logic-with-Engineering-Applications-3ed-Timothy-J.-Ross-Wiley-2010.pdf

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24-PCC-CS-5-02 : Security in Computing		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Computer Network, Number System		
Companion Course: Laboratory Practice -I		

Course Objectives:

- To Understand the essential for protecting information systems against unauthorized access
- To understand cryptographic principles to implement secure communication and data protection solutions.
- To identify various cybersecurity threats and vulnerabilities through understanding of attack techniques.
- To manage and enforce access to digital resources securely, ensuring confidentiality, integrity, and availability .
- To understand information security risks and assessment methodologies, and defensive strategies.
- To understand the legal frameworks, analyze and navigate complex legal issues in digital environments.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Understand** fundamental knowledge to effectively protect digital information from vulnerabilities.
CO2: **Implement** data protection solutions based on understanding cryptographic principles.
CO3: **Identify** and **evaluate** information security threats and vulnerabilities and apply security measures.
CO4: **Implement** secure access to digital resources, ensuring confidentiality, integrity, and availability.
CO5: **Understand** to assess, mitigate, and manage information security risks effectively.
CO6: **Analyze** various types of cybercrimes, **understand** the ethical and legal complexities in cybersecurity practices, and navigate legal frameworks.

Course Contents

Unit I	Basics of Information Systems Security	9 Hours

Definition and importance of information security, Goals of information security: confidentiality, integrity, availability (CIA triad) Threats, vulnerabilities, and risks in information systems, Principles of encryption and decryption, Securing network infrastructure: firewalls, routers, switches, Authentication methods: passwords, biometrics, tokens.

#Exemplar/Case Studies: In a multinational corporation handling sensitive financial data, the implementation of robust information security practices was paramount to safeguarding their operations and customer trust.
Scenario Overview: The corporation, dealing with extensive financial transactions and client data, recognized the critical importance of information security to maintain confidentiality, integrity, and availability (CIA triad) of their systems and data. They faced significant threats such as targeted cyber attacks, insider threats, and potential vulnerabilities in their network

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infrastructure.		
Unit II	**Cryptography**	**8 Hours**
Introduction of Cryptography and Modern Cryptography, Public Key Cryptography versus Symmetric Cryptography, Encrypting Communications Channels, Hardware Encryption versus Software Encryption, Compression, Encoding, and Encryption, Detecting Encryption, Hiding and Destroying Information.		
#Exemplar/Case Studies: In a government agency tasked with handling classified information, the adoption of advanced cryptographic techniques was crucial to safeguarding sensitive communications and protecting national security. **Scenario Overview:** The government agency recognized the critical need for secure communication channels to prevent espionage and ensure confidentiality. They faced challenges such as potential interception of communications, insider threats, and the need to comply with stringent security standards.		
Unit III	**Attacks Threats and Vulnerabilities**	**8 Hours**
Basic concepts: Attack, threats and vulnerabilities, Malicious attacks Threats and Vulnerabilities, Attack tools, What is security breach, Malicious softwares, Countermeasures. Risk management, BIA, BCP and DRP, Active vs Passive attacks, Assessing risk and Vulnerabilities, Compliance laws, confidentiality of data.		
#Exemplar/Case Studies: The financial institution faced numerous cyber threats including phishing attacks targeting customer accounts, malware infiltration attempts, and the potential for insider threats compromising data integrity. Regulatory requirements mandated strict compliance with data protection laws to safeguard customer confidentiality.		
Unit IV	**Access Controls**	**8 Hours**
Basics of access controls, identification methods, authentication processes and requirements, Access Control Models: Discretionary Access Control (DAC),Mandatory Access Control (MAC),Role-Based Access Control (RBAC), Access Control in Web Applications Managing Database Privileges, Controlling Code Execution in J2EE and .NET Platforms.		
#Exemplar/Case Studies: In a multinational technology firm managing critical infrastructure and proprietary software, the implementation of robust access control measures was crucial to protect intellectual property and maintain operational integrity. **Scenario Overview:** The technology firm faced challenges including unauthorized access attempts to sensitive code repositories, insider threats exploiting database privileges, and the need to comply with stringent regulatory requirements for data protection and access control.		
Unit V	**Risk Management and Information Security**	**9 Hours**
Risk management and information security, risk analysis, Disaster Recovery Planning: Risk Assessment and Mitigation, Developing Recovery Time Objectives (RTO) and Recovery Point Objectives (RPO), Testing and Updating Disaster Recovery Plans. Backup Strategies and Planning: Full, Incremental, and Differential Backups,Backup Scheduling and Automation,On-site vs. Off-site Backups Cloud Backup Solutions.		
#Exemplar/Case Studies: In a global healthcare organization managing sensitive patient data and critical medical systems, the implementation of robust risk management and disaster recovery strategies was essential to ensure continuous service delivery and data protection. **Scenario Overview**: The healthcare organization faced various risks including data breaches, natural disasters impacting		

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infrastructure, and regulatory compliance requirements necessitating stringent data protection measures.

Unit VI	Cybercrimes & Cybersecurity: The Legal Perspective	9 Hours

Types of Cybercrimes: Hacking, identity theft, phishing, cyberbullying, and cyberterrorism. Cyberspace and Criminal Behavior, Traditional problems associated with computer-based cyber Crime, Classification of Cybercrimes, Cyber stalking, The Indian IT Act, Ethical and Legal Issues: Ethical considerations surrounding cybersecurity practices, such as surveillance, encryption policies, and the balance between security and privacy rights.

#Exemplar/Case Studies: A multinational corporation operating in the technology sector encountered diverse cyber threats amid global expansion and digital transformation initiatives. The corporation managed critical infrastructure, proprietary software platforms, and confidential business data. Recent cybersecurity incidents highlighted vulnerabilities in their systems and underscored the need for robust cybersecurity measures and compliance with regulatory frameworks.

Learning Resources

Text Books

T1. Michael E. Whitman, Herbert J. Mattord," "Principles of Information Security" , Cengage Learning , 6th Edition ,978-1337102063
T2.William Stallings , "Cryptography and Network Security: Principles and Practice", Pearson ,8th Edition , 978-0134444284

Reference Books :

R1. Wm. Arthur Conklin, Gregory White, et al. , "Principles of Computer Security: CompTIA Security+ and Beyond", McGraw-Hill Education, 5th Edition , 978-1260454580
R2. Bill Ballad, Tricia Ballad, "Access Control, Authentication, and Public Key Infrastructure" , Jones & Bartlett Learning , 978-1284031634
R3. Jones & Bartlett Learning , 978-1284031634"Principles of Risk Management and Insurance" , Pearson, 14th Edition, 978-0134082578
R4. Thomas J. Holt and Adam M. Bossler, "Cybercrime and Digital Forensics: An Introduction" Routledge, 978-1138859126
R5. Taxmann, "The Information Technology Act, 2000: Rules, Regulations, Notifications, Guidelines, Circulars, etc.",Taxmann Publications Pvt. Ltd,978-9350715736
R6.Jon F. Merz,"Ethical and Legal Issues in Cybersecurity",Jones & Bartlett Learning, 978-1284055995

Additional Resources: (Books, e-Resources)

1. https://www.coursera.org/specializations/certified-in-cybersecurity
2. https://www.edx.org/learn/information-security

MOOC Courses links :

1. **Foundations of Cryptography**
   https://onlinecourses.nptel.ac.in/noc22_cs03/preview
2. **Introduction to Information security**
   https://nptel.ac.in/courses/106106129

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24-PCC-CS-5-03 : Advanced Algorithms		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE** : 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Design and Analysis of Algorithms		
Companion Course: Laboratory Practice -I		

Course Objectives:

1. Utilize algorithmic strategies effectively in problem-solving scenarios.
2. To Understand Randomized and Distributed Algorithms.
3. Analyze various graph algorithms effectively to solve and analyze problems.
4. Develop and use parallel algorithms for solving fundamental problems.
5. Explore a variety of NP problems and investigate solutions using approximation algorithms.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Analyze** the asymptotic performance of algorithms.
CO2: **Apply** algorithmic strategies effectively in problem-solving scenarios.
CO3: **Develop** problem-solving approaches such as Dynamic Programming and Amortized Analysis through structured learning and practice.
CO4: **Apply** various graph algorithms,randomized and distributed Algorithms to solve and analyze Problems.
CO5: **Apply** parallel algorithms to solve fundamental problems.
CO6: **Apply** and prove NP completeness of given problem and solve it using approximation algorithms.

Course Contents

Unit I	**Fundamentals of Technological Design and Analysis**	**8 Hours**

The Significance of Algorithms in Computational Science: Analyzing, Designing, and Exploring Insertion Sort, Merge Sort, and Quick Sort , **Algorithm analysis techniques** time complexity, space complexity, asymptotic analysis **Overview of Algorithmic Strategies:** Greedy, Divide and Conquer, Dynamic Programming , Branch and Bound

#Exemplar/Case Studies: Traveling Salesman problem by Dynamic programming.

Unit II	**Problem-Solving Approaches: Dynamic Programming and Amortized Analysis**	**8 Hours**

Principles of Dynamic Programming: Assembly Line Scheduling, Longest common subsequence, Optimal Binary search Tree,Knapsack Problem,Traveling Salesman problem.
Principles of Amortized Analysis: Aggregate analysis, The accounting method, Table Doubling, The potential method.

#Exemplar/Case Studies: Optimize Data Structure Operations with Amortized Analysis

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Unit III	**Randomized and Distributed Algorithms**	**8 Hours**
Randomized Algorithms: Reasons for using randomized algorithms, Examples:Randomized Qsort, min-cut problems, Introduction to approximation algorithms,**Examples:** TSP, 3-coloring problem,**Advanced Algorithms in Parallel and Distributed Computing:** Multithreaded Problem Solving,Distributed Breadth-First Search and Distributed Minimum Spanning Tree. **String Matching**: Introduction, The Naive string-matching algorithm, The Rabin-Karp algorithm.		
#Exemplar/Case Studies : Optimizing Network Performance with Randomized and Distributed Algorithms		
Unit IV	**Graphs algorithms**	**7 Hours**
Graphs algorithms: Single-Source Shortest Paths-The BellmanFord algorithm, Dijkstra's algorithm, Maximum Flow-Transport networks, The Ford-Fulkerson method, Maximum bipartite matching		
#Exemplar/Case Studies: Optimizing Logistics with Graph Algorithms		
Unit V	**Parallel Algorithms**	**7 Hours**
Overview of parallel computing paradigms,Need of parallel algorithms, Amdahl'S law, Parallel algorithms design paradigms and challenges,Parallel sorting algorithms (prefix sum,list ranking, parallel merge sort, quicksort),Parallel shortest path algorithms (Floyd-Warshall algorithm).		
#Exemplar/Case Studies: Case Studies of industry relevance/recent trends		
Unit VI	**Complexity Theory**	**7 Hours**
P, NP complete complexity classes,non deterministic algorithms,NP Completeness and reducibility ,NP Complete Problems (SAT,3-SAT,Clique,Vertex cover,TSP), Approximation algorithm		
#Exemplar/Case Studies: Case Study on Graph Coloring Problem.		
Learning Resources		
Text Books		
T1. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, ISBN 978-81-203-1131-2. **T2. .**Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978 817371 6126, 81 7371 61262 . **T3.**Parag Himanshu Dave, Himanshu Bhalchandra Dave, " Design And Analysis of Algorithms",Pearson Education, ISBN 81-7758-595-9		
Reference Books :		
R1.Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms" Cambridge University Press, ISBN: 978-0-521-61390-3 **R2.**.Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, " Introduction toAlgorithms", MIT Press; ISBN 978-0-262-03384-8 . **R3**.Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations," Analysis and InternetExamplesII, Wiley, ISBN 978-81-265-0986-7		

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Additional Resources: (Books, e-Resources)

e-Books :

1. https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analy sis_of_algorithms_tutorial.pdf
2. https://www.ebooks.com/en-in/book/1679384/algorithms-design-techniques-andanalysis/m-h-alsuwaiyel

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc23_cs63/preview

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24-PCC-CS-5-04 : Laboratory Practical-I

Teaching Scheme:	**Credit:** 02	**Examination Scheme:**
Practical: 04 Hours/Week		**TW** : 50 Marks **OR**: 50 Marks

Prerequisite Courses: Computer network, Number System, Design and analysis of algorithm Lab.

Companion Course: Security in Computing, Advanced Algorithms.

Course Objectives:

- To understand the secure data by converting and restoring it into a coded form that prevents unauthorized access.
- To understand information security risks management and data disaster management.
- To understand the legal provisions and specific laws governing cybercrimes.
- Design and implement various algorithmic strategies using Java/Python/C++.
- Employ various design strategies for problem solving.
- Measure and compare the performance of different algorithms.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Understand** how to secure data by Encrypting and Decrypting to prevent unauthorized access.

CO2: **Implement** various strategies and procedures to recover and protect data in the event of a disaster

CO3: **Analyze** and **apply** various legal principles to address current and future cybercrime issues.

CO4: **Design** algorithms using appropriate design techniques (brute-force, greedy, dynamic programming, etc.)

CO5: **Implement** a variety of algorithms such assorting, graph related, combinatorial, etc., in a high level language.

CO6: **Analyze** and **compare** the performance of algorithms using language features.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a reference and hands-on resource. It should include prologue (about institute/ department), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals must be avoided. Use of CD containing student programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

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Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as Write-up, Correctness and Documentation of Program, Viva, Timely Completion.

Guidelines for Laboratory Conduction

List of laboratory assignments is provided below . The instructor is expected to conduct the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. Encourage students for appropriate use of coding style, proper indentation and comments. Use of open source software and recent versions is to be encouraged.

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments: Security in Computing (Compulsory)

Sr No	Assignment Title
1.	Using Python Language develop Encrypting Communication Channels: securing a communication channel using TLS.Demonstration of encrypted messaging using Python libraries (e.g., cryptography and pycryptodome).
2.	Develop and Implement Firewalls and IDS/IPS Using Snort, and Apply Encryption Techniques with OpenSSL and GnuPG"
3.	Implement and manage access controls in web applications by securing the application using OWASP ZAP for vulnerability scanning and applying access control policies for different user roles in a sample web application using Python Flask or ASP.NET Core.
4.	Develop and test a comprehensive disaster recovery plan by conducting risk assessments, defining Recovery Time Objectives (RTO) and Recovery Point Objectives (RPO), and simulating disaster scenarios to evaluate and update the plan. Tools Use: Risk assessment software like RiskWatch , Simulation tools like Simul8 for planning and testing scenarios. Recovery testing tools from disaster recovery software providers like Veeam or Acronis.
5.	Write a full depth research article on Overview of Cybercrime Sections and Case Law Analysis

Group B: Assignments (Out of List perform any 5)

Sr No	Assignment Title
1.	Implement algorithm for problem that can be solve by one or more strategy Divide and Conquer and Greedy using Java/Python/C++.
2.	Implement dynamic programming technique (Problems 0/1 Knapsack problem, Travelling Salesman Problem) using Java/Python/C++.

