SCTR's PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE-43

An Autonomous Institute affiliated to the
Savitribai Phule Pune University
Approved by AICTE & Government of Maharashtra,
Accredited by NAAC (A+) & NBA [All eligible UG Programs]

Master of Technology (Computer Engineering)
Department of Computer Engineering
Curriculum Structure
(With effect from year 2024-25)

(Approved by the Board of Studies and Academic Council)

SCTR'S PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE-43
M. Tech. (Computer Engineering) Curriculum Structure
With effect from the A.Y. 2024-25

Semester - I

Broad category of Course	Subject code	Name of subjects	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					Total
			L	P	T	Total	L	P	T	Total	Theory			Practical		
											ISE	CIE	ESE	CIE/ TW	ESE(PR/OR)	
PCC	MCE1-001	Mathematical Foundations for Computing	3	-	-	3	3	-	-	3	20	30	50	-	-	100
PCC	MCE1-002	Advanced Algorithms	4	-	-	4	4	-	-	4	20	30	50	-	-	100
PCC	MCE1-003	Information Security	3	-	-	3	3	-	-	3	20	30	50	-	-	100
AEC	MCE1-004	Research Methodology	3	-	-	3	3	-	-	3	20	30	50	-	-	100
PEC	MCE1-005	Program Elective - I	3	-	-	3	3	-	-	3	20	30	50	-	-	100
VSEC	MCE-006	Laboratory Proficiency-I	-	4	-	4	-	2	-	2	-	-	-	25	25	50
AAC	MCE1-007	Research and Technical Communication Lab	-	2	-	2	-	1	-	1	-	-	-	25	-	25
VSEC	MCE1-008	Programming Proficiency Lab	-	2	-	2	-	1	-	1	-	-	-	25	-	25
		Total	16	8	-	24	16	4	-	20	100	150	250	75	25	600

MCE1-005:Program Elective - I	
MCE1-005A: IoT Architecture and Protocols	MCE1-005B: Machine Learning
MCE1-005C: Natural Language Processing	MCE-005D: Distributed Operating Systems

MCE1-006: Lab Proficiency – I
Laboratory Assignments will be based on Program Core and Program Elective Courses.

SCTR'S PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE-43
M. Tech. (Computer Engineering) Curriculum Structure
With effect from the A.Y. 2024-25

Semester – II

Broad Category of Course	Subject code	Name of subjects	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					Total
			L	P	T	Total	L	P	T	Total	Theory			Practical		
											ISE	CIE	ESE	CIE/ TW	ESE (P/OR)	
PCC	MCE2-009	Cloud Computing	3	-	-	3	3	-	-	3	20	30	50	-	-	100
PCC	MCE2-010	Applied Deep Learning	4	-	-	4	4	-	-	4	20	30	50	-	-	100
PEC	MCE2-011	Program Elective - II	3	-	-	3	3	-	-	3	20	30	50	-	-	100
OE	MCE2-012	Open Elective - I	4	-	-	4	4	-	-	4	20	30	50	-	-	100
VSEC	MCE2-013	Laboratory Proficiency - II	-	6	-	6	-	3	-	3	-	-	-	50	50	100
VSEC	MCE2-014	Skills Enhancement Lab	-	2	-	2	-	1	-	1	-	-	-	25	-	25
AEC	MCE2-015	Seminar-I	-	4	-	4	-	2	-	2	-	-	-	50	25	75
		Total	14	12	0	26	14	6	0	20	80	120	200	125	75	600

MCE2-011:Program Elective - II	
MCE2-011A: Edge Computing and IoT Applications	MCE2-011B: Information Retrieval and Web mining
MCE2-011C: Multimodal Computing	MCE2-011D: Advanced Compilers
MCE2-011E: Applied Security	

MCE2-012:Open Elective - I (MOOCs)	MOOC link
MCE2-012A: Computer Vision	https://onlinecourses.nptel.ac.in/noc19_cs58/preview
MCE2-012B: Mobile Computing	https://nptel.ac.in/courses/106106147
MCE2-012C: Software Architecture	https://onlinecourses.nptel.ac.in/noc22_cs39/preview

Semester – III

SCTR'S PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE-43
M. Tech. (Computer Engineering) Curriculum Structure
With effect from the A.Y. 2024-25

Broad Category of Course	Subject code	Name of subjects	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					Total
			L	P	T	Total	L	P	T	Total	Theory			Practical		
											ISE	CIE	ESE	CIE/ TW	ESE (P/OR)	
PEC	MCE3-016	Program Elective Course - III	4	-	-	4	4	-	-	4	20	30	50	-	-	100
OE	MCE3-017	Open Elective Course - II	4	-	-	4	4	-	-	4	20	30	50	-	-	100
IKS	MCE3-018	Indian Knowledge System and Human Values	1	2	-	3	1	1	-	2	-	30	-	20	-	50
AEC	MCE3-019	Internship/Field Study	-	8	-	8	-	4	-	4	-	-	-	50	50	100
AEC	MCE3-020	Seminar – II	-	4	-	4	-	2	-	2	-	-	-	50	50	100
AEC	MCE3-021	Dissertation Stage -I	-	8	-	8	-	4	-	4	-	-	-	50	50	100
		Total	9	22	0	31	9	11		20	40	90	100	170	150	550

MCE3-016:Program Elective - III (MOOCs)	
MCE3-016A: Digital Forensic	MCE3-016B: Pattern Recognition
MCE3-016C: Big Data Analytics	MCE3-016D: Business Intelligence