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3.	Implement Backtracking Algorithm (N-Queen Problem) using Java/Python/C++.
4.	Implement parallel algorithms for fundamental problems such as sorting,searching,merging using Java/Python/C++.
5.	Implement All-Pairs Shortest Paths problem using Floyd's algorithm using Java/Python/C++.
6	Implementation of genetic algorithms using Java/Python/C++.

Text Books:

T1. Michael E. Whitman, Herbert J. Mattord," "Principles of Information Security" , Cengage Learning , 6th Edition ,978-1337102063
T2. William Stallings , "Cryptography and Network Security: Principles and Practice", Pearson ,8th Edition , 978-0134444284
T3. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, ISBN 978-81-203-1131-2.
T4. . Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978 817371 6126, 81 7371 61262 .
T5. Parag Himanshu Dave, Himanshu Bhalchandra Dave, " Design And Analysis of Algorithms",Pearson Education, ISBN 81-7758-595-9

Reference Books :

R1. Wm. Arthur Conklin, Gregory White, et al. , "Principles of Computer Security: CompTIA Security+ and Beyond", McGraw-Hill Education, 5th Edition , 978-1260454580
R2. Bill Ballad, Tricia Ballad, "Access Control, Authentication, and Public Key Infrastructure" , Jones & Bartlett Learning , 978-1284031634
R3. George E. Rejda, Michael McNamara, "Principles of Risk Management and Insurance" , Pearson, 14th Edition, 978-0134082578
R4. Thomas J. Holt and Adam M. Bossler, "Cybercrime and Digital Forensics: An Introduction" Routledge, 978-1138859126
R5. Taxmann, "The Information Technology Act, 2000: Rules, Regulations, Notifications, Guidelines, Circulars, etc.", Taxmann Publications Pvt. Ltd,978-9350715736
R6. Jon F. Merz,"Ethical and Legal Issues in Cybersecurity",Jones & Bartlett Learning, 978-1284055995
R7. Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms" Cambridge University Press, ISBN: 978-0-521-61390-3
R8. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, " Introduction toAlgorithms", MIT Press; ISBN 978-0-262-03384-8 .
R9. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations," Analysis and InternetExamplesll, Wiley, ISBN 978-81-265-0986-7

Virtual Lab :

1. **Cryptography**
   https://cse29-iiith.vlabs.ac.in/

MOOC Courses links :

1. **Foundations of Cryptography**
   https://onlinecourses.nptel.ac.in/noc22_cs03/preview
2. **Introduction to Information security**
   https://nptel.ac.in/courses/106106129

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24-PEC-CS-5-01A : AI Driven Problem Solving		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE** : 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Artificial Intelligence		

Course Objectives:

- To grasp the concept of Artificial Intelligence (AI) through its applications in diverse intellectual tasks
- Understanding problem-solving through unique search strategies in AI
- Exploring multi-agent interactions in competitive environments
- Learning the basics of knowledge and reasoning
- Formulating action plans crucial for achieving AI goals
- Cultivating unconventional problem-solving skills for real-world challenges

Course Outcomes:

After completion of the course, learners should be able to
CO1: Recognize and utilize appropriate intelligent agents across diverse AI applications
CO2: Construct intelligent systems using various informed, uninformed, or heuristic search methods
CO3: Identify relevant knowledge and utilize ontological engineering to devise problem-solving strategies
CO4: Apply suitable algorithms to tackle AI challenges effectively
CO5: Implement concepts underpinning contemporary logical inference systems
CO6: Represent intricate problems using a precise yet appropriately constrained language of representation

Course Contents

Unit I	**Introduction to AI**	**6 Hours**

Introduction to Artificial Intelligence, Core Concepts in AI, Evolution of AI, Current Developments and applications,, Risks and Advantages of AI, Intelligent Agents, Agents and Their Environments, Rational Behavior: Understanding Rationality, Characteristics of Environments, Architecture of Agents.

#Exemplar/Case Studies Creating a Chess Playing AI IBM's Deep Blue defeating Garry Kasparov in 1997 showcased early AI capabilities in strategic decision-making and pattern recognition.

Unit II	**Problem Solving**	**6 Hours**

State Space Search Generate and Test, Simple Search ,Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Search Strategies- Hill climbing - Backtracking - Graph search - Properties of A* algorithm

#Exemplar/Case Studies Sudoku Solver Using generate and test, the solver generates possible number combinations for each cell in a Sudoku puzzle and tests them against Sudoku rules until a valid solution is found.

Unit III	**Advanced Problem-Solving Techniques in Games**	**6 Hours**

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Searching game trees- Minimax procedure - Alpha-beta pruning, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP) and Examples.		
#Exemplar/Case Studies Tic-Tac-Toe A IExample: A Tic-Tac-Toe AI employs minimax to search through possible moves, alternating between maximizing its chance of winning and minimizing the opponent's chances, ensuring the best possible outcome or a draw.		
Unit IV	**Logic and Inference**	**6 Hours**
Formal Logic,Propositional Logic,Resolution Method in Propositional Logic, First Order Logic,Resolution Refutation in FOL, Horn Clauses and SLD Resolution, Unification and First-Order,Inference, Forward Chaining, Backward Chaining, Knowledge Representation, Ontological Engineering		
#Exemplar/Case Studies Logical Puzzles Example: Solving logical puzzles like the Sudoku puzzle using resolution method to derive conclusions from a set of propositional statements, often represented as constraints.		
Unit V	**Reasoning and Planning**	**6 Hours**
Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information, Automated Planning, Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources,		
#Exemplar/Case Studies: Image Classification Example: Using categories to classify objects in images, such as distinguishing between different types of animals in wildlife photography, using machine learning models trained on labeled datasets.		
Unit VI	**Introduction to NLP and Expert Systems**	**6 Hours**
Natural Language Processing- Introduction - Understanding - Perception - Machine learning. Theory Explanation based learning Applications: Environmental science, Robotics, Aerospace, Medical Science etc.		
#Exemplar/Case Studies: Climate Change Analysis Example: NLP techniques are used to analyze large volumes of textual data from climate reports, scientific articles, and social media to track public sentiment, understand climate change impacts, and inform policy decisions.		
Learning Resources		
Text Books		
T1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597 **T2.** Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1 **T3.** Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN-978-0-07-008770-5		
Reference Books :		
R1. Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011. **R2.** John Haugeland, Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985.		

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R3. Pamela McCorduck, Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, A K Peters/CRC Press; 2 edition, 2004.
R4. Zbigniew Michalewicz and David B. Fogel. How to Solve It: Modern Heuristics. Springer; 2nd edition, 2004.
R5. Judea Pearl. Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley, 1984.
R6. Eugene Charniak, Drew McDermott. Introduction to Artificial Intelligence, Addison-Wesley, 1985.

Additional Resources: (Books, e-Resources)

- https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf
- https://www.cin.ufpe.br/~tfl2/artificial-intelligence-modern-approach.9780131038059.25368.pdf
- http://aima.cs.berkeley.edu/

MOOC Courses links :

- https://nptel.ac.in/courses/106/102/106102220/
- https://nptel.ac.in/courses/106/105/106105077/
- https://nptel.ac.in/courses/106/105/106105078/
- https://nptel.ac.in/courses/106/105/106105079/

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24-PEC-CS-5-01B : Digital Image Processing

Teaching Scheme:	**Credit:** 03	**Examination Scheme:**
Theory: 3 Hours/Week		**ISE** : 40 Marks **SEE** : 60 Marks

Prerequisites Courses: Computer Graphics

Course Objectives:

1. To provide students with a comprehensive understanding of the fundamental principles and techniques of digital image processing.
2. To develop practical skills in implementing image processing algorithms using software tools such as MATLAB, OpenCV, and Python.
3. To enable students to apply image processing techniques to solve real-world problems in various fields such as medical imaging, multimedia, and security.
4. To introduce advanced topics in image processing, including frequency domain processing, wavelets, and machine learning applications.
5. To prepare students for research and development in the field of digital image processing, encouraging them to explore emerging trends and applications.

Course Outcomes:
After completion of the course, learners should be able to
CO1: Understand and explain the fundamental concepts of digital image processing, including image formation, representation, and basic image operations.
CO2:Apply image enhancement techniques in the spatial domain, such as gray level transformations and spatial filtering, to improve image quality.
CO3: Utilize frequency domain processing techniques, including Fourier transforms and filtering, for image enhancement and restoration.
CO4: Implement various image restoration and noise reduction techniques to recover degraded images.
CO5: Perform image segmentation and morphological processing to extract meaningful information and features from images.
CO6: Apply advanced image processing techniques, such as color image processing, wavelet transforms, and machine learning, to solve complex image processing problems and develop innovative solutions.

Course Contents

Unit I	**Introduction to Digital Image Processing**	**8 Hours**

Fundamentals of Image Processing : Definition and origins of DIP, Components of an Image Processing System, Applications of image processing; **Image Formation :** Human visual system,Image Sensing and Acquisition, Image Sampling and Quantization, **Basic Concepts :** Neighbors of Pixel, Adjacency, Connectivity, Regions and Boundaries

#Exemplar/Case Studies :
Case Study: Enhancing Historical Document Images , **Exemplar:** Application of Image Sampling and Quantization in Medical

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Imaging		
Unit II	**Image Enhancement in Spatial Domain**	**8 Hours**
Intensity Transformations: Image Negatives,Log,Gamma,Piecewise Linear; **Histogram Processing :** equalization, matching **Image Filtering :** Spatial filtering, Smoothing and sharpening filters, Median and mean filters **Image Arithmetic and Logic Operations :** Addition, subtraction, multiplication, and logical operations., **Image Enhancement Techniques:** High-frequency and low-frequency emphasis , Noise reduction techniques		
#Exemplar/Case Studies : **Case Study:** Enhancing Satellite Images for Environmental Monitoring , **Exemplar:** Application of Histogram Equalization in Consumer Electronics		
Unit III	**Image Enhancement in Frequency Domain**	**8 Hours**
Fourier Transform and Its Properties : Fourier series and transform, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) **Filtering in Frequency Domain :** Ideal, Butterworth, and Gaussian filters, Frequency domain smoothing and sharpening , **Homomorphic Filtering :** Illumination and reflectance model, Homomorphic filter design and implementation; **Practical Applications and Examples :** Real-world applications of frequency domain processing		
#Exemplar/Case Studies **Case Study:** Restoring Damaged Archival Photos , **Exemplar:** Noise Reduction Techniques in Security Surveillance Systems		
Unit IV	**Image Restoration and Reconstruction**	**8 Hours**
Degradation Model : Noise models (Gaussian, salt and pepper, etc.) , Image degradation process ; **Restoration Techniques :** Inverse filtering, Wiener filtering , Constrained least squares filtering ; **Noise Reduction Techniques :** Spatial domain and frequency domain methods , Adaptive filters ; **Image Reconstruction :** Basic concepts and methods , Applications in medical imaging		
#Exemplar/Case Studies **Case Study:** Restoring Damaged Archival Photos , **Exemplar:** Noise Reduction Techniques in Security Surveillance Systems		
Unit V	**Image Segmentation and Morphological Processing**	**7 Hours**
Segmentation Techniques: Edge detection (Sobel, Canny, etc.), Thresholding (global and adaptive) , Region-based segmentation **Morphological Image Processing :** Dilation, erosion, opening, and closing ; Morphological algorithms (boundary extraction, hole filling, etc.) **Representation and Description :** Shape representation (boundary descriptors, region descriptors) , Object recognition and feature extraction		

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#Exemplar/Case Studies: **Case Study:** Segmentation in Medical Imaging for Tumor Detection , **Exemplar:** Morphological Processing in Optical Character Recognition (OCR)		
Unit VI	**Advanced Image Processing Techniques**	**6 Hours**
Color Image Processing : Color models and conversions, **Wavelets :** Wavelet transform , Applications of wavelets in image compression and denoising **Compression Techniques :** Lossless and lossy compression methods, JPEG, MPEG standards **Emerging Trends and Applications :** Machine learning in image processing, AI in image processing and AI tools in image processing		
#Exemplar/Case Studies: Case Study: Using Machine Learning for Facial Recognition, **Exemplar:** Application of Wavelet Transforms in Image Compression		
Learning Resources		
Text Books		
T1. Gonzalez, R.C. and Woods, R.E., "Digital Image Processing," Pearson. **T2.** Jain, A.K., "Fundamentals of Digital Image Processing," Prentice-Hall.		
Reference Books :		
R1. Sonka, M., Hlavac, V., Boyle, R., "Image Processing, Analysis, and Machine Vision," Cengage Learning. **R2.** Pratt, W.K., "Digital Image Processing: PIKS Inside," John Wiley & Sons. **R3.** Digital Image Processing - Algorithms and Applications by I. Pitas, Publisher: John Wiley.		
Additional Resources: (Books, e-Resources) **A1.** MATLAB documentation and tutorials **A2.** OpenCV documentation and tutorials **A3.** Online courses on platforms such as Coursera, edX, and Udacity		
MOOC Courses links : • Digital Image Processing by University at Buffalo & The State University of New York on Coursera • Fundamentals of Image Processing by Northwestern University on Coursera		

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24-PEC-CS-5-01C : Virtual Reality and Augmented Reality		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Computer Graphics		
Course Objectives: ● Understand the fundamental concepts of Virtual Reality (VR). ● Analyze the geometry and physiological principles behind VR. ● Introduce the basics and applications of Augmented Reality (AR). ● Explore the hardware components and technologies used in AR. ● Develop VR and AR applications using Unity. ● Examine Mixed Reality (MR) and the applications of VR, AR, and MR in the industry and the Metaverse.		
Course Outcomes: After completion of the course, learners should be able to CO1: Demonstrate an understanding of the fundamental principles and history of VR. CO2: Apply knowledge of geometry and human vision to create immersive VR environments. CO3: Describe the key concepts and applications of AR and how it differs from VR. CO4: Identify and evaluate various AR hardware technologies and their functionalities. CO5: Develop and implement VR and AR applications using Unity. CO6: Assess the role of MR and the impact of VR, AR, and MR on various industries and the development of the Metaverse.		
Course Contents		
Unit I	**Introduction to Virtual Reality**	**7 Hours**
Definition of Virtual Reality,Historical Evolution of VR, Human Physiology and Perception in Virtual Environments, Essential Components of the Virtual Reality Experience, Virtual Reality Systems: Architecture and Components, Interface with the Virtual World: Input and Output Mechanisms - Visual, Aural, and Haptic Displays, Practical Applications and Uses of Virtual Reality		
#Exemplar/Case Studies: Study the use of Virtual Reality at NASA		
Unit II	**The Geometry of Virtual Worlds & The Physiology of Human Vision**	**7 Hours**
Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.		
#Exemplar/Case Studies: Sweeping coverage of eye movements		
Unit III	**Introduction to Augmented Reality**	**7 Hours**
Defining Augmented Reality, History of AR , The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality		