MCE3-017 Open Elective - II (MOOCs)	MOOC link
MCE3-017A: Industrial IoT	**Introduction to Industry 4.0 and Industrial Internet of Things** By Prof. Sudip Misra	IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_cs69/preview
MCE3-017B: Bioinformatics	**BioInformatics: Algorithms and Applications** By Prof. Michael Gromiha	IIT Madras https://onlinecourses.nptel.ac.in/noc21_bt06/preview
MCE3-017C: AI in Healthcare	Coursera-AI in Healthcare Specialization [5 courses] (Stanford)	Coursera **NPTEL-Applied Accelerated Artificial Intelligence** Prof. Satyajit Das, Prof. Satyadhyan Chickerur, Prof. Bharatkumar Sharma, Prof. Adesuyi Tosin, Prof.Ashrut Ambastha,IIT Palakkad, KLE Technological University, NVIDIA, NVIDIA https://onlinecourses.nptel.ac.in/noc22_cs83/preview
MCE3-017D: AI for Investments	**Artificial Intelligence (AI) for Investments** By Prof. Abhinava Tripathi, IIT Kanpur https://onlinecourses.nptel.ac.in/noc23_mg63/preview
MCE3-017E: Responsible and Safe AI	**Responsible & Safe AI Systems** By Prof. Ponnurangam Kumaraguru, Prof. Balaraman Ravindran, Prof. Arun Rajkumar,IIIT Hyderabad, IIT Madras https://onlinecourses.nptel.ac.in/noc24_cs132/preview
MCE3-017F: AI for Economics	**Artificial Intelligence for Economics** Prof. Adway Mitra, Prof. Dripto Bakshi, Prof. Palash Dey, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_cs76/preview
MCE3-017G: ML for Soil and Crop Management	**Machine Learning For Soil And Crop Management** Prof. Somsubhra Chakraborty, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22_ag05/preview
MCE3-017H: Robotics	**Robotics** Prof. Dilip Kumar Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_me76/preview
MCE3-017I: Ethical Hacking	**Ethical Hacking** Prof. Indranil Sen Gupta, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22_cs13/preview
MCE3-017J: AR/VR	**Introduction to Virtual Reality** Ramesh C Sharma, Dr B R Ambedkar University Delhi, New Delhi onlinecourses.swayam2.ac.in/nou23_ge34/preview

Semester – IV

Broad Category of Course	Subject code	Name of subjects	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					Total
			L	P	T	Total	L	P	T	Total	Theory			Practical		
											ISE	CIE	ESE	CIE/ TW	ESE (P/OR)	
AEC	MCE4-022	Seminar – III	-	8	-	8	-	4	-	4	-	-	-	50	50	100
AEC	MCE4-023	Dissertation Stage – II	-	32	-	32	-	16	-	16	-	-	-	100	50	150
		Total	-	40	-	40	-	20	-	20	-	-	-	150	100	250

Guidelines
Program Elective Course
● Students may select any one of the courses or NPTEL MOOCs course from the list recommended by the department. The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Elective. (One credit will be awarded for a four-week MOOCs course). MOOCs course list will be updated at the beginning of the academic year.
Open Elective Course
● Students may select any one of the courses of 4 credits offered by any department in the Institute or Industry supported Course or MOOCs. The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Open Elective Course. (One credit will be awarded for a four week MOOCs). MOOCs list will be updated at the beginning of the academic year.
Exit Criteria:
● Post graduate diploma will be awarded if a student completes 40 credits and wishes to exit after the first year of PG. A student will be allowed to enter/re-enter only at the odd semester and can only exit after the even semester.

Abbreviations:

PCC	Program Core Course	**L**	Lecture	**ISE**	In Semester Examination
PEC	Program Elective Course	**P**	Practical	**ESE**	End Semester Examination
OEC	Open Elective Course	**CIE**	Continuous Internal Evaluation	**AEC**	Ability Enhancement Course
VSEC	Vocational Skill Enhancement Course	**TW**	Term Work	**MOOC**	Massive Open Online Course
HSS	Humanities/IKS/Research	**OR**	Oral	**T**	Tutorial

CIE [30]	*Continuous Internal Evaluation:* (Activity Based Learning Evaluation) The department shall declare the set of all applicable activities such as Problem Based Learning, Quizzes, field work, group discussion, but not limited to etc. The course coordinator, in consultation with course teachers, shall select any of three to four activities suitable for the course from the list declared by the department and get the selected activities approved from HoD. The Course teacher shall get the activities carried out by students, evaluate the student performance based on the prescribed rubrics. Department shall prepare the rubrics for all the activities and display the same before the commencement of academics.
ISE [20]	*In-Semester Examination:* Written examination shall be conducted for one hour duration on First Module for 20 marks.
ESE [50]	*End-Semester Examination:* Written examination shall be conducted for three hours duration on Modules II, III, IV for 50 marks.

Semester I

Semester I

MCE1-001 Mathematical Foundations for Computing		
Teaching Scheme: L: 03 Hrs/week	**Credits**: 03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Fundamental of Mathematics

Course Objectives :

Course intends to prepare the students

1. To explore basics of discrete mathematics for computing in computer science/Data Science applications.
2. To explore various data structures and algorithmic solutions for storage and retrieval of data computational problems.
3. To explore statistical measures and hypotheses for computing.
4. To understand the use of probability for solving computer science/Data Science problems.
5. To understand the use of linear algebra and calculus for solving computational problems.