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Augmented Reality Concepts- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.		
#Exemplar/Case Studies: Timeline of evolution of AR from VR		
Unit IV	**Augmented Reality Hardware**	**8 Hours**
Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.		
#Exemplar/Case Studies: Study the design of an AR application with C#		
Unit V	**VR AR App Development with Unity**	**8 Hours**
VR SDK's – VR SDK'S and Frameworks – OpenVR SDK, StreamVR SDK, VRTK, Oculus SDK, Google VR SDK. VR Concept Integration- Motion Tracking, Controllers, Camera , Setting up Unity with VR, AR Foundation, AR Algorithms – Briefing on SLAM Algorithm, Setting up Unity with AR		
#Exemplar/Case Studies: Case study of VR AR application in Unity		
Unit VI	**Mixed Reality and VR and AR for Industry Metaverse**	**8 Hours**
Introduction to mixed reality, Applications of mixed reality, Input and Output in Mixed reality, Computer Vision and Mixed Reality, Introduction to Metaverse, History of Metaverse, Metaverse value chain		
#Exemplar/Case Studies: Learn Advanced AR Concepts by building a project for an Industry		
Learning Resources		
Text Books		
T1.Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2023. ISBN, 1107198933, 9781107198937. **T2.** Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, "Developing Virtual Reality Applications: Foundations of Effective Design",2009,ISBN : 978-0-12-374943-7 **T3.** Allan Fowler"AR Game Development", 1st Edition, A press Publications, 2018, ISBN 978-1484236178 **T4.** Schmalstieg / Hollerer, "Augmented Reality: Principles & Practice" Pearson Education India; First edition (12 October 2016),-10: 9332578494 **T5**. Naveen, P. (2023)," Understanding the Metaverse and its Technological Marvels: Beyond Reality. (n.p.)" Cambridge Scholars Publishing,ISBN-1-5275-6577-7		
Reference Books :		
R1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005. **R2.** Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003. ISBN:9780471723752, 0471723754 **R3**. Kharis O'Connell " Designing for Mixed Reality", Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381		

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R4. Jesse Glover, Jonathan Linowes, " Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications",ISBN:978-1-83864-818-3
R5. Jonathan Linowes, Krystian Babilinski," Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia", Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

Additional Resources: (Books, e-Resources)

https://lavalle.pl/vr/
https://learn.microsoft.com/en-us/windows/mixed-reality/
https://ptgmedia.pearsoncmg.com/images/9780321883575/samplepages/9780321883575.pdf
https://publications.vtt.fi/pdf/science/2012/S3.pdf
https://ptgmedia.pearsoncmg.com/images/9780201758672/samplepages/0201758679.pdf

MOOC Courses links :

- https://onlinecourses.swayam2.ac.in/nou23_ge34/preview
- https://nptel.ac.in/courses/106/106/106106138/
- https://www.coursera.org/learn/ar
- https://www.coursera.org/learn/introduction-virtual-reality
- https://www.coursera.org/learn/augmented-reality

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24-PEC-CS-5-01D : Soft Computing		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Data Structures and Algorithms & Mathematics for Computer Science		
Course Objectives: ● Provide an understanding of the different paradigms of soft computing such as fuzzy logic, neural networks, and genetic algorithms. ● Explore the applications of fuzzy logic in control systems and decision making. ● Provide an in-depth understanding of artificial neural networks and deep learning. ● Explore the applications of evolutionary algorithms in optimization problems. ● Explain how different soft computing techniques can be integrated to solve complex problems. ● Provide an understanding of the latest research and developments in soft computing.		
Course Outcomes: After completion of the course, learners should be able to CO1: Students will be able to differentiate between traditional computing and soft computing techniques. CO2: Students will learn to apply fuzzy logic to solve control system problems and make decisions under uncertainty. CO3: Students will gain a solid foundation in neural network architectures and learning algorithms. CO4: Students will learn to apply evolutionary algorithms to solve optimization problems effectively. CO5 :Students will be able to design and implement hybrid systems combining fuzzy logic, neural networks, and genetic algorithms. CO6: Students will be able to apply advanced soft computing techniques to complex problems.		
Course Contents		
Unit I	**Introduction to Soft Computing**	**6 Hours**
Overview of Soft Computing: Definition, importance, and comparison with traditional hard computing methods. **Components of Soft Computing**: Key concepts of fuzzy logic, neural networks, genetic algorithms, and evolutionary computation techniques.		
#Exemplar/Case Studies: Various real-world applications and case studies illustrating the use of soft computing.		
Unit II	**Fuzzy Logic**	**6 Hours**
Fuzzy Sets and Systems: Understanding fuzzy sets, operations on fuzzy sets, and fuzzy relations.**Fuzzy Logic Controllers:** Design principles, implementation, and practical applications.**Fuzzy Inference Systems:** Mamdani and Sugeno models, defuzzification methods.		
#Exemplar/Case Studies: A case study on fuzzy logic-based risk assessment in oil and gas industry		
Unit III	**Artificial Neural Networks (ANN)**	**6 Hours**

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Introduction to ANN: Basic concepts, models, and biological inspiration behind neural networks.**Learning and Training:** Methods of supervised, unsupervised, and reinforcement learning.**Types of Neural Networks:** Overview of feedforward, recurrent, convolutional, and deep neural networks.		
#Exemplar/Case Studies: Examples of ANN applications in image and speech recognition, and natural language processing.		
Unit IV	**Evolutionary Algorithms**	**6 Hours**
Introduction to Evolutionary Computation: Overview of genetic algorithms, evolution strategies, and genetic programming. **Genetic Algorithms:** Basic concepts including selection, crossover, mutation, and fitness functions. **Advanced Algorithms:** Concepts of differential evolution, particle swarm optimization, and ant colony optimization.		
#Exemplar/Case Studies: Use cases of evolutionary algorithms in optimization, machine learning, and complex system modeling.		
Unit V	**Hybrid Systems**	**6 Hours**
Combining Techniques: Integration of neuro-fuzzy systems, genetic-neural systems, and fuzzy-genetic systems. **Design and Implementation:** Methodologies for combining soft computing techniques.		
#Exemplar/Case Studies: Practical examples and applications of hybrid systems.		
Unit VI	**Advanced Topics in Soft Computing**	**6 Hours**
Deep Learning: Introduction, architectures, and frameworks of deep learning. **Reinforcement Learning:** Principles, Markov decision processes, and Q-learning. **Recent Advances and Trends:** Latest research, emerging technologies, and future directions in soft computing.		
#Exemplar/Case Studies: Practical implementation of a comprehensive project using one or more soft computing techniques.		
Learning Resources		
Text Books		
T1. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 3rd Edition, Wiley, 2018. **T2**. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence," Prentice-Hall, 1997. **T3**. S. Haykin, "Neural Networks and Learning Machines," 3rd Edition, Pearson, 2008.		
Reference Books :		
R1.D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning," Addison-Wesley, 1989. **R2**. M. Mitchell, "An Introduction to Genetic Algorithms," MIT Press, 1998		
Additional Resources: (Books, e-Resources) Introduction to Fuzzy Logic :https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_introduction.htm Neural Networks and Deep Learning:http://neuralnetworksanddeeplearning.com/ Genetic Algorithms Overview: https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_introduction.htm		

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MOOC Courses links : Neural Networks and Deep Learning

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24-VSEC-CS-5-01 : Instructional Design and Development		
Teaching Scheme: Practical: 4 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW** : 50 Marks

Course Objectives:

- Learn about instructional design models and educational pedagogies.
- Use digital tools to apply reflective and experiential learning techniques.
- Utilize digital platforms to foster collaborative and interactive learning environments.
- Engage students in inquiry-based and integrative learning using digital tools.

Course Outcomes:

After completion of the course, learners should be able to
CO1: Learn about the instructional design model and various pedagogical approaches used in education.
CO2: Apply reflective and experiential learning techniques using digital tools to enhance learning outcomes.
CO3: Utilize various digital platforms to foster collaborative and interactive learning environments.
CO4: Utilize various digital platforms to engage students through inquiry-based learning and integrative instructional models.
CO5: Demonstrate proficiency in integrating technology-enhanced instructional strategies.

Course Contents

Unit I	**Introduction to Instructional Design**	**6 Hours**

Discipline of Instructional Design, ADDIE model of Instructional Design, Overview of Pedagogical Approaches, Students Learning Through Five Pedagogical Approaches In Education (R-2I-2C)

Assignment:

1. **Design a comprehensive lesson plan for the given scenario: A computer science instructor aims to improve student engagement and understanding of "Dynamic Programming" using the ADDIE model and integrating five pedagogical approaches.**

Unit II	**Reflection Approach**	**7 Hours**

Introduction To Experiential Learning Cycle, Kolb's Experiential Learning Cycle, Benefits And Challenges Of Using The Reflective Pedagogical Approach Study of **Reflective Tools and Techniques like Google Forms/Docs, Mentimeter: KWL (Know, Want to know and Learned) Method, Flashcard etc.**

Assignment

1. **Create a digital KWL chart using Google Docs to explore Renewable Energy Sources.**
2. **Develop interactive flashcards to explore various aspects of global climate change, encouraging self-assessment and deeper reflection on its causes, impacts, and mitigation strategies.**

Unit III	**Constructivist and Collaborative Approaches**	**6 Hours**

Significance of Collaborative and Constructive approaches**,** Collaborative learning model: Personal Learning Networks, Peer Learning Networks, Types of constructivism, The Role of teachers in a constructivist classroom, Study of Collaborative and

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Constructivist and Tools like **Copilot, WhiteBoard, Padlet, CodePen, Edpuzzle etc.**		
Assignments: 1. **Explore sustainable rural development through collaborative reflections and idea sharing on the interactive board.** 2. **Develop a collaborative coding project using an online collaborative platform to explore AI-assisted programming techniques.** 3. **Create a collaborative brainstorming session using any White board tools to design a sustainable city plan, integrating urban development and environmental conservation strategies**		
Unit IV	**Inquiry-Based and Integrative Approaches**	**7 Hours**
Definition and Theoretical Foundations of Inquiry-Based Learning, Phases of Inquiry-based learning, 7 E -Instructional model, Significance of Integrative Approach, The role of teacher in integrative approach, Challenges to Integrative Pedagogical Approach, Study of Tools for **Inquiry-Based and** Integrative Approaches **like Kahoot, Edmodo, Slido, Socrative; Activity-Based Learning, Game Pedagogy, MindMeister etc.**		
Assignments: 1. **Conduct a collaborative ideation session using an online interactive tool to generate innovative ideas for digital solutions addressing current societal challenges.** 2. **Develop an online quiz(any inquiry based tool) to test knowledge of significant historical events, enhancing engagement and retention through gamified learning.** 3. **Create and conduct an interactive poll to gather opinions on current global affairs, analyzing diverse perspectives and trends in real time.** 4. **Develop an online quiz(any integrative tool) to evaluate comprehension of the Industrial Revolution, emphasizing technological innovations, economic changes, and social impacts.**		
Learning Resources		
Text Books		
T1. Abbie H. Brown, Timothy D. Green, "The Essentials of Instructional Design: Connecting Fundamental Principles with Process and Practice" 5th Edition, 978-1032518497 **T2**. A compilation of online presentations delivered during the webinar on "The Making of Teacher-Experts in the New Normal: Deepening the Understanding of Pedagogical Approaches" last 22 June 2022, "Pedagogical Approaches In Education, Theories, Practices, and Applications in the Classrooms" - link		
Additional Resources: (Books, e-Resources) https://www.aihr.com/blog/addie-model/ https://www.skillshub.com/what-are-kolbs-learning-styles/ https://pdfs.semanticscholar.org/c3e2/36c0a1e16d9769b611be32f12bec92f48845.pdf		

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24-ELC-CS-5-01 : Research Methodology

Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 02	**Examination Scheme:** **ISE** : 50 Marks

Course Objectives:

- To introduce students to the fundamental concepts and principles of research, including its meaning, objectives, and significance.
- To develop students' skills in critically analyzing research literature and identifying research gaps.
- To provide an in-depth understanding of various types of research and their appropriate applications.
- To guide students through the sequential steps involved in the research process from problem definition to conclusion.
- To instill the importance of ethical principles and standards in conducting and reporting research.

Course Outcomes:

After completion of the course, learners should be able to

CO1: Identify and differentiate between various types of research and their appropriate applications.
CO2: Analyze research literature to identify gaps and formulate research problem definition.
CO3: Employ different research approaches and methodologies in their investigations.
CO4: Recognize and apply ethical principles and standards in conducting and reporting research.

Course Contents

Unit I	**Introduction to Research Methodology**	**8 Hours**

Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Steps involved in research, Criteria of Good Research, Defining research problem

#Exemplar/Case Studies Select a research topic and finalization of Objective

Unit II	**Literature Review, Research Design and Methods**	**7 Hours**

Sources of literature, Accessing literature, Exercises on literature review on some topics and preparation of a report of the review. Identification of gaps in literature. Meaning of Research Design, Need for Research Design,Features of a Good Design, Concepts Relating to Research Design, Methods of research design, Basic Principles of Experimental Designs ,Research Process and Steps Involved.

#Exemplar/Case Studies: Tools for Literature Review, Compare different research design and methods for developing your problem definition

Unit III	**Data Collection, Analysis and interpretation**	**8 Hours**

Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in data collection.Quantitative Data Analysis, Qualitative Data Analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software ,Statistical inference, Interpretation of results

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#Exemplar/Case Studies:
Data Collection through Survey Research, Field Study, Open-Source Data, Citizen Science Data
Develop Quantitative and Qualitative Data Analysis approaches of your research topic

Unit IV	**Technical Writing and reporting of research**	**7 Hours**

Writing research report and research proposals, structure and content of reports, styles of referencing and citations, bibliography, use of endnote, Referencing and referencing styles, Research Journals, Indexing and citation of Journals,Intellectual property, Ethical issues related to publishing, Plagiarism

#Exemplar/Case Studies: Use of tools / techniques for Research: Dissertation writing using Overleaf/other tool

Learning Resources

Text Books

T1. "Research Methodology- Methods and Techniques", Kothari C.K, New Age International, New Delhi,2004.
T2. "Research Methodology- A Step-By-Step Guide for Beginners", Ranjit Kumar, Pearson Education, Delhi, ISBN: 81-317-0496-3, 2006.
T3. "Research design: Qualitative, quantitative, and mixed methods approaches", Creswell, John W. , Sage publications, 2013.

Reference Books :

R1. "Research Methods", Trochim, William M.K., 2/e, Biztantra, Dreamtech Press, New Delhi, ISBN: 81-7722-372-0, 2003
R2. "Applied Statistics & Probability for Engineers", Montgomery, Douglas C. &Runger, George C., 3/e, Wiley India, 2007
R3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition

Additional Resources: (Books, e-Resources)
1. International Journal of Social Research Methodology
2. The Postgraduate Research Handbook by Gina Wisker.
3. Research Methodology: Motivation for Research; Dr. S.N. Sridhara

MOOC Courses links :
- https://www.coursera.org/learn/research-methods
- https://onlinecourses.swayam2.ac.in/cec20_hs17/preview

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24-PCC-CS-5-05 : Advanced Cloud Computing		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE**: 40 Marks **SEE**: 60 Marks
Prerequisite Courses: Cloud Computing		
Companion Course: Laboratory Practice-II		

Course Objectives:

- To understand the concepts of advanced cloud computing, virtualization, and cloud storage systems.
- To Design and implement service-oriented architecture (SOA) in cloud environments.
- To Analyze and evaluate cloud security systems and protocols.
- To Develop and deploy applications on advanced cloud platforms such as AWS, Azure, and Google Cloud.

Course Outcomes:

After completion of the course, learners should be able to
CO1: Understand the different tools and techniques of Cloud Computing
CO2: Achieve advanced proficiency in virtualization and cloud infrastructure
CO3: Analyze and implement cloud storage systems, including object, block, and file storage.
CO4: Design and implement service-oriented architecture (SOA) in cloud environments, including microservices, API gateways, and service discovery.
CO5:Design and implement cloud security systems, including identity and access management, data encryption, and network security.
CO6: Develop and deploy applications on advanced cloud platforms, including AWS, Azure, and Google Cloud.

Course Contents

Unit I	**Introduction to Advanced Cloud Computing**	**9 Hours**

Introduction, Roots of Cloud Computing: From mainframe to Cloud, Benefits of Cloud Computing SOA, Web services, Web 2.0, Mashups, Grid computing, Utility computing, Hardware virtualization, Essentials of Cloud characteristics, Challenges, Cloud economics, Role of Networks in Cloud Computing: Cloud types and service models, Cloud computing platforms: OpenStack, Open Nimbus, Eucalyptus Primary Cloud Service models, Cloud Services brokerage, Primary cloud deployment models, cloud computing reference model, The greenfield and brownfield deployment options

#Exemplar/Case Studies: Examining popular open-source cloud computing platforms' features, capabilities, and deployment scenarios.

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Unit II	**Virtualization**	**8 Hours**
Introduction, Characteristics of Virtualized environments, Taxonomy of Virtualization techniques, Pros and Cons of Virtualization, Technology examples: Xen, KVM, Vmware, Microsoft Hyper-V Infrastructure as Service, best-of-breed cloud infrastructure components, cloud-ready converged infrastructure, Virtual machine provisioning and migration services, Anatomy of Cloud infrastructure, Distributed management of virtual infrastructure, scheduling techniques, SLA Commitment		
#Exemplar/Case Studies: Datacenter virtualization managed services		
Unit III	**Cloud Storage systems**	**9 Hours**
Storage system architecture, Big data, virtualized data center (VDC) architecture, VDC Environment, server, storage, networking, desktop and application virtualization techniques and benefits, Virtual Machine Components and Process of converting physical to VMs, Block and file level storage virtualization, Virtual Provisioning, and automated storage tiering, VLAN, VSAN and benefits, Network traffic management techniques in VDC, Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo. Features and comparisons among GFS, and HDFS.		
#Exemplar/Case Studies : Virtualized Data Center (VDC) Architecture and Big Data Storage Solutions for ABC Corporation		
Unit IV	**Service Oriented Architecture**	**8 Hours**
Introduction and architecture for federated cloud computing, Performance prediction for HPC on Cloud. SLA management: Types of SLA, Life cycle of SLA, Traditional approaches of SLA. service catalog, service ordering process, management and functional interfaces of services, cloud portal and its functions, cloud interface standards along with SOAP and REST, system integration and work-flow modeling, cloud service life-cycle phases: service planning, service creation, service operation, and service termination Control layer, its functions and benefits, element and unified manager, software-defined approach and techniques for managing IT resources		
#Exemplar/Case Studies: Federated Cloud Computing and SLA Management for High-Performance Computing (HPC) at ABC Research Institution		
Unit V	**Cloud Security Systems**	**9 Hours**
Introduction, Global Risk and Compliance aspects in cloud environments and key security terminologies, Technologies for Data Security, Data security risk, Cloud computing and identity, Digital identity and access management, Content level security, Security-As-A-Cloud Service, Cloud Security: Issues with Multi-tenancy, Isolation of users/VMs from each other, VM vulnerabilities, hypervisor vulnerabilities, VM migration attacks, Cloud-based DDOS, Developing cloud security models, end-to-end methods for enforcing Security, Security policies and programming models with privacy-aware APIs		
#Exemplar/Case Studies:SecureCloud: A Comprehensive Cloud Security Solution for ABC Corporation		
Unit VI	**Advanced Cloud Platforms**	**7 Hours**
Cloud Platforms: Overview and Architecture, Azure, Google App Engine, Amazon Web Services.		

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Cloud Orchestration: Elements of Cloud Orchestration, Example platforms: OpenStack and vSphere, OpenStack Deep dive: Covers Networking, Storage, Authentication modules of OpenStack, Nova, Quantum, Keystone and Cinder, Swift.
#Exemplar/Case Studies: Implementing OpenStack and vSphere for ABC Corporation
Learning Resources
Text Books
T1. RajkumarBuyya, "Cloud computing principles and paradigms", Wiley **T2.** Gautam Shroff, Enterprise Cloud Computing, Cambridge **T3.** Handbook of Cloud Computing, Springer Publication **T4**. RajkumarBuyya, "Mastering Cloud computing", McGraw Hill **T5**. Tim Mather, Subra K, ShahidL., Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5 **T6.** Dr. Kumar Saurabh," Cloud Computing", Wiley Publication **T7**. Greg Schuler," Cloud and virtual data storage networking", CRC Press **T8**. Barrie Sosinsky," Cloud Computing", Wiley India
Reference Books :
R1. Kailash Jayaswal, " Cloud computing", Black Book, Dreamtech Press **R2.** Anthony T. Velte, Cloud Computing: A Practical Approach, Tata McGraw Hill, 2009, ISBN: 070683514 **R3**. Richard Hill, Guide to Cloud Computing: Principles and Practices, Springer ISBN-10: 1447146026 **R4**. Kai Hwang, Geoffrey and KJack, Distributed and Cloud computing, Elsevier **R5**. Shailendra Singh, Cloud Computing, Oxford Higher Education, , 2018 References: **R6.** Danielle Ruest and Nelson Ruest, Virtualization, A beginners Guide, Tata McGraw Hill,2009 **R7**. Tom White, Hadoop: The Definitive Guide, O'Reilly, 3rd Edition, 2012 **R8**. Dinakar Sitaram and Geetha Manjunath, Moving to the cloud, Elsevie
Additional Resources: (Books, e-Resources) • https://computingforgeeks.com/top-open-source-cloud-platforms-and-solutions/ • https://www.onx.com/resources/case-studies/datacenter-virtualization-managed-services • https://dgtlinfra.com/virtual-data-center/ • https://www.ijrte.org/wp-content/uploads/papers/v10i2/B63110710221.pdf • https://youtu.be/0Pu3IopE4_A
MOOC Courses links : • https://onlinecourses.nptel.ac.in/noc24_cs131/ • https://www.udemy.com/course/total-cloud-computing-comptia-cloud-cert-cv0-002/?couponCode=NVDIN35 • https://www.udacity.com/course/cloud-developer-nanodegree--nd9990

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24-PCC-CS-5-06: Laboratory Practice -II

Teaching Scheme:	**Credit:** 2	**Examination Scheme:**
Practical: 4 Hours/Week		**TW** : 50 Marks **OR**: 50 Marks

Prerequisite Courses: Cloud Computing, Artificial Intelligence

Companion Course: Advanced Cloud Computing

Course Objectives:

1. Design and develop secure cloud-based applications using industry-leading cloud platforms (AWS, Azure, Google Cloud).
2. Configure VMware to create and manage virtual machines (VMs)
3. Preprocess and Clean Textual Data for Sentiment Analysis

Course Outcomes:

After completion of the course, learners should be able to
CO1:To identify the robot's navigation system by analyzing experimental data
CO2: To Develop cloud-native applications using cloud platforms (AWS, Azure, Google Cloud).
CO3: Design and configure virtual machine (VM) infrastructure using VMware.

Guidelines for Instructor's Manual

The instructor's manual will be developed as a reference and hands-on resource. It should include a prologue (about the University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students as a journal. The journal consists of a Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments will be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environmental awareness, attaching printed papers as part of write-ups and program listing to journals must be avoided. The use of DVDs containing student programs maintained by the Laboratory in charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on the overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grades/marks based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to the satisfactory implementation of the problem statement. Relevant questions may be

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asked at the time of evaluation to test the student's understanding of the fundamentals and effective and efficient implementation. This will encourage transparent evaluation and a fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Virtual Laboratory:

- Software Modeling and Architectures: http://vlabs.iitkgp.ernet.in/se
- Information Security: http://cse29-iiith.vlabs.ac.in

Suggested List of Laboratory Experiments/Assignments

Sr No	Assignment Title
1	Design and develop Applications using Salesforce Cloud/AWS/Azure
2	Developing a Real-time Analytics Dashboard on Google Cloud
3	Building a Secure and Compliant Healthcare Application on Salesforce Cloud/AWS/Azure
4	Install Virtualbox/VMware Workstation with different flavors of Linux or Windows OS on top of Windows or 8.
5	Implement paravirtualization by launching a Linux VM instance on an Amazon EC2 Cloud.

Learning Resources

Text Books

T1: Srikanta Patnaik "Robot Cognition and Navigation: An Experiment with Mobile Robots Cognitive Technologies",Springer Science & Business Media, 2007, ISBN 3540689168, 9783540689164
T2: Michael J. Kavis,"Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)" ,Publisher: Wiley,ISBN-13: 978-1118617618
T3: Mohith Shrivastava,"Learning Salesforce Lightning Application Development", Packt Publishing,ISBN-13: 978-1786467355
T4: Joe Baron, Hisham Baz, Tim Bixler, Biff Gaut, Kevin E. Kelly, Sean Senior, John Stamper "AWS Certified Solutions Architect Official Study Guide: Associate Exam" by Publisher: Sybex,ISBN-13: 978-1119138556
T5: Ritesh Modi,"Azure for Architects: Create secure, scalable, high-availability applications on the cloud" ,Publisher: Packt Publishing,ISBN-13: 978-1788397391
T6: Ted Simpson and Jason Novak,"Hands-On Virtual Computing" Publisher: Cengage Learning,ISBN-13: 978-1305107649

Reference Books :

R1. Kailash Jayaswal, " Cloud computing", Black Book, Dreamtech Press
R2. Anthony T. Velte, Cloud Computing: A Practical Approach, Tata McGraw Hill, 2009, ISBN: 070683514
R3. Ultimate AWS Certified Cloud Practitioner's Exam Guide

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc21_cs14/preview
- https://www.udemy.com/topic/amazon-aws/

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24-PEC-CS-5-02A : AI-Powered IoT Applications		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Machine Learning Internet of Things and Embedded Systems Deep Learning		

Course Objectives:

The main objective of this course is to introduce the students to the basics of Machine Learning Concepts applicable with Internet of Things

- To learn and understand techniques used in Machine Learning and the Internet of Things.
- To get acquainted with machine learning for IOT Data Analysis.
- To learn and understand Machine learning and deep learning methods for IoT applications.
- To Design IoT Application using Machine learning and Deep Learning.
- To Develop programming skills needed to engage in research in machine learning and the Internet of Things and its benefits for society.

Course Outcomes:

After completion of the course, learners should be able to

CO1: Identify and understand the fundamental concepts of machine learning.
CO2: Identify and understand the fundamental concepts of the Internet of Things.
CO3: Design and Implement advanced machine learning and deep learning algorithms for IOT.
CO4: Analyze and Apply IIoT analytics to real-world applications.
CO5: To Understand and implement the end-to-end life cycle of IoT systems.
CO6: Design and Develop various IoT applications using ML and DL techniques.

Course Contents

Unit I	**Overview of Machine Learning Techniques and Paradigms**	**9 Hours**

Introduction to ML, Introduction to Statistical Learning Methods, Classic and adaptive machines, Machine-Learning Problem, Machine-Learning Techniques and Paradigms, Machine Intelligence, Elements of Machine Learning, ML methods for IoT Applications : Decision Trees (DTs), Support Vector Machines (SVMs), Bayesian theorem-based algorithms, kNearest neighbour (KNN), Random forest (RF), Association Rule (AR) algorithms.

#Exemplar/Case Studies *Predicting House Prices Using Linear Regression*: This study explores the application of linear regression to predict house prices based on various features such as location, size, and amenities.

Unit II	**Predictive Intelligence in IoT**	**8 Hours**

IoT Data Pre-processing: Preparing Data for Predictive Maintenance Models, Cleaning and Standardizing IoT Data, Using

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Advanced Data Exploration Methods, Feature Engineering: Investigating Feature Engineering, Utilizing Feature Selection Techniques, Selecting Feature Sets with Machine Learning , Applying Machine Learning to IoT Data Analysis.		
#Exemplar/Case Studies *Smart City Data Integration*: This study demonstrates the cleaning and standardization of heterogeneous IoT data collected from various sensors in a smart city project, ensuring data consistency and reliability for further analysis.		
Unit III	**IoT Design Methodology**	**8 Hours**
Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, Difference between IoT and M2M, IoT Physical Devices & Endpoints, Case Studies Illustrating IoT Design.		
#Exemplar/Case Studies Agricultural enterprises integrate IoT sensors and machine learning to optimize crop management practices, enhance yield, and conserve resources.		
Unit IV	**Industrial Internet of Things and Industry 4.0**	**9 Hours**
Introduction to Industrial Internet of Things and Industry 4.0, Industry 4.0: Basics, Industrial Internet of Things: Basics, Enabling Technologies of IIoT, IIoT Analytics, Applications and Case Studies-Healthcare,Inventory Management and Quality Control,Plant Safety and Security.		
#Exemplar/Case Studies Energy Efficiency Optimization in Office Buildings.		
Unit V	**Deep Learning for IOT**	**9 Hours**
The End-to-End Life Cycle of the IoT, Deep Learning Architectures for IoT, IoT applications and image recognition, DL for sound/audio recognition in IoT, IoT Security, Advanced Aspects and Analytics in IoT		
#Exemplar/Case Studies: Smart Traffic Management in Urban Areas.		
Unit VI	**ML and IoT Case Studies**	**8 Hours**
Applications of ML and IOT : Case Studies: IOT for Agriculture, Remote Patient Monitoring, Smart City, Smart Transportation, Traffic Analysis and Healthcare.		
#Exemplar/Case Studies: A smart city implements secure communication protocols using machine learning to protect data transmitted across its IoT infrastructure, including traffic management and public safety systems.		
Learning Resources		
Text Books		
T1. Bishop, Christopher M., and Nasser M. Nasrabadi, "Pattern recognition and machine learning",Vol. 4.No. 4. New York: springer, 2006. **T2.** Ethem Alpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013 **T3.** Hantao Huang, Hao Yu, "Compact and Fast Machine Learning Accelerator for IoT Devices,"Edition: 1st ed. Publisher: Springer Singapore Year: 2019 ISBN: 978-981-13-3323- 1		

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T4. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014.
T5. Andrew Minteer: Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices, Packt Publishing, 2017
T6. IoT Data Analytics using Python M S Hariharan BPB publication.