Course Outcomes :

At the end of the course students will be able to

1. **Apply** discrete mathematics concepts like sets, relations to **solve** computing problems
2. **Choose** suitable tree and graph data structures and its algorithms for solving problems in various domains.
3. **Analyze** various central tendency, dispersion, and relationship measures for preprocessing data and use hypothesis testing.
4. **Select** probability distributions functions and probabilistic models for clustering and classification problems.
5. **Apply** linear algebra methods for reducing dimensionality and evaluating multi variable linear systems.

	Course Contents	
	Discrete Mathematics for Computing	
Module I	**Set Theory:** Elementary Theory of Sets, Set Rules & Sets Combinations. **Relations**: Binary Relation, Equivalence Relation, Composite Relation, Partial Ordering Relation. **Fundamentals of Graph Theory**: Types, graph representation methods, Traveling-salesman problem, applications. **Trees & Search Trees**: balanced search trees, Multiway balanced search trees, splay tree, Trie, KD Tree Heaps: Binomial Heaps, Fibonacci Heap. **Case Study**: Mathematical modeling for applications of Graph Electrical network problem/ Flow graph notation/ Test case generation using graphs/Trie for spell checker/autocomplete string/ KD Tree for geographic information systems (GIS)	**8 Hrs**

Module II	**Statistical Inference**	**8 Hrs**
	Types of Statistical Inference, Descriptive Statistics, Inferential Statistics, Importance of Statistical Inference in computing. Measures of Central Tendency: Mean, Geometric mean, Harmonic mean, Median, Mode, Midrange, Measures of Dispersion: Range, inter quartile range, Variance, Mean Deviation, Standard Deviation. Coefficient of variation: Moments, Skewness, Kurtosis, Pearson Correlation. Measures of relationship: Covariance, Pearson Correlation. Hypothesis testing: Parametric Tests: Means, for Differences between Means, for Comparing Two Related Samples of Proportions, for Difference between Proportions, for Comparing a Variance to Some Hypothesized Population Variance. Chi-square Test, and Analysis of variance and covariance. Nonparametric Tests: Sign Test, Wilcoxon (Signed Rank). **Case study**: Study datasets like Iris/Diamond/Churn and apply suitable central tendency, dispersion and relationship measures to preprocess the datasets.Use of open-source statistical tools for hypothesis testing	
Module III	**Probability Theory**	**8 Hrs**
	Elements of Probability Theory: Basic Concept, Conditional Probability. Random variables: Cumulative Distribution Function, Expectation and Variance of Random variables, Covariance & Correlation. Probability Distributions: Discrete Uniform Distribution, Bernoulli, Binomial, Poisson, Geometric, and Hypergeometric Distributions. Continuous Distribution: Continuous Uniform Distribution, Normal Distribution, Exponential Distribution. Inductive statistics: Maximum Likelihood Estimation. Bayes' Theorem, Joint Probability, Bayesian network. Markov model. **Case Study**: Bayesian Network for Spatial data/Markov model for product lifecycle	
Module IV	**Linear Algebra & Vector Calculus**	**8 Hrs**
	Matrix and vector algebra, systems of linear equations using matrices, linear independence, Matrix factorization concept/LU decomposition, Eigenvalues and eigenvectors. Understanding of calculus: concept of function and derivative, Multivariate calculus: concept, Partial Derivatives, chain rule. **Case Study**: System of linear equations for Electrical Networks/Eigen values & Eigen vector for PageRank and PCA algorithm/ Gradient Descent	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. K.H. Rosen, "Discrete Mathematics and its application," Tata McGraw Hill 8th edition, ISBN 978-1-259-67651-2.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L., Rivest Clifford Stein, "Introduction to Algorithms," The MIT Press 4th Edition, ISBN 9780262046305.
3. Richard A. Johnson, Irwin Miller, John Freund, "Probability and Statistics for Engineers," Pearson Education 9th Edition, ISBN 978-0-321-98624-5.

4. Peter Brass, "Advanced Data Structures," Cambridge University Press, ISBN: 978-1-107-43982-5 ISBN 978-0-511-43685-7.

Reference Books

1. Tremblay and Manohar, "Discrete Mathematical Structures with Applications to Computer Science," Tata McGraw Hill Edition 1997, ISBN-13: 978-0-07-463113-3
2. Irwin Miller, Marylees Miller, "Mathematical Statistics with Applications," Pearson Education 8th Edition, ISBN -9789332519053.
3. Joe Mott, Abraham Kandel, "Discrete Mathematics and its application," Prentice Hall, 2nd Edition, ISBN 978-81-203-1502-0.
4. David C. Lay, Steven R. Lay, and Judi J. McDonald, "Linear Algebra and its applications," Pearson Publication, 5th Edition, ISBN 978-0-321-98238-4.