Reference Books :

R1. Tom M. Mitchell , " Machine Learning", McGraw-Hill Science/Engineering/Math; (March 1, 1997)ISBN: 0070428077
R2. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition, Springer Series in Statistics, Feb 2009
R3.Neeraj Kumar, Aaisha Makkar, " MACHINE LEARNING IN COGNITIVE IOT", https://www.routledge.com/Machine-Learning-in-Cognitive-IoT/KumarMakkar/p/book/9780367359164 ISBN 9780367359164 Published June 1, 2020 by CRC Press
R4. Puneet Mathur, " IoT Machine Learning Applications in Telecom, Energy, and Agriculture, With Raspberry Pi and Arduino Using Python", ISBN 978-1-4842-5549-0
R5.Nicolas Modrzyk, " Real-Time IoT Imaging with Deep Neural Networks - Using Java on the Raspberry Pi 4" , Apress Publication Year: 2020, ISBN: 9781484257210, 978148425722
R6.D. Barber, Bayesian Reasoning and Machine Learning, Cambridge University Press (2012)
R7. Michael Stanley and Jongmin Lee: Sensor Analysis for the Internet of Things, Morgan & Claypool Publishers, 2018.
R8. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
R9. Hands-On Deep Learning for IoT: Train neural network models to develop intelligent IoT applications by Dr. Mohammad Abdur Razzaque ,Md. Rezaul Karim Packt Publishing, June 2019
R10. Deep Learning for Beginners: A beginner's guide to getting up and running with deep learning from scratch using Python By Dr. Pablo Rivas Sep 2020.
R10. Internet of Things: A Hands-on Approach Arshdeep Bahga and Vijay Madisetti ISBN 9788173719547 2015

Additional Resources: (Books, e-Resources)

1. M. S. Mahdavinejad et al., "Machine learning for Internet of Things data analysis: A survey," Digit. Commun. Netw., vol. 4, no. 3, pp. 161–175, Aug. 2018. https://www.sciencedirect.com/science/article/pii/S235286481730247X
2. J. Jagannath, N. Polosky, A. Jagannath, F. Restuccia, and T. Melodia, "Machine learning for wireless communications in the Internet of Things: A comprehensive survey," Ad Hoc Netw., vol. 93, 2019. https://arxiv.org/abs/1901.07947

MOOC Courses links :

- Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc23_cs18/preview
- Link to NPTEL course contents: Introduction to Internet of Things https://onlinecourses.nptel.ac.in/noc17_cs26/preview
- Predictive Analytics for IOT, by Microsoft on edx Link: https://www.edx.org/course/predictive-analytics-for-iotsolutions?source=aw&awc=6798_1594277292_cca42f86ac9afe29904595a53aad9e1c
- INTERNET of Things and Machine Learning Training https://shop.boltiot.com/products/internet-of-things-and-machine-learning-training

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24-PEC-CS-5-02B : Advanced Data Visualization and Storytelling		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Database Management System, Statistical Methods for Data Science		

Course Objectives:

- To understand the fundamentals of data visualization and the importance of storytelling in data analysis.
- To learn and apply different data visualization techniques and tools.
- To develop skills in creating interactive and dynamic visualizations.
- To enhance the ability to interpret and communicate data insights effectively.
- To apply visualization and storytelling techniques to real-world case studies and projects.

Course Outcomes:
After completion of the course, learners should be able to
CO1: Design and implement effective data visualizations.
CO2: Utilize various data visualization tools and software.
CO3: Create interactive and dynamic visualizations for different data sets.
CO4: Develop compelling data stories that communicate insights clearly.
CO5: Apply data visualization and storytelling techniques to solve real-world problems.

Course Contents

Unit I	**Introduction to Data Visualization**	**8 Hours**

Introduction to Data Visualization: Importance and principles of data visualization. **Terminology in Data Visualization:** Key terms and concepts in data visualization. **Basic Charts and Plots:** Creating and interpreting bar charts, line graphs, scatter plots, and pie charts. **Multivariate Data Visualization Techniques:** Techniques for visualizing data with multiple variables. Evolution of data visualization - Role of data visualization in decision making

#Exemplar/Case Studies - Case Study on Effective Data Dashboards

Unit II	**Design Principles**	**8 Hours**

Visual Perception and Cognitive Load : Understanding Visual Perception Managing Cognitive Load
Color Theory and Visual Hierarchy : Color Theory in Data Visualization Creating Visual Hierarchy
Designing for Accessibility : Principles of Accessible Design Implementing Accessibility Features for data visualization

#Exemplar/Case Studies - Case Study on User-Friendly Visual Designs

Unit III	**Data Interpretation**	**8 Hours**

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Statistical analysis and interpretation - Identifying trends, patterns, and outliers, Data cleaning and preprocessing, Techniques for data summarization, Data integration from multiple sources		
#Exemplar/Case Studies - Case Study on Data Interpretation in Business Intelligence		
Unit IV	**Interactive Visualizations**	**9 Hours**
Introduction to Interactive Dashboards: Importance and benefits of interactive dashboards in data analysis. User experience (UX) design principles for interactive data products. Key features of effective interactive dashboards. **Techniques for Dynamic Data Visualization:**Best practices for creating dynamic and responsive visualizations. Strategies for incorporating real-time data updates and interactions. **Tools for Interactive Visualization:** Overview and comparison of popular tools: Tableau, D3.js, Power BI, and more.		
#Exemplar/Case Studies - Case Study on Interactive Financial Dashboards		
Unit V	**Data Storytelling**	**9 Hours**
Introduction to Data Storytelling: Definition, importance, and benefits of data storytelling in data science. **Elements of a good data story:** context, characters, conflicts, and resolutions. Psychological principles of storytelling. Structuring a Data Narrative: Techniques for creating a clear and engaging narrative flow: beginning, middle, and end.Crafting a compelling data story: best practices for making data stories engaging and persuasive. **Tailoring Data Stories for Different Audiences:**Identifying the audience: understanding and tailoring the story for different audience types.Adapting narrative techniques to suit audience needs and preferences.		
#Exemplar/Case Studies - Case Study on Impactful Data Stories in Multidisciplinary Streams.		
Unit VI	**Advanced Visualization Techniques**	**8 Hours**
Real-Time Data Visualization: Importance and applications of real-time data visualization. Techniques for implementing real-time visualizations.Tools and libraries: D3.js, Grafana, Plotly, Power BI. **Large-Scale Data Visualization:** Challenges and strategies for visualizing large datasets.Techniques for efficient data rendering and interactivity.Tools and libraries: Apache ECharts, Tableau.		
#Exemplar/Case Studies - Case Study on Real-Time Data Visualization in IoT		
Learning Resources		
Text Books		
T1. Cole Nussbaumer Knaflic, "Storytelling with Data," Wiley; 1st edition, ISBN 13 : 978-1119002253		
Reference Books :		

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R1. Edward R. Tufte, "The Visual Display of Quantitative Information," Graphics Pr; 2nd edition, Graphics Press INC, ISBN-13 : 978-1930824133
R2. Edward R. Tufte, "Envisioning Information," Graphics Press USA, ISBN-13 : 978-0961392116
R3. Foster Provost and Tom Fawcett, "Data Science for Business," Shroff; First Edition, ISBN-13 : 978-9351102670
R4. Foster Provost and Tom Fawcett, "Data Science for Business," Shroff; First Edition, ISBN-13 : 978-9351102670
R5. Stephen Few, "Information Dashboard Design," Analytics Press, ISBN-13 : 978-1938377006
R6. Dr. Neha Sharma, "Exploring Stories as Pedagogy : Classroom and Beyond," Notion Press, ASIN : B0D8JYHF24

Additional Resources: (Books, e-Resources)
https://www.storytellingwithdata.com/books
https://www.storytellingwithdata.com/videos
https://www.storytellingwithdata.com/chart-guide
https://www.verywellmind.com/color-psychology-2795824
https://www.behavioraldesign.academy/blog/visual-hierarchy-and-color-psychology
https://onlinelibrary.wiley.com/doi/10.1155/2022/7259595
https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2015.00368/full

MOOC Courses links :

1) NPTEL : Advanced R Programming for Data Analytics in Business,
   Link: https://onlinecourses.nptel.ac.in/noc24_mg113/preview
2) NPTEL : "Data to Dashboard: Mastering Visual Storytelling with Tableau,"
   Link:
   https://elearn.nptel.ac.in/shop/iit-workshops/completed/data-to-dashboard-mastering-visual-storytelling-with-tableau/?v=c86ee0d9d7ed

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24-PEC–CS-5-02C : Application Development using Augmented Reality

Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE**: 40 Marks **SEE**: 60 Marks

Prerequisite Courses: Interaction and Experience Design for AR/VR

Course Objectives:

- This course aims to provide a foundation for the fast-growing field of AR and make the students aware of the various AR devices and AR Application development.

Course Outcomes:

After completion of the course, learners should be able to
CO1: Describe how AR systems work and list the applications of AR
CO2: Develop AR applications for different Mobile OS
CO3: AR Application Development Vuforia and Vumark :
CO4: Use Software Design Patterns for AR Application development
CO5: Mobile Application development with AR
CO6: Develop real-life AR applications

Course Contents

Unit I	**Introduction to AR**	**9 Hours**

Introduction to AR: AR vs VR, How AR works, Types of AR targets, Technical issues in relation to AR, Using AR in Enterprise, Using AR in industry 4.0, Applications of AR, Setting up your System: introduction to unity for AR development, Understanding the Unity interface, Unity's main elements, installing to unity, Scripting first example in C#.

Unit II	**AR Application Development using Unity**	**8 Hours**

Using ARCore for Unity, Apple ARKit for Unity, and MixedReality Toolkit for Unity, Using Cameras in AR, Getting and using Vuforia, Getting and using ARToolkit, Identifying platforms and toolkits, building and running from Unity, targeting Android, Targeting iOS, targeting Microsoft Hololens

Unit III	**AR Application Development Vuforia and Vumark**	**9 Hours**

Augmenting Business Cards: Planning, setting up Vuforia, adding image targets, adding objects, building and running, and animating the drone. AR Solar System: Project Plan, Setting up the project, introduction to unit C# programming, using Vumark targets, building and running, AR for automation with Vuforia and AR Glasses, AR for Tourism with ARKit

Unit IV	**AR Application Development using ARkit and MaxST**	**9 Hours**

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AR Software design patterns, creating the UI, Creating an instructions controller, Creating an instruction data model, Loading data from a CSV file, Abstracting UI elements, Augmenting the instruction manual: Setting up the project for AR with Vuforia, using user-defined tags, adding visual helpers, integrating augmented content, using ARKit for spatial anchoring, Aholographic instruction manual. AR Application development using MaxST and Wikitude		
Unit V	**AR with Mobile Application Development**	**8 Hours**
AR with Mobile Application Development, Room decoration with AR: the project plan, setting up the project and scene, mixed reality toolkit input manager, abstract selection menu UI, building for ios with ARKit, Building for mobile AR with Vuforia, Poke the ball game, Augmenting real-world objects		
Unit VI	**AR Application development using ARCore and WebAR**	**7 Hours**
AR for Manufacturing with ARCore, AR for Training with WebAR and Augmented Class, AR for marketing with EasyAR, AR for retail with Vuforia		
Learning Resources		
Text Books		
T1. Jonathan Linowes, Kryshtian Babilinski, "Augmented Reality For Developers", Packt Publishing, ISBN - 9781787288041, 1787288048 **T2.** Jorge R Lopez Benito, Enara Artetxe Gonzalez, "Enterprise Augmented Reality Projects", Packt Publishing, ISBN - 9781789803150, 1789803152		
Reference Books :		
R1. John Peddie, "Augmented Reality: Where we will all live",Springer International Publishing, ISBN - 9783319545028, 3319545027		
Additional Resources: (Books, e-Resources)		
MOOC Courses links : • Introduction to Augmented Reality and ARCore, https://www.coursera.org/learn/ar?action=enroll		

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24-PEC-CS-5-02D : Computer Vision and Pattern Recognition		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** :40 Marks **SEE** :60 Marks

Prerequisites Courses: Machine Learning , Deep Learning

Course Objectives:

- Understand mathematical modeling behind image processing tasks
- Apply different approaches to solve the real life problems
- Identify error estimation and decision theory behind the pattern recognition tasks
- Identify the algorithms to solve the problems

Course Outcomes:

After completion of the course, learners should be able to
CO1: Apply mathematical modeling methods for low, intermediate, and high-level image processing tasks
CO2: Identify and apply various pattern recognition and classification approaches to solve the problems
CO3: Analyze an algorithm to solve a recent of the art computer vision and pattern recognition problem
CO4: Recognize and understand the practical applications of computer vision and pattern recognition in real-world scenarios.

Course Contents

Unit I	**Foundation of Computer Vision**	**8 Hours**

Introduction to Computer Vision, examples of Computer Vision, Basic concepts of image representation, Image digitization- Sampling & Quantization, Visual perception of the image, **Image formation** - Geometric primitives and transformations, Photometric image formation, The digital camera.