Paper References:

1. Christopher Krapu, Robert Stewart, and Amy Rose. 2023, "A Review of Bayesian Networks for Spatial Data," in ACM Transaction on Spatial Algorithms System, Vol.9, Issue 1, Article 7 (January 2023), 21 pages. https://doi.org/10.1145/3516523.
2. L. Wan, F. Xia, X. Kong, C. -H. Hsu, R. Huang and J. Ma, "Deep Matrix Factorization for Trust-Aware Recommendation in Social Networks," in IEEE Transactions on Network Science and Engineering, vol. 8, no. 1, pp. 511-528, 1 Jan.-March 2021, doi: 10.1109/TNSE.2020.3044035.
3. Emmert-Streib, Frank, and Matthias Dehmer, "Understanding Statistical Hypothesis Testing: The Logic of Statistical Inference," in MDPI Journal of Machine Learning and Knowledge Extraction, vol. 1, no. 3, pp. 945-961, doi: https://doi.org/10.3390/make1030054

Relevant MOOCs Course

1. Introduction to Probability Theory and Statistics By Prof. S Dharmaraja, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_ma81/preview
2. Discrete Mathematics – IIITB By Prof. Ashish Choudhury IIIT Bangalore https://onlinecourses.nptel.ac.in/noc21_cs36/preview.
3. Graph Theory By Prof. S.A. Choudum Department of Mathematics, IIT Madras https://archive.nptel.ac.in/courses/111/106/111106050/

Other Resources/Links

1. https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/

Home

MCE1-002 Advanced Algorithms		
Teaching Scheme: L: 04 Hrs/week	**Credits:** 04	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Foundation in data structures and algorithms, Proficiency in programming, Understanding of discrete mathematics, probability, and linear algebra.

Course Objectives :

Course intends to prepare the students

1. To understand different algorithm design techniques.
2. To analyze performance of different algorithmic strategies in terms of time and space.
3. To apply algorithmic strategies while solving problems.
4. To Understand Multithreaded and Distributed Algorithms.

Course Outcomes:

At the end of the Course Students will be able to

1. **Evaluate** and **contrast** the efficiency of polynomial time algorithms by examining their performance across worst, best, and average case scenarios.
2. **Utilize** appropriate algorithmic techniques to address problems involving binomial coefficients, chain matrix multiplication, and longest common subsequence.
3. **Develop** and **apply** problem-solving skills to address real-world business challenges and decision-making scenarios.
4. **Evaluate** the effectiveness and **accuracy** of randomized algorithms, considering both their efficiency and correctness.
5. **Apply** problem-solving techniques tailored for multi-core, distributed, or concurrent environments to effectively address complex computational challenges.

Module I	**Introduction**	**8 Hrs**
	Review and Introduction: Role of algorithms in computing, Growth functions, Recurrences, Solving Recurrences: Substitution method, Recursive Tree method and Master method. Review of algorithmic strategies: Greedy method, Divide and Conquer method, Dynamic Programming, Branch and Bound method.	
Module II	**Dynamic programming and Linear Programming**	**8 Hrs**
	Dynamic programming: Control abstraction for dynamic programming, elements of dynamic programming, use of dynamic programming method to solve the problems: binomial coefficients, chain matrix multiplication, longest common subsequence. Linear programming: Its use, problem formulation as linear programming model, simplex method, duality.	
Module III	**Randomized and Distributed Algorithms**	**8 Hrs**
	Randomized Algorithms: Reasons for using randomized algorithms, Examples: Randomized Qsort, min-cut problems, Introduction to approximation algorithms, Examples: TSP, 3-coloring problem, Parallel and Distributed Algorithms: Parallel loops, Race conditions, Problem Solving using Multithreaded Algorithms, Multithreaded matrix multiplication, Multithreaded merge sort. Distributed Algorithms: Introduction, Distributed breadth first search, Distributed Minimum Spanning Tree. String Matching: Introduction, The Naive string-matching algorithm, The Rabin-Karp algorithm.	
Module	Complexity Theory	**8 Hrs**

IV	Introduction: Limitations of algorithms and computational resources; problem instances, complexity classes. Classes of problems: P, NP, NP-complete, and NP-hard. Examples- Travelling salesman problem, post correspondence problem. P vs NP: The implications of solving this problem, its relevance to cryptography, and its connections to real-world applications. Reduction Techniques: Polynomial-time reductions and Cook reductions.	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms," ISBN: 978-0-262-04630-5, 4th edition MIT press, 2022. 2. Parag Himanshu Dave, Himanshu Bhalchandra Dave, "Design and Analysis of Algorithms," Pearson Education, ISBN 81-7758-595-92, 2nd edition , 2013.
Reference Books
1. Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms," Cambridge University Press, ISBN: 978-0-521-61390-3, 1st edition, 2004. 2. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics," PHI, ISBN 978-81-203-1131-2. 3. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples," Wiley, ISBN 978-81-265-0986-7, 1st edition 2006. 4. Dan Gusfield, "Algorithms on Strings, Trees and Sequences," Cambridge University Press, ISBN:0- 521-67035-7,1st edition 1997.. 5. Horowitz and Sahani, "Fundamentals of Computer Algorithms," University Press, ISBN: 978 817371 6126, 81 7371 61262, 2nd edition 2008.
Paper References:
1. Edson Antônio Gonçalves de Souza, Marcelo Seido Nagano, Gustavo Alencar Rolim, Dynamic Programming algorithms and their applications in machine scheduling: Areview, Expert Systems with Applications, Volume 190, 2022, 116180, ISSN 0957-4174. https://www.sciencedirect.com/science/article/abs/pii/S0957417421014998?via%3Dihub 2. Huang, B., & Shen, P. (2024). A new branch and bound method for solving linear multiplicative programming problems. Optimization-A Journal of Mathematical Programming and Operations Research, 1–21. https://doi.org/10.1080/02331934.2024.2323684 3. Kunwar, R., & Sapkota, H. P. (2022). An Introduction to Linear Programming Problems with Some Real-Life Applications. European Journal of Mathematics and Statistics, 3(2), 21–27. https://doi.org/10.24018/ejmath.2022.3.2.108 4. S. Ahmadi-Asl et al.,Randomized Algorithms for Computation of Tucker Decomposition and Higher Order SVD (HOSVD) in IEEE Access, vol. 9, pp. 28684- 28706, 2021, doi: 10.1109/ACCESS.2021.3058103. 5. Nitin Chityal, Sagar Sapkal, Performance analysis of GA, PSO and JA for determining the optimal parameters in friction drilling process, Engineering Science and Technology, an International Journal,Volume 35, 2022, 101246, ISSN 2215-0986. 6. Li, W., Ding, Y., Yang, Y. et al. Parameterized algorithms of fundamental NP-hard problems: a survey. Hum. Cent. Comput. Inf. Sci. 10, 29 (2020).https://doi.org/10.1186/s13673-020-00226-w 7. Katoch, Sourabh, Chauhan, Sumit Singh Kumar, Vijay, A review on genetic algorithm: past, present, and future, Multimedia Tools and Applications, 80, 8091–8126 (2021).https://doi.org/10.1007/s11042- 020-10139-6