#Exemplar/Case Studies : Computer vision used in agriculture sector

Unit II	**Processing Images**	**9 Hours**

Point operators- Pixel transforms, color transforms, Compositing and matting, Histogram equalization, Linear filtering- Separable filtering, Examples of Linear filtering, Band-pass and steerable filters,More neighborhood operators-Nonlinear filtering, Median filtering, Bilateral filtering, Binary image processing, Morphology, Geometric transformations, Parametric transformations, Mesh-based warping

#Exemplar/Case Studies: Feature-based morphing

Unit III	**Fundamentals of Pattern Recognition**	**8 Hours**

Introduction of Pattern Recognition, Datasets for pattern recognition, Different paradigms for pattern recognition, feature extraction - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Feature selection - Exhaustive search, branch and bound search, selection of best individual features, sequential selection, sequential floating search, max-min approach for feature selection, stochastic search techniques

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#Exemplar/Case Studies: Image classification using PCA		
Unit IV	**Error Estimation & Decision Theory**	**9 Hours**
Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve. Introduction, Bayesian decision theory-continuous and discrete features, two- category classification, minimum error rate classification, discriminant functions, Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality. Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and NearestNeighbor classification; Fuzzy classification		
#Exemplar/Case Studies: Spatial and temporal air quality pattern recognition using environ metric techniques		
Unit V	**Conventional algorithms**	**9 Hours**
Computer Vision: Algorithms: Object Detection Algorithms: From R-CNN to YOLO, Image Classification Using Convolutional Neural Networks (CNNs) Pattern Recognition: Types of algorithms, k-nearest neighbors, decision trees, random forests, support vector machines, and neural networks		
#Exemplar/Case Studies: Traffic Sign Recognition for Autonomous Vehicles		
Unit VI	**Applications**	**7 Hours**
Surveillance and security, manufacturing,Autonomous vehicles and transportation, social media and entertainment Image recognition, Text pattern recognition, Cybersecurity, Robotics.		
#Exemplar/Case Studies: Identify intrusion detection with IBM QRadar		
Learning Resources		
Text Books		
T1 Richard Szeliski,Computer Vision: Algorithms and Applications, Second Edition, Springer, Hardcover ISBN 978-3-030-34371-2, eBook ISBN 978-3-030-34372-9 **T2** Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and Machine Vision, Fourth Edition, Cengage Learning,ISBN 978-9386858146 **T3** Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad, ISBN: 9788173717253 **T4.** Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0		
Reference Books :		
R1. Forsyth / Ponce, Computer Vision: A Modern Approach ,pearson, ISBN:978-9332550117 **R2**.Duda, Richard O., Peter E. Hart, and David G. Stork, Pattern classification, Wiley, Second Edition, ISBN-13. 978-8126511167 **R3** C H Chen, L F Pau, P S P Wang, Handbook of Pattern Recognition and Computer Vision, World Scientific Publishing,		

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ISBN:978-981-02-1136-3

Additional Resources:

- https://www.ibm.com/topics/computer-vision#:~:text=Computer%20vision%20is%20a%20field,they%20see%20defects%20or%20issues
- https://www.mdpi.com/2079-9292/12/22/4626
- https://www.upgrad.com/blog/computer-vision-algorithms/
- https://mindtitan.com/resources/blog/computer-vision-applications/#:~:text=In%20healthcare%2C%20computer%20vision%20applications,object%20recognition%20and%20decision%2Dmaking
- https://www.tutorialspoint.com/applications-of-pattern-recognition

MOOC Courses links :

- https://nptel.ac.in/courses/106105216
- https://nptel.ac.in/courses/106106224
- https://www.coursera.org/learn/introduction-computer-vision-watson-opencv?action=enroll

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24-PEC-CS-5-03A : Industrial IoT		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Internet of Things		

Course Objectives:

- To understand industry 4.0 for the industrial internet of things.
- To understand the basics of the industrial internet of things.
- To study the various layers of the industrial internet of things.
- To understand SDN, ML, DS related to the industrial internet of things.
- To study the security aspects of the industrial internet of things.
- To study real-time applications of the industrial internet of things.

Course Outcomes:

After completion of the course, learners should be able to

CO1: Understand industry 4.0 for industrial internet of things.
CO2: Understand the basics of the industrial internet of things.
CO3: Study the various layers of the industrial internet of things.
CO4: Understand SDN, ML, DS related to the industrial internet of things.
CO5: Study the security aspects of the industrial internet of things.
CO6: Study real-time applications of the industrial internet of things.

Course Contents		
Unit I	**Understanding Industry 4.0**	**9 Hours**
Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Cybersecurity in Industry 4.0		
#Exemplar/Case Studies		**Milk Processing and Packaging Industries**
Unit II	**Basics of Industrial IoT**	**8 Hours**
Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems, IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II		
#Exemplar/Case Studies		**Manufacturing Industries**
Unit III	**Industrial IoT Layers**	**8 Hours**
Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I, Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III		

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#Exemplar/Case Studies		**Virtual Reality**
Unit IV	**Industrial IoT - SDN, ML, DS**	**9 Hours**
Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop, Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II		
#Exemplar/Case Studies		**Steel Technology**
Unit V	**Industrial IoT Security**	**8 Hours**
Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry		
#Exemplar/Case Studies		**Pharmaceutical Industry**
Unit VI	**Applications of Industrial IoT**	**9 Hours**
Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), oil, chemical industry, Applications of UAVs in Industries		
#Exemplar/Case Studies		**Facility Management**
Learning Resources		
Text Books		
T1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on Approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515 **T2**. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley Publication, ISBN: 978-1-119-99435-0		
Reference Books :		
R1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press **R2.** S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.		
MOOC Courses links : ● https://onlinecourses.nptel.ac.in/noc24_cs95/preview		

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24-PEC-CS-5-03B : Social Network Analytics		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Basic Mathematics and Statistics, Introduction to Programming:		
Course Objectives: ● To understand the fundamentals of Social Network Concepts ● To learn techniques for collecting, cleaning, and preparing social network data from various sources. ● To Calculate and interpret key network metrics such as degree, centrality measures, density, and clustering coefficients. ● Apply social network analysis to real-world problems in marketing, epidemiology, sociology, and more.		
Course Outcomes: After completion of the course, learners should be able to CO1 : Understand fundamental concepts of social networks and graph theory. CO2 :Learn techniques for collecting, cleaning, and preparing social network data. CO3 : Learn proficiency in visualizing and interpreting network data CO4 : Understanding of advanced topics in social network analysis, CO5: Analyze dynamic networks and their temporal changes. CO6: Apply social network analysis to real-world problems while considering ethical implications		
Course Contents		
Unit I	**Introduction to Social Networks:**	**09 Hours**
Understand the foundational concepts and terminologies in social network analysis, including nodes, edges, and graph theory fundamentals. Gain familiarity with various types of social networks(Different types of networks: social, biological, information, and technological networks.Examples of real-world social networks (e.g., Facebook, LinkedIn, Twitter)., their representations, and tools for basic visualization and analysis((e.g., Gephi, Cytoscape, NetworkX).)		
#Exemplar/Case Studies : Case studies on the application of social network analysis.		
Unit II	**Data Collection and Preparation for Social Network Analysis**	**08 Hours**
Data Collection : Learn techniques for collecting social network data from various sources, including web scraping and APIs(e.g., Beautiful Soup, Scrapy). **Data Cleaning**: Remove duplicates and irrelevant information (e.g., spam, advertisements). Handle missing data through imputation or deletion.**Data Preprocessing:**Transform data into a suitable format for network analysis (e.g., edge list representing user interactions).**Ethical Considerations: :**Understand ethical considerations and privacy		
#Exemplar/Case Studies: Case studies on Collecting and Preparing Twitter Data for Analysis		
Unit III	**Network Visualization and Analysis**	**09 Hours**

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Introduction to Network Visualization (Overview of visualization tools and libraries (e.g., Gephi, Cytoscape, NetworkX, matplotlib, ggplot2) , **Basic Visualization Techniques:**Creating basic network plots (e.g., node-link diagrams, matrix plots) ,**Advanced Visualization Techniques:**Using interactive features for exploring large networks,Visualizing dynamic networks and temporal changes.**Network Metrics and Analysis**:Calculating and interpreting basic network metrics (e.g., degree centrality, betweenness centrality, clustering coefficient).Identifying important nodes (e.g., hubs, authorities) and network structures (e.g., communities, cliques).		
#Exemplar/Case Studies: Analyzing a Twitter Network		
Unit IV	**Advanced Topics in Social Network Analysis**	**09 Hours**
I**Advanced Network Metrics:**Eigenvector centrality and its applications.PageRank algorithm for ranking nodes in a network.Community detection algorithms (e.g., modularity, hierarchical clustering),**Dynamic Networks:**Analysis of evolving networks over time, Temporal analysis techniques (e.g., temporal centrality, network growth). , **Network Models:**Introduction to different network models (e.g., random graphs, small-world networks, scale-free networks), Application of models to real-world networks and their implications.**Network Sampling and Bias:** Techniques for sampling large-scale networks,Handling biases in network data and their impact on analysis.**Influence and Information Diffusion:**Models and algorithms for studying influence propagation in networks,Predicting information diffusion and viral marketing strategies**, Ethical Considerations in Advanced Analysis**		
#Exemplar/Case Studies Case studies on Investigating real-world examples of dynamic networks and influence propagation ,Presenting findings and implications from advanced network analysis project		
Unit V	**Analyzing Dynamic Networks and Their Temporal Changes**	**08 Hours**
Evolution of dynamic networks over time, applying temporal analysis techniques to track changes in structure, key players, and communities. Use tools like Gephi and NetworkX to visualize these changes and gain insights into network dynamics and their real-world implications.		
#Exemplar/Case Studies: Analysis of network and hardware security breaches.		
Unit VI	**Applying Social Network Analysis to Real-World Problems and Ethical Considerations**	**08 Hours**
Applications in marketing, epidemiology, sociology, political science, and technology networks , Conducting comprehensive case studies using real-world data.Ethical considerations in real-world applications of social network analysis		
#Exemplar/Case Studies: Develop targeted marketing strategies and present actionable insights with an emphasis on ethical considerations.		
Learning Resources		
Text Books		
T1 : David Easley and Jon Kleinberg , "Networks, Crowds, and Markets: Reasoning About a Highly Connected World" Cambridge University Press, 978-0521195331 **T2** : Stanley Wasserman and Katherine Faust, "Social Network Analysis: Methods and Applications", Cambridge University		

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Press
T3 : Matthew A. Russell , "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More", 3rd Edition,9781491973509
T4 : Stephen P. Borgatti, Martin G. Everett, and Jeffrey C. Johnson, "Analyzing Social Networks" by 2nd Edition , SAGE Publications Ltd ,ISBN-13 978-1526404107
T5: Yaneer Bar-Yam, "Dynamics of Complex Systems",1st Edition , ISBN 0813341213 ,https://doi.org/10.1201/9780429034961
T6: Stanley Wasserman and Katherine Faust, "Social Network Analysis: Methods and Applications"

Reference Books :

R1. "Social Network Analysis: Methods and Applications" by Stanley Wasserman and Katherine Faust
R2. Networks, Crowds, and Markets: Reasoning About a Highly Connected World" by David Easley and Jon Kleinberg
R3 : "Analyzing Social Networks" by Stephen P. Borgatti, Martin G. Everett, and Jeffrey C. Johnson
R4: "Networks: An Introduction" by Mark Newman
R5 :Social Network Analysis for Startups: Finding connections on the social web" by Maksim Tsvetovat and Alexander Kouznetsov
R6 :"Handbook of Social Network Analysis" edited by Peter J. Carrington, John Scott, and Stanley Wasserman

Additional Resources: (Books, e-Resources)

Coursera: Social Network Analysis (University of Michigan),
edX: Introduction to Social Network Methods (University of California, Davis)

MOOC Courses links :
Social Network Analysis by NPTEL(https://onlinecourses.nptel.ac.in/noc22_cs117/preview)

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24-PEC-CS-5-03C : Ethical Hacking		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Basic concepts in programming and networking, Security in Computing		
Course Objectives: ● To understand the fundamentals of ethical hacking and computer networking. ● To gain practical knowledge in vulnerability scanning and system hacking. ● To learn about cryptographic techniques and network-based attacks. ● To explore hardware security and various attack methodologies. ● To analyze real-world attack scenarios and their countermeasures.		
Course Outcomes: After completion of the course, learners should be able to CO1: Understand and explain the fundamentals of ethical hacking and networking protocols. CO2: Perform information gathering and vulnerability scanning. CO3: Implement cryptographic techniques for securing data. CO4: Conduct network-based and hardware security attacks. CO5: Utilize tools such as Metasploit for executing various types of attacks. CO6: Analyze and propose solutions to mitigate real-world attack scenarios.		
Course Contents		
Unit I	**Fundamentals of Ethical Hacking and Networking**	**08 Hours**
Introduction to ethical hacking, Fundamentals of computer networking, TCP/IP protocol stack, IP addressing and routing, TCP and UDP, IP subnets		
#Exemplar/Case Studies : Real-world examples of network breaches and ethical hacking interventions.		
Unit II	**Advanced Networking and Information Gathering**	**08 Hours**
Routing protocols, IP version 6, Installation of attacker and victim systems, Information gathering using advanced tools (Google search, archive.org, netcraft, whois, host, dig, dnsenum, NMAP)		
#Exemplar/Case Studies: Case studies on successful information gathering techniques.		
Unit III	**Vulnerability Scanning and System Hacking**	**08 Hours**
Vulnerability scanning using NMAP and Nessus, Creating a secure hacking environment, System hacking: password cracking, privilege escalation, application execution, Malware and Virus, ARP spoofing and MAC attack		
#Exemplar/Case Studies: Examples of vulnerability scanning and system hacking incidents.		

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Unit IV	**Cryptography and Network-based Attacks**	**09 Hours**
Introduction to cryptography, Private-key encryption, Public-key encryption, Cryptographic hash functions, Digital signatures and certificates & applications, Steganography, Biometric authentication, Network-based attacks (DNS and Email security)		
#Exemplar/Case Studies Case studies on cryptographic applications and network-based attacks.		
Unit V	**Network and Hardware Security Attacks**	**09 Hours**
Packet sniffing using Wireshark and Burp Suite, Password attacks using Burp Suite, Social engineering attacks, Denial of Service (DoS) attacks, Elements of hardware security: side-channel attacks, physical unclonable functions, hardware trojans		
#Exemplar/Case Studies: Analysis of network and hardware security breaches.		
Unit VI	**Advanced Attacks and Case Studies**	**08 Hours**
Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, Attacks on web servers: password attacks, SQL injection, cross-site scripting, Case studies: various attack scenarios and their remedies		
#Exemplar/Case Studies: Detailed case studies on advanced attacks and mitigation strategies.		
Learning Resources		
Text Books		
T1. W. Stallings, "Data and Computer Communications," Pearson Education India, ISBN : 978-9332518865, https://amzn.in/d/01MFsoPQ **T2**. B. A. Forouzan, "TCP/IP Protocol Suite," McGraw Hill Education, ISBN : 978-0070706521, https://amzn.in/d/06P7Yv3y **T3**. W. Stallings, "Cryptography and Network Security: Principles and Practice," Pearson Education, ISBN : 978-9332585225, https://amzn.in/d/0cESQTNk		
Reference Books :		
R1. C-H. Wu and J. D. Irwin, "Introduction to Computer Networks and Cybersecurity," CRC Press Inc, ISBN : 978-1466572133, https://amzn.in/d/0b0Ahbij **R2.** B. A. Forouzan, "Data Communication and Networking," McGraw Hill Education India Pvt Ltd, ISBN : 978-0070634145, https://amzn.in/d/0gwL7Pwb		
Additional Resources: (Books, e-Resources)		
MOOC Courses links : • **Ethical Hacking** by NPTEL (https://onlinecourses.nptel.ac.in/noc22_cs13/preview)		

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24-PEC-CS-5-03D : Business Analytics		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE** : 40 **SEE** : 60
Prerequisites Courses: Data Analysis, Database Management, Data Visualization		
Course Objectives: ● Understand the role of business analytics in decision-making. ● Learn various statistical and machine learning techniques for analyzing data. ● Gain hands-on experience with data analytics tools and software. ● Develop skills to interpret and communicate analytic results effectively.		
Course Outcomes: After completion of the course, learners should be able to CO1 : Understand fundamental concepts of business analytics. CO2 : Understand the significance of data quality and integration in business analytics. CO3 : Learn to interpret and visualize data effectively CO4 : Understanding of predictive modeling and machine learning algorithms CO5: Learn principles and techniques of data visualization for effective communication of analytical findings CO6: Apply analytics techniques to real-world business problems.		
Course Contents		
Unit I	**Introduction to Business Analytics**	**09 Hours**
Definition and scope of business analytics, History and evolution of business analytics, The importance of data in business decision-making, Types of business analytics: Descriptive, Predictive, and Prescriptive, The business analytics process, Key success factors in implementing business analytics, Introduction to big data and its significance in business analytics, Overview of analytics software and tools, Role of data scientists and analysts in business.		
#Exemplar/Case Studies : Analyzing customer behavior data to optimize marketing strategies in retail industries.		
Unit II	**Data Management and Data Warehousing**	**08 Hours**
Data collection and preprocessing, Techniques for handling missing data, Data normalization and transformation, Data warehousing concepts and architecture, OLAP (Online Analytical Processing) vs. OLTP (Online Transaction Processing), ETL (Extract, Transform, Load) processes, Data integration and quality, Data governance and security, Introduction to SQL and database management systems, Introduction to NoSQL databases.		
#Exemplar/Case Studies: Implementing a data warehousing solution for a multinational corporation to streamline data integration and improve decision-making.		

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Unit III	**Statistical Methods for Business Analytics**	**08 Hours**
Descriptive statistics and data visualization, Measures of central tendency and variability, Probability distributions and sampling, Confidence intervals and margin of error, Hypothesis testing and confidence intervals, Types of hypothesis tests: t-tests, chi-square tests, ANOVA, Regression analysis and correlation, Linear vs. multiple regression, Assumptions of regression models, Time series analysis, Forecasting methods: moving average, exponential smoothing, Seasonal decomposition of time series data.		
#Exemplar/Case Studies: Using regression analysis to forecast sales trends and optimize inventory management for a manufacturing company.		
Unit IV	**Predictive Analytics and Machine Learning**	**09 Hours**
Introduction to predictive modeling, Model evaluation and validation techniques, Overfitting and underfitting, Supervised and unsupervised learning, Cross-validation and bootstrapping, Classification techniques: Decision trees, k-nearest neighbors, SVM, Naive Bayes classifier, Regression techniques: Linear and logistic regression, Assumptions and diagnostics of regression models, Clustering techniques: K-means, hierarchical clustering, Dimensionality reduction techniques: PCA, LDA, Ensemble methods: Random forests, boosting, bagging, Case studies and applications of predictive analytics.		
#Exemplar/Case Studies: Developing a churn prediction model for a telecommunications company using machine learning algorithms.		
Unit V	**Data Visualization and Business Intelligence**	**08 Hours**
Principles of effective data visualization, Types of data visualizations: bar charts, line charts, scatter plots, histograms, Tools for data visualization: Tableau, Power BI, etc., Best practices for dashboard design, Interactive visualizations and user interfaces, Storytelling with data, Techniques for highlighting key insights, Data visualization for different audiences, Case studies on business intelligence applications, Introduction to Geographic Information Systems (GIS) and spatial data analysis, Visualizing large datasets and handling performance issues.		
#Exemplar/Case Studies: Creating interactive dashboards in Tableau to visualize financial performance metrics and aid executive decision-making.		
Unit VI	**Advanced Topics in Business Analytics**	**08 Hours**
Big data analytics, Technologies for big data processing: Hadoop, Spark, Overview of cloud-based analytics solutions, Text and web mining, Techniques for text analysis: sentiment analysis, topic modeling, Social media analytics, Mining insights from social networks, Ethical and privacy issues in business analytics, Regulatory compliance in data usage, Future trends in business analytics, AI and machine learning advancements, Real-time analytics and IoT, Case studies on advanced analytics applications.		
#Exemplar/Case Studies: Applying social network analysis techniques to understand customer influence networks in social media for targeted marketing campaigns.		
Learning Resources		
Text Books		
T1 : Albright, Winston, "Business Analytics: Data Analysis and Decision Making", Cengage Learning, 978-1285187273		

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T2 : Sam Anahory, Dennis Murray, "Data Warehousing in the Real World", Addison-Wesley Professional, 978-0201174936
T3 : Paul Newbold, William L. Carlson, Betty Thorne, "Statistics for Business and Economics", Pearson, 978-0134763686
T4 : Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 978-0387848570
T5: Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization Guide for Business Professionals", Wiley, 978-1119002253
T6: Viktor Mayer-Schönberger, Kenneth Cukier, "Big Data: A Revolution That Will Transform How We Live, Work, and Think", Eamon Dolan/Mariner Books, 978-0544227750

Reference Books :

R1:.Davenport, Harris, "Competing on Analytics: The New Science of Winning", Harvard Business Review Press, 978-1422103326
R2: Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann, 978-0123814791
R3 :Richard A. Johnson, Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson, 978-0134995391
R4: Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 978-0262018029
R5 :Steve Wexler, Jeffrey Shaffer, Andy Cotgreave, "The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios", Wiley, 978-1119282716
R6 :Foster Provost, Tom Fawcett, "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking", O'Reilly Media, 978-1449361327

Additional Resources: (Books, e-Resources)

Coursera: https://www.coursera.org/specializations/business-analytics
edX: Business Analytics
https://www.udemy.com/course/business-analytics-complete-course-w/?utm_source=adwords&utm_medium=udemyads&utm_campaign=BusinessAnalysis_v.PROF_la.EN_cc.INDIA_ti.&campaigntype=Search&portfolio=India&language=EN&product=Course&test=&audience=DSA&topic=&priority=&utm_content=deal4584&utm_term=_.ag_124366375391_.ad_533157714181_.kw__.de_c_.dm_.pl_.ti_dsa-1243351521275_.li_9299906_.pd_.&matchtype=&gad_source=1&gclid=CjwKCAjw1920BhA3EiwAJT3lSaCCawNhZ-Ukr7Q6wf9xfOgCVJ2gaail2OmH6kCVVzV8y1yvGpgJvRoCefQQAvD_BwE&couponCode=IND21PM

MOOC Courses links :

- Business Analytics For Management Decision by NPTEL(https://onlinecourses.nptel.ac.in/noc20_mg11/preview)
- Business Analytics & Data Mining Modeling using R by NPTEL(https://onlinecourses.nptel.ac.in/noc24_mg70/preview)
- Business Analytics & Text Mining Modeling using Python(https://onlinecourses.nptel.ac.in/noc24_mg79/preview)

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24-VSEC-CS-5-02 : Drone Technology and Applications		
Teaching Scheme: Practical: 4 Hours/ Week	**Credit:** 02	**Examination Scheme:** **TW** : - 50 Marks **OR:** - 50 Marks
Prerequisites Courses: Basics of Electronics, physics, mathematics, Computer science, Communication system		
Course Objectives: ● Understand the basic principles and concepts of drone technology ● Learn the principles and practices of drones ● Explore the simulation tools, Drone Programming and firmware used in drone technology. ● Examine the diverse applications and use cases of drones in various sectors.		
Course Outcomes: After completion of the course, learners should be able to CO1: Identify and Explain Drone Components and Systems CO2: Design and Assemble a Functional Drone CO3: execute programs on Simulation Tools and utilize the firmware. CO4: Analyze and Apply Drones in Industry-Specific Use Cases		
Course Contents		
Unit I	**Fundamentals of Drone**	**7 Hours**
Types of Drone, Main Components and secondary components of Drone, Applications of Drone, Identification of motor movements and motor sizes, Selection of components as per sizes, Propeller Direction, UAS and its Types, Drone Rules, Drone Zone-Permission Protocol. **Assignment 1:** To understand the fundamentals of drone flight dynamics		
#Exemplar/Case Studies- Study of Assembly of drones using components.		
Unit II	**Drone Design and Operations**	**7 Hours**
Drone Design - pixhawk 2.4.8 Connection, **Assembling Drone Components**,Yaw, Roll, Pitch, Throttle, **Flight Operation-**Pre-Flight Planning (Weather, Airspace, Mission Objectives), Flight Path and Waypoint Planning,Flight Logs and Team Management,, Ground Testing and Calibration, Flight Testing Procedures **Assignment 2:**Take a flight of drones to navigate through a set course autonomously.		
#Exemplar/Case Studies: Study of Aero GCS Green		
Unit III	**Communication and firmware Development**	**8 Hours**
Communication Protocols-Need and Importance**, Drone Simulators**-ArduPilot, Mission Planner, Implementing sensors in simulation, **Drone Programming with Python-**Dronekit Python installation**,,** Integrate **Arduino** with drone components, Android development, Firmware development		

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Assignment 3:

a. Program a drone that can drop a small payload.
b. Program a drone-based light show
c. Synchronize drone movements with music.

#Exemplar/Case Studies : Flying a Drone using Mission planner

Unit IV	**Use Cases of Drones**	**8 Hours**

Drones in Agriculture, Surveying and Mapping, Data Collection and Image Analysis,Machine Learning and AI in Drone Data Analysis,Swarm Drones and Cooperative Behavior,

Assignment 4:

a. Capture stunning aerial photos and videos.
b. To design a drone-based system for monitoring crop health and environmental conditions.
c. To Simulate drones for mapping and surveying applications.

#Exemplar/Case Studies: Study of Aerogcs orange,Pickstork for image analysis

Learning Resources

Text Books

T1. Tony Phan,Drone Builder's Guide: From Amateur to Professional,ISBN: 9781541016360
T2. Michael J. Singer, Drone Operations: A Comprehensive Guide for Commercial Drone Pilots ,ISBN*: 9781733282100
T3. David McGriffy, Make: Drones: Teach an Arduino to Fly,ISBN: 9781680451715
T4. Joseph Howse, Programming Drones with Python: Build and Code Drones from Scratch, ISBN: 9781789346466
T5. K. R. Krishna, Drones in Agriculture, ISBN: 9781771886846
T6. Fergus Kennedy, Drone Photography & Video Masterclass, ISBN*: 9781781575383

Reference Books :

R1. John Baichtal, Building Your Own Drones: A Beginner's Guide to Drones, UAVs, and ROV, ISBN: 9780134000121
R2. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment, ISBN*: 9781119964261
R3. David McGriffy, Make: Drones: Teach an Arduino to Fly, ISBN: 9781680451715
R4. Adam Juniper, Drones: The Complete Guide, ISBN*: 9781781575383
R5. P. Karthikeyan, Sathish Kumar, and V. Anbarasu, Drone Data Analytics in Aerial Computing, ISBN: 9780367332517

Additional Resources: (Books, e-Resources)

- Drone Communities and Forums https://diydrones.com/
- https://projecthub.arduino.cc/suhaspn007/autopilot-drone-d3fa9f
- https://www.youtube.com/playlist?list=PLgiealSjeVyx3t4N9GroE29SbVwhYrOtL

MOOC Courses links :

- Robotics: Aerial Robotics (https://www.coursera.org/learn/robotics-flight)
- Drone Programming and AI (https://www.udacity.com/course/flying-car-nanodegree--nd787)

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24-CCC-CS-5-01 : The Scientific Study of Mind, Matter, and Consciousness		
Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW** : 50 Marks
Prerequisites Courses: Indian Knowledge System		
Course Objectives: • To introduce the core concepts of mind, matter, and consciousness from a scientific perspective. • To explore the neuroscience of the mind and its relation to consciousness. • To develop techniques for managing emotions and promoting mental well-being. • To practice mindfulness and conscious decision-making.		
Course Outcomes: After completion of the course, learners should be able to CO1: Understand core concepts of mind, matter, and consciousness. CO2: Identify the relation to neuroscience of mind and consciousness. CO3: Use strategies for emotional regulation and mental health. CO4: Assimilate mindfulness and philosophical insights to improve decision-making.		
Course Contents		
Unit I	**Introduction to Neuroscience**	**07 Hours**
Foundation of Neuroscience, Basic Concepts: Mind, matter, and consciousness definitions; **Brain Anatomy:** Major structures and their functions; **Brain Waves:** Types (Alpha, Beta, Delta, Theta, Gamma), Correlation with consciousness states (awake, sleep, meditation)		
#Exemplar/Case Studies: Meditation, Biofeedback : optimizing brain wave patterns.		
Unit II	**Emotions and Thinking**	**07 Hours**
Emotions and the Brain: Framework for Emotional Intelligence, Biological mechanisms (amygdala, prefrontal cortex), Emotional regulation; **Emotion Management Techniques**: Mindfulness, Meditation, Cognitive Behavioral Therapy (CBT); **Critical Thinking:** Cognitive biases and logical fallacies, **Decision Making:** Rational vs. intuitive models.		
#Exemplar/Case Studies: Real-life scenarios and its influence on mind		
Unit III	**Mindfulness Practices**	**09 Hours**
Inner Circle Management : Prime and Non-prime Activity, Self Awareness and Self Care through Meditation, **Five Core Concepts of Mindfulness:** (a) present-focused awareness, (b) an accepting or open attitude, (c) a non-judging approach, (d) compassion for self and others, and (e) the energy of		

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mindfulness**, Benefits of Mindfulness, Mindfulness Techniques:** Mindful Yoga, **Scientific Evidence** : Research findings on Neuroplasticity and Mindfulness

#Exemplar/Case Studies: Success Routine Framework (21 Days : write a report), Practice any type of breathing exercise (Presentation : share the experience)

Unit IV	**Saptajyotirvikas and Wisdom of "SEE"**	**07 Hours**

Saptajyotirvikas Philosophy: Rise of this philosophy in 21st Century, Core principles of Saptajyotirvikas, **Wisdom of "SEE" (Scientific/Social Perspective, Experience, Expertise):** Definition, framework and components, **Integration of Saptajyotirvikas and SEE:** Practical applications in decision-making.

#Exemplar/Case Studies
Techniques for Advancing Consciousness:
Mindfulness and meditation practices.
Strategies for mental stability and conscious decision-making.