Relevant MOOCs Course
Design and Analysis of Algorithms, By Prof. Madhavan Mukund, Chennai Mathematical Institute https://onlinecourses.nptel.ac.in/noc19_cs47/preview

Home

MCE1-003 Information Security		
Teaching Scheme: L: 03 Hrs/week	**Credits:** 03	**Examination Scheme:** ISE:20 Marks CIE:30 Marks ESE:50 Marks
Prerequisite: Basic Mathematics, Matrix inverse, Networking Protocols, Sniffing tools		

Course Objectives

Course intends to prepare the students
1. To classify threats to assess damages to information systems.
2. To acquire the knowledge of mathematics for cryptography, understand the concepts of cryptography.
3. To examine firewalls in the context of intrusion detection systems.
4. To learn the strengths & weaknesses of the Indian IT Act along with the amendment to the Act.

Course Outcomes:

At the end of the Course Students will be able to :
1. **Apply** the Euclidean algorithm, Fermat's theorem and Euler's theorem.
2. **Apply** appropriate cryptographic techniques by learning symmetric and asymmetric key cryptography.
3. **Evaluate** information security threats, vulnerabilities in information systems and security measures.
4. **Comprehend** the authentication services Kerberos & X.509 directory services

	Course Contents	
Module I	**Mathematical Foundation for cryptography** Modular Arithmetic: Notations & Operations, Divisibility & Division Algorithm, Euler's totient theorem, General formula Phi function, Euclid's method of finding GCD, Extended Euclid's algorithm. Computing Galois field, Factoring, Prime numbers, relative prime, Fermat's theorem, Application of Fermat's little theorem & congruence. Primality testing & its types, Recommended primality test. The Chinese Remainder Theorem, Discrete Logarithm. Applications of mathematics in cryptography.	**8 Hrs**
Module II	**Elementary Cryptography** Security Attacks, Security Services. CIA. Classical Encryption Techniques: Stream Ciphers, Substitution Techniques: Caesar, Mono alphabetic Ciphers, Playfair Cipher, Hill Cipher, Polyalphabetic Ciphers, Transposition Techniques, Block Ciphers, Data Encryption Standards, 3DES, Advanced Encryption standard. Public key Cryptography & RSA, Mutual trust: Key Management & distribution, Diffie–Hellman key exchange, Elliptic curve cryptography. Exercise problem solving. For a given case identify & justify levels of compromise in CIA Open source / Trial version Tools: Cryptool2. Survey papers e.g. fully homomorphic encryption(FHE)	**8 Hrs**
Module III	**Security to Authenticity and Integrity** Authentication: Requirements, Protocols: One–way Authentication, Mutual Authentication, Centralized Authentication, The Needham–Schroeder Protocol versions, Applications: Kerberos, X.509 Directory Services, Biometrics. Cryptographic Hash functions: SHA3, MD5.	**8 Hrs**
Module IV	**Cybercrimes & Cybersecurity: The Legal Perspective** Cyber Crime, Classification of Cybercrimes, Cyber stalking, The Indian IT Act, Psychology, Personality disorder & its causes. Cybercrime & Cyberterrorism:	**8 Hrs**

	Social, Political, Ethical & Psychological mindset Dimensions, Cyber offenses: How criminals plan them. Intellectual Property in Cyberspace. Cybercrime: Illustrations, Mini–cases	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books

1. William Stallings, "Cryptography and Network Security, Principles and Practice," Pearson, 7th edition, ISBN: 978–1–292–15858.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security ", 2nd edition, TMH, ISBN: 978–00–707–0208–0.
3. Nina Godbole, Sunita Belapure, "Cyber Security - Understanding Cyber Crimes, Computer, Forensics and Legal Perspectives," Wiley India, 1st edition 2011, ISBN: 978–81–265–2179–1.
4. C. K. Shyamala, N Harini, Dr. T. R. Padmanabhan, 'Cryptography and Security', Wiley India. ISBN: 978–81–245–2285–9.