Learning Resources

Text Books

T1. Eran Asoulin, et al., "Introduction to Philosophy: Philosophy of Mind," Rebus Community, 2019, ISBN 13: 9781989014073 (https://open.umn.edu/opentextbooks/textbooks/776)
T2. Yashraj Patil, "Harmony 360 - Advancing Humanity through the Wisdom of "SEE" and Saptajyotirvikas," Writer's Pocket, 2024, ISBN-13 : 978-93-6083-226-1 (https://amzn.in/d/0iuJ88O4)
T3. Ann Swanson, "Science of Yoga," Dorling Kindersley Publication, 2019, ISBN-13: 9780241341230 (https://www.amazon.in/Science-Yoga-Understand-Physiology-Practice/dp/146547935X)
T4. Casey Henley, "Foundations of Neuroscience", Michigan State University, 2021, ISBN 13: 9781626101098 (https://open.umn.edu/opentextbooks/textbooks/1005)

Reference Books :

R1. Simply the Brain (DK Simply Series), Dorling Kindersley Publication, 2022, ISBN-13: 978-0241515891 (https://amzn.in/d/060rexqx)
R2. Rita Carter, "The Human Brain Book: An Illustrated Guide to Its Structure, Function, and Disorders," Dorling Kindersley Publication, 2019, ISBN-13: 978-0241302255 (https://amzn.in/d/0cfZ04LV)
R3. Gaur Gopal Das, "Energize Your Mind: A Monk's Guide to Mindful Living" Sourcebooks, 2023, ISBN-13: 978-1728265377 (https://www.amazon.in/Energize-Your-Mind-Gaur-Gopal/dp/1728265371)

Additional Resources: (Books, e-Resources)

Buddha's Brain: Neuroplasticity and Meditation
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2944261/

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What is Cognitive Behavioral Therapy?
https://www.apa.org/ptsd-guideline/patients-and-families/cognitive-behavioral

Mindfulness by American Psychological Association
https://www.apa.org/topics/mindfulness

What Are The 7 Principles of Mindfulness?
https://psychcentral.com/blog/non-judging-non-striving-and-the-pillars-of-mindfulness-practice

MOOC Courses links :

- Swayam Course : **Psychiatry - An Overview and How the Brain Creates Mind**
  https://onlinecourses.nptel.ac.in/noc21_hs34/preview
- Swayam Course : **Introduction to Brain & Behaviour**
  https://onlinecourses.nptel.ac.in/noc20_hs33/preview

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24-ELC-CS-5-02 : Technical Communication		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW** : 50 Marks
Prerequisites Courses: Research Methodology		
Course Objectives: ● Identify research gaps and select an advanced topic that addresses these gaps. ● Analyze the latest technologies and methodologies in research to present creatively. ● Create high-quality technical documents and professional communication materials using enhanced writing skills. ● Evaluate complex engineering problems, formulate solutions, and apply critical thinking skills to develop and present comprehensive research plans.		
Course Outcomes: After completion of the course, learners should be able to CO1: Critically analyze advanced topics of professional interest. CO2: Write high-quality technical documents and research papers. CO3: Deliver and present advanced research methodologies. CO4: Deliver professional technical presentations with confidence and clarity.		
Course Contents		
Unit I	**Introduction and Topic Selection**	**8 Hours**
Overview of seminar objectives and structure, Guidelines for selecting advanced research topics for dissertation, Conducting a comprehensive literature review, Advanced use of academic databases and citation management tools.		
#Exemplar/Case Studies: Select a research topic in consultation with the guide. Hands-on session on systematic literature search.		
Unit II	**Writing Research Papers and Reports**	**8 Hours**
Components and structure of high-quality research papers. Using LaTeX for professional report preparation.		
#Exemplar/Case Studies : Formatting and structuring research papers in LaTeX.		
Unit III	**Professional Presentation Skills**	**8 Hours**
Designing professional presentations, Techniques for engaging public speaking, Create and deliver a detailed presentation on the selected research topic.		
#Exemplar/Case Studies Creating presentation using popular tools like Canva.		
Unit IV	**Seminar of Research Topic**	**6 Hours**

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Deliver seminar presentations on any topic of interest (30-35 minutes each). Submit research reports in LaTeX format on any topic presented.
#Exemplar/Case Studies Presenting a Dissertation/Thesis
Learning Resources
Text Books
T1. "Research Methodology- Methods and Techniques", Kothari C.K, New Age International, New Delhi,2004. **T2.** "Research Methodology- A Step-By-Step Guide for Beginners", Ranjit Kumar, Pearson Education, Delhi, ISBN: 81-317-0496-3, 2006. **T3.** "Research design: Qualitative, quantitative, and mixed methods approaches", Creswell, John W. , Sage publications, 2013.
Reference Books :
R1. "Research Methods", Trochim, William M.K., 2/e, Biztantra, Dreamtech Press, New Delhi, ISBN: 81-7722-372-0, 2003 **R2.** "Applied Statistics & Probability for Engineers", Montgomery, Douglas C. &Runger, George C., 3/e, Wiley India, 2007 **R3**. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
Additional Resources: (Books, e-Resources) 1. International Journal of Social Research Methodology . 2. The Postgraduate Research Handbook by Gina Wisker. 3. Research Methodology: Motivation for Research; Dr. S.N. Sridhara
MOOC Courses links : ● https://www.coursera.org/learn/research-methods ● https://onlinecourses.swayam2.ac.in/cec20_hs17/preview

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24-VEC-CS-5-01: Introduction to Human Rights and Duties

Teaching Scheme: Theory: 1 Hours/Week	**Credit:** 1	**Examination Scheme:** **TW:** 25 Marks

Prerequisites Courses: NA

Companion Course: NA

Course Objectives:

- To understand the fundamental concepts of human rights and duties, including human values such as dignity, liberty, equality, and justice
- To explore the interrelationship between rights and duties and analyze their significance in individual and group contexts
- To examine various legal instruments and understand their binding nature, including covenants, declarations, treaties, and protocols in the context of human rights.
- To analyze the role of the United Nations in promoting and protecting human rights through international charters and declarations, with a special focus on the Universal Declaration of Human Rights

Course Outcomes:
After completion of the course, learners should be able to

CONo	CO	BL
CO1	Explain the core concepts of human values and their relevance in human rights education.	2
CO2	Illustrate the relationship between rights and duties and demonstrate how they apply in personal and societal contexts.	3
CO3	Identify and interpret key legal instruments and their significance in enforcing human rights at national and international levels.	3
CO4	Analyze and evaluate the historical development and provisions of the Universal Declaration of Human Rights and its role in protecting civil, political, economic, social, and cultural rights.	4

Course Contents

Unit I	**Basic Concept**	**3 Hours**

Human Values- Dignity , Liberty, Equality , Justice, Unity in Diversity, Ethics and Morals, Meaning and significance of Human Rights Education

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#Exemplar/Case Studies: Human Values in Action – The School Debate Incident		
***Mapping of Course Outcomes**	**CO1**	
Unit II	**Perspectives of Rights and Duties**	**3 Hours**
Rights: Inherent-Inalienable-Universal- Individual and Groups, Nature and concept of Duties, Interrelationship of Rights and Duties		
#Exemplar/Case Studies: The Village Water Supply Issue		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Introduction to Terminology of Various Legal Instruments**	**2 Hours**
Meaning of Legal Instrument- Binding Nature, Types of Instruments: Covenant-Charter-Declaration-Treaty-Convention-Protocol-Executive Orders and Statutes		
#Exemplar/Case Studies: Protecting Wetlands – An International Agreement		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**United Nations And Human Rights**	**4 Hours**
Brief History of Human Rights- International and National Perspectives, Provision of the charters of United Nations, Universal Declaration of Human Rights- Significance-Preamble, Civil and Political Rights-(Art. 1-21), Economic, Social and Cultural Rights-(Art.22-28), Duties and Limitations-(Art. 29), Final Provision (Art. 30)		
#Exemplar/Case Studies: Human Rights in Disaster Relief – The Cyclone Fani Incident		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Leah Levin: Human Rights (Questions and Answers) National Book Trust India, New Delhi, 1992 **T2.** Justice D.M. Dharmadhikari: Human Values and Human Rights: Universal Publications, New Delhi,2010		
Reference Books :		
R1. Daniel Fishlin & Marth Nandorfy: The concise guide to Global Human Rights; Oxford University Press; 2007		
Additional Resources: (Books, e-Resources) http://unipune.ac.in/pdf_files/Final%20Book_03042012.pdf		
MOOC Courses links : ● https://onlinecourses.swayam2.ac.in/cec20_hs24/preview		

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24-VEC-CS-5-02: Human rights of vulnerable and disadvantaged groups

Teaching Scheme: Theory: 1 Hours/Week	**Credit:** 1	**Examination Scheme:** **TW:** 25 Marks

Prerequisites Courses: NA

Companion Course: Introduction to Human Rights and Duties

Course Objectives:

- To understand the concept of vulnerability and the challenges faced by disadvantaged groups.
- To explain the social status and human rights of women and children from national and international perspectives.
- To analyze the conditions of socially and economically disadvantaged groups and their rights.
- To evaluate the human rights issues of vulnerable groups and explore measures for their protection.

Course Outcomes:
After completion of the course, learners should be able to

CONo	CO	BL
CO1	Explain the meaning and challenges of vulnerable and disadvantaged groups.	2
CO2	Describe the human rights standards for women and children at national and international levels.	2
CO3	Articulate how poverty and social status affect human rights.	3
CO4	Relate the laws and policies that protect vulnerable groups	3

Course Contents

Unit I	**General Introduction**	**2 Hours**

Meaning and Concept of Vulnerable and Disadvantaged, Groups, Customary, Socio-Economic and Cultural Problems of, Vulnerable and Disadvantaged Groups

#Exemplar/Case Studies : Education for Children in Rural India

***Mapping of Course Outcomes**	**CO1**

Unit II	**Social status of women and children in International and national perspective**	**3 Hours**

Human Rights and Women's Rights –International and National Standards, Human Rights of Children-International and National

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Standards		
#Exemplar/Case Studies : Child Marriage in Rural India		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Status of Social and Economically Disadvantaged people**	**4 Hours**
Status of Indigenous People and the Role of the UN, Status of SC/ST and Other Indigenous People in the Indian Scenario , Human Rights of Aged and Disabled, The Minorities and Human Rights		
#Exemplar/Case Studies : Rights of Indigenous Tribal People in Jharkhand		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Human rights of vulnerable groups**	**3 Hours**
Stateless Persons, Sex Workers, Migrant Workers, HIV/AIDS Victims		
#Exemplar/Case Studies: Rights of Vulnerable Groups in India - Migrant Workers, Sex Workers, and HIV/AIDS Victims		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Prof. Y.S.R. Murthy , "HUMAN RIGHTS HANDBOOK" by Lexis Nexis Butterworth in October, 2007 **T2.** Prof. Dr. T.S.N. Sastry, "INDIA AND HUMAN RIGHTS REFLECTIONS" by Concept Publishing Company, New Delhi, 2005		
Reference Books :		
R1. Surinder Khanna, "DALIT WOMEN AND HUMAN RIGHTS" by Swastik Publications Delhi, ISBN: 93-80138-36-7, 2011		
Additional Resources: (Books, e-Resources) http://unipune.ac.in/university_files/1Human%20Rights%20of%20Vulnerable%20&%20Disadvantaged%20Groups_211212.pdf		
MOOC Courses links : ● https://onlinecourses.swayam2.ac.in/cec21_lw07/preview		

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Internal Semester Exam Question paper Format

SNJB's Late Sau. Kantabai Bhavarlalji Jain College of Engineering

Department of Computer Engineering

Internal Semester Test Exam (Academic Year :__ Semester: __)

Class :	Marks : 20	Date : / /	Time :	Duration : 1 Hr.

Course Name :: Course Code

Instructions:

Q. No.	Questions	Marks	Unit No.	Marking Scheme
Q.1 A)		6		
Q.1 B)		4		
OR				
Q.2 A)		6		
Q.2 B)		4		
Q.3A)		6		
Q.3 B)		4		
OR				
Q.4A)		6		
Q.4B)		4		

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Semester End Exam Question paper Format

Semester End Examination (Regular) <<Moth Year>>

Programme: Class:
Course and Code: Semester:
Academic Year: Pattern:
Time: 2Hr 30 Min Examination: SEE (Month Year) Max. Marks: 60

Instructions to the candidates:

1. *Solve Q.1 OR Q.2, Q.3 OR Q.4, Q.5 OR Q.6, Q.7 OR Q.8, Q.9 OR Q.10, Q.11 OR Q.12*
2. *Bold-faced figures to the right indicate full marks.*
3. *Assume the suitable data if necessary, but Justify it.*
4. *Draw the neat labelled diagrams, wherever necessary.*

QN	Question	Marks
1 a)	Unit I	6
1 b)	Unit I	4
	OR	
2 a)	Unit I	6
2 b)	Unit I	4
3 a)	Unit II	6
3 b)	Unit II	4
	OR	
4 a)	Unit II	6
4 b)	Unit II	4
5 a)	Unit III	6
5 b)	Unit III	4
	OR	
6 a)	Unit III	6
6 b)	Unit III	4
7 a)	Unit IV	6
7 b)	Unit IV	4
	OR	
8 a)	Unit IV	6
8 b)	Unit IV	4
9 a)	Unit V	6
9 b)	UnitIV	4
	OR	
10 a)	Unit V	6
10 b)	Unit V	4
11 a)	Unit VI	6
11 b)	Unit VI	4
	OR	
12 a)	Unit VI	6
12 b)	Unit VI	4

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Supporting Document

Sr. No.	Syllabus Contains	Short Answer	Yes / No	Page No. (In Syllabus)
1	अभ्यासक्रम	Enclosed in Syllabus	Yes	1-76
2	पात्रता	(As per the Rules and Regulations mentioned in MoM)	Yes	79
3	अभ्यासक्रमाची उद्दिष्टे	Enclosed in Syllabus	Yes	11
4	विषयाचे नाव	Enclosed in Syllabus	Yes	6
5	घटकांचा तपशील	Enclosed in Syllabus	Yes	6
6	तासिका	Enclosed in Syllabus	Yes	6
7	श्रेयांक पद्धत	Enclosed in Syllabus	Yes	6
8	संदर्भ साहित्य	Enclosed in Syllabus	Yes	12
9	संदर्भ ग्रंथ	Enclosed in Syllabus	Yes	12
10	प्रश्नपत्रिकेचे स्वरूप	Enclosed in Syllabus	Yes	77
11	अंतर्गत मूल्यमापनाचे स्वरूप	Enclosed in Syllabus	Yes	6
12	सत्र परीक्षेचे स्वरूप	Enclosed in Syllabus	Yes	78
13	गुणांकन	Enclosed in Syllabus	Yes	6

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