Reference Books

1. Bernard Menezes, "Network Security and Cryptography," Cengage Learning India, 2014, ISBN: 8131513491.
2. Atul Kahate, "Cryptography and Network Security," 3rd edition McGraw Hill Education.
3. V. K. Pachghare, "Cryptography and Information Security," 2nd edition, PHI Learning, ISBN: 978–81–203–5082–3.
4. Bruice Schneier, "Applied Cryptography– Protocols, Algorithms and Source code in C," 2nd edition, Wiley Indian Edition, India Pvt. Ltd, ISBN 978–81–265–1368–0.
5. Hoffstein, Jeffrey, Pipher, Jill, Silverman, J.H., "An Introduction to Mathematical Cryptography"
6. Vivek Sood, "Cyber Law Simplified,"McGrawHill Education, ISBN: 0070435065.

Paper References:

1. Springer Nature, Published: 03 May 2022 Volume 9, pp 3759–3786, 2023 DOI https://doi.org/10.1007/s40747-022-00756-z
2. Whitfield Diffie and Martin E. Hellman, member IEEE: New Directions in Cryptography, IEEE transactions on Information Theory, Vol. IT-22, no. 6th November 1976 pp 644-654
3. Alexander Viand, Christian Knabenhans, Anwar Hithnawi; 'Verifiable Fully Homomorphic Encryption', 11th February 2023, arXiv, Cornell University. pp: 1–8 DOI: https://doi.org/10.48550/arXiv.2301.07041

Relevant MOOCs

1. Cryptography and Network Security Prof. Sourav Mukhopadhyay, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_cs21/preview
2. Forensic Linguistics Prof. Deepak Mashru   National Forensic Sciences University (INI) https://onlinecourses.nptel.ac.in/noc24_hs88/preview

Other Resources/Links

3. https://ocw.mit.edu/courses/

MCE1-004 Research Methodology		
Teaching Scheme: L: 03 Hrs/week	**Credits:** 03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Mathematical foundations

Course Objectives:
Course intends to prepare the students
1. To understand the philosophy of research in general.
2. To understand diverse aspects of research methodologies.
3. To enhance proficiency in both verbal and written presentation abilities.
4. To get familiar with Intellectual Property Rights (IPR) and plagiarism.

Course Outcomes:
At the end of the Course Students will be able to
1. **Develop** the significance of research and methodologies to collect and analyze data.
2. **Formulate** hypotheses through experimentation.
3. **Design** a comprehensive research report.
4. **Distinguish** various forms of intellectual properties.

Course Contents

	Introduction to RM, defining the research problem and research design	
Module I	Why do research? Meaning, objectives, Research types: computer science and engineering applications specific to nature of research in system building, research process, Criteria of good research. Formulating a research problem: Selecting a research problem, Writing research Objectives. Conceptualizing a research design: Meaning, Need and Basic principles of research design.	**8 Hrs**
	Literature survey, Data Collection and Sampling methods	
Module II	Literature Survey: Importance, planning, locating relevant literature, managing information, and writing a review. Methods for primary and secondary data collection, data processing operations, measures for analyzing data, basics of sampling theory, concept of standard error, estimations on populations, determining sample size.	**8 Hrs**
	Technical Content Writing	
Module III	Report writing significance and steps. Types of technical content publishing: White paper, journal, conference, poster, short paper etc. Writing various technical papers: survey paper, journal paper, indexing agencies, COPE.	**8 Hrs**
	Intellectual Property Rights	
Module IV	Intellectual property: types of IP, IPR in India and abroad. Steps in patenting: Searching prior art, preparing the patent application, claims, filing, prosecution, objections, appeal, issuance or rejection of patent. Plagiarism and Research ethics.	**8 Hrs**

	Research Tools: Plagiarism checking tools, Grammer checker tools	
	Discussion on research by eminent researchers and their research work with citation analysis and related patents and IPR	5 Hrs
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Ranjit Kumar, Research Methodology- a step-by-step guide for beginners, SAGE Publication,4th edition, ISBN: 9789351501336, 2014
2. C. R. Kothari, "Research Methodology- Methods and Techniques," New Age International Publishers, 4th edition, ISBN: 9789386649225, 2019.

Reference Books
1. David V. Thiel, Research Methods for Engineers, Cambridge University Press., 2nd edition, ISBN: 9781139542326, 2017
2. C.G. Thomas, "Research methodology and scientific writing," Springer, 2nd edition, ISBN: 978-3-030-64864-0, 2021
3. Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013: https://www.icsi.edu/media/webmodules/IPRLP_NOV29.pdf

Paper References
1. Bayoudh, K., Knani, R., Hamdaoui, F. et al. A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets. The Visual Computer, 38(8), 2939–2970 (2022). https://doi.org/10.1007/s00371-021-02166-7
2. Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. How to Choose a Sampling Technique for Research (April 10, 2016).
3. Romer, Paul. When should we use intellectual property rights?. American Economic Review 92.2 (2002): 213-216.
4. Wang, Yuntao, et al. A survey on ChatGPT: AI-generated contents, challenges, and solutions. IEEE Open Journal of the Computer Society (2023).

Relevant MOOCs
1. Research Methodology :Prof. Edamana Prasad, Prof. Prathap Haridoss, IIT Madras https://onlinecourses.nptel.ac.in/noc24_ge21/preview Research Methodology :Prof. Soumitro Banerjee, IISER Kolkata https://onlinecourses.nptel.ac.in/noc22_ge08/preview
2. Introduction to Statistical Hypothesis Testing: Dr. Arun Tangirala IIT Madras https://nptel.ac.in/courses/103106120
3. Roadmap for patent creation: Dr. Gouri Gargate IIT Kharagpur https://nptel.ac.in/courses/127105008

Other Resources/Links
1. The world intellectual Property Organization: https://www.wipo.int/portal/en/index.html
2. IP India: http://www.ipindia.nic.in/
3. Cell For IPR Promotion and Management : http://cipam.gov.in/
4. Draft patent rules: http://cipam.gov.in/wp-content/uploads/2018/12/Draft-Patent-Rules-2018.pdf
5. Manual of Patent Office Practice and Procedure: http://www.ipindia.nic.in/writereaddata/Portal/Images/pdf/Manual_for_Patent_Office_Practice_and_Procedure_.pdf

6. WIPO IPR Resources: https://www.wipo.int/reference/en/

MCE1-005 Program Elective Courses: I

MCE1-005A IoT Architecture and Protocol		Hom
Teaching Scheme:	**Credits :03**	**Examination Scheme:**

L: 03 Hrs/week		ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Computer Networks, Data Communication, Wireless Sensor Network

Course Objectives :

Course intends to prepare the students
1. To understand the fundamentals of embedded systems and IoT.
2. To learn methodologies for IoT application development.
3. To study architecture and protocol standards of IoT systems.
4. To learn real world application scenarios of IoT using real time example case studies.

Course Outcomes:

At the end of the Course Students will be able to
1. **Summarize** the need of IoT and embedded systems.
2. **Illustrate** integration of sensors with embedded devices like Raspberry Pi/BBB/Arduino.
3. **Illustrate** and **compare** different IoT application layer protocols.
4. **Design** cloud based IoT applications using embedded devices.

	Course Contents	
	Introduction to embedded systems and IoT	
Module I	**Introduction to Embedded systems:** Introduction to Embedded systems, Sensors and actuators, Challenges. **IoT:** Introduction, characteristics, application areas, Structure of IoT Applications and Functional blocks of IoT **IoT enabling technologies:** Cloud computing, Big data analytics, WSN, advantages and disadvantages of IoT with challenges.	**8 Hrs**
	IoT Architectures and Components	
Module II	**IoT Architectures:** Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Hardware and software Components of IoT:** Introduction to Arduino, Raspberry pi, NodeMCU, BBB and interfacing. Designing IoT applications using embedded devices.	**8 Hrs**
	IoT Data Link Layer and Network Layer protocols	
Module III	IoT reference model, IoT Levels and Deployment templates. Physical/Link Layer, IEEE802.15.4 and ZigBee, Low-power Wi-Fi, Bluetooth and BLE. Network Layer IP Based Protocols, The 6LoWPAN Adaptation Layer and RPL.	**8 Hrs**
	IoT application layer protocols	
Module IV	**Application Layer protocols:** MQTT, CoAP, AMQP, XMPP, WebSocket. Integration of IoT with cloud and REST Architecture. IoT Security challenges, Privacy Issues in the IoT, The Role of Authorization, IoT-OAS: Delegation-based Authorization for the Internet of Things, MQTTs, HTTPs. **Case Study:** Home Automation system/Smart Irrigation system/remote health monitoring using IoT.	**8 Hrs**
	Case Study of industry relevance/recent trends	**5 Hrs**

Text Books

1. Cirani, Simone, Gianluigi Ferrari, Marco Picone, and Luca Veltri "Internet of Things: Architectures, Protocols and Standards" John Wiley & Sons, 2018. DOI: 10.1002/9781119359715,ISBN: 9781119359678
2. Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-On Approach" January 2014,Edition: 1,Publisher:Orient Blackswan Private Limited Publication - New Delhi ISBN:978-0996025515
3. Jeeva Jose "Internet of Things," Khanna Publishing House ISBN: 9788195123162, Edition: First, 2022,Pages: 344.

Reference Books

1. Hersent, Olivier, David Boswarthick, and Omar Elloumi, second edition, "The Internet of Things: Key Applications and Protocols" ISBN: 978-1-119-99435-0 February 2012, 376 Pages John Wiley Sons, 2011.
2. Bradbury, Alex, and Ben Everard, "Learning Python with Raspberry Pi" John Wiley Sons, 2014. Raj Kamal "Internet of Things," Second edition, 2022 TMH.

Paper References

1. Lata, N. Kumar, R. (2020, November). Internet of Things: A Review of Architecture and Protocols. In 2020 International Conference on Decision Aid Sciences and Application (DASA) (pp. 1027-1031).IEEE.
2. Castellani, Angelo P., et al, "Architecture and protocols for the internet of things: A case study" 2010 8th IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops). IEEE, 2010.

Relevant MOOCs

1. Swayam NPTEL "Introduction To Internet of Things," by Sudip Mishra,IIT Kharagpur.
2. Udemy: A Complete Course on an IOT system - Design and Development.
3. Udemy:The Ultimate Guide to IoT with Raspberry Pi and Python -2024.

Hom

MCE1-005B Advanced Machine Learning		
Teaching Scheme: L: 03 Hrs./week	**Credits**: 03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Mathematics, Data Mining.

Course Objectives :

Course intends to prepare the students

1. To understand basic concepts and possible applications of machine learning.
2. To study and illustrate various data preprocessing methods and Supervised, Unsupervised machine learning techniques.
3. To study the basic principles of reinforcement learning
4. To understand the basic principles of optimization and its importance in machine learning**.**

Course Outcomes :

At the end of the Course Students will be able to:

1. Describe the basic concepts and possible applications of machine learning.
2. Apply classification, regression and clustering methods for real world applications for specified data.
3. Apply reinforcement algorithms to real world problems.
4. Solve Optimization problems in machine learning

Course Contents

Module I	**Basics of Machine Learning and Regression** **Models of Machine learning**: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models **Features:** Concept of Feature**,** Feature Extraction, Feature Selection Data Preprocessing and Dimensionality Reduction. **Regression:** Introduction, Multivariate Linear regression, Logistic regression, Lasso and Ridge Regression Assessing performance of regression – Error measures, Overfitting.	**8 Hrs**
Module II	**Classification and Clustering algorithms** **Classification:** Classification concepts, Binary and multi-class classification, K nearest neighbor, Decision Tree Representation, Alternative measures for selecting attributes, ID3 algorithm, Naïve Bayes, Support Vector Machines as a linear and non-linear classifier. **Ensemble methods** – Introduction, Bagging, Boosting and Adaboost, Random Forest. **Clustering:** Introduction, Distance based clustering- K-means algorithm, Hierarchical Clustering-Agglomerative and Hierarchical, Expectation Maximization methods, Choosing number of clusters- silhouettes. **Performance measure metric:** Mean Square Error, R-squared, Precision, Recall, F1-score, Accuracy.	**8 Hrs**
	Reinforcement Learning	**8 Hrs**

Module III	Elements of Reinforcement Learning, Model-Based Learning, Dynamic programming, Monte Carlo, Temporal Difference Learning, Generalization. Bandit algorithms: Upper Confidence Bound algorithm. Case Study: Incremental Document Classification	
Module IV	**Optimization Algorithms**	
	Convex Functions, First and Second Order Conditions for Optimisations, Convex and Non Convex Optimisation, problems in Machine Learning. Gradient Descent: math, programming basic optimisation problems and their solutions, Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent.	**8 Hrs**
	Case Study: Stochastic Gradient Descent for Employee Attrition	**5 Hrs**

Text Books
1. Ethem Alpaydin, "Introduction to Machine Learning" , PHI, 2nd edition, 2013, 978-0-262-01243-0.
2. Kevin Murphy, "Machine Learning: A Probabilistic Approach," MIT Press, 1st Edition, 2012, ISBN No.: 978-0262-30616-4.
3. C.M. Bishop, "Pattern Recognition and Machine learning," Springer, 1st Edition, 2013, ISBN No.: 978-81-322-0906-5.
4. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach," O'Reilly Media, Inc, 2017, ISBN No.: 9781491914250
Reference Books
1. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques," Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.
2. Hastie, Trevor, et al., "The elements of statistical learning: data mining, inference, and prediction," Vol. 2. New York: springer, 2009.
3. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of data, Cambridge University Press, 1st Edition, 2012, ISBN No.: 978-1-316-50611-0.
4. Hastie, Tibshirani, Friedman, Introduction to statistical machine learning with applications in R, Springer, 2nd Edition, 2013, ISBN No.: 978-1-4614-7138-7.
5. Tom Mitchell, Machine Learning, McGraw Hill, 1997, 0-07-042807-7.
6. Parag Kulkarni, Reinforcement and Systemic Machine learning for Decision Making, Wiley-IEEE Press, 2012, 978-0-470-91999-6.
Paper References
1. Gou, Jianping, Wenmo Qiu, Zhang Yi, Yong Xu, Qirong Mao, and Yongzhao Zhan; "A local mean representation-based K-nearest neighbor classifier," ACM Transactions on Intelligent Systems and Technology (TIST) 10, no. 3 (2019): 1-25.
2. Mudumba, Bharadwaj, and Md Faisal Kabir, "Mine-first association rule mining: An integration of independent frequent patterns in distributed environments," Decision Analytics Journal (2024): 100434.
3. Taye, Mohammad Mustafa, "Theoretical Understanding of Convolutional Neural Network: Concepts, Architectures, Applications, Future Directions," 2023,Computation 11, no.3: 52. https://doi.org/10.3390/computation11030052.
Relevant MOOCs

1. Introduction to Machine Learning by Sudeshna Sarkar IIT Kharagpur.
   https://nptel.ac.in/courses/106105152
2. Introduction to Machine Learning by Dr. Balaraman Ravindran, IIT Madras.
   https://nptel.ac.in/courses/106106139
3. Machine Learning with Python by IBM.
   https://cognitiveclass.ai/courses/machine-learning-with-python
4. Deep Learning by Prof. Prabir Kumar Biswas,IIT Kharagpur.
   https://onlinecourses.nptel.ac.in/noc20_cs62/preview

Hom

MCE1-005C Natural Language Processing

Teaching Scheme: L.: 03 Hrs/ Week	Credits: 03	Examination Scheme: ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Theory of Computation, Elementary Probability and Statistics, Basic understanding of Machine Learning.

Course Objectives:

Course intends to prepare the students
1. To be familiar with fundamental concepts of Computational Linguistics.
2. To understand various text pre-processing methods like tagging, parsing and semantic analysis.
3. To study neural network models for processing of natural language.
4. To get acquainted with modern approaches and applications in Computational Linguistics.

Course Outcomes

At the end of the course students will be able to
1. **Apply** text processing techniques in NLP.
2. **Analyze** syntax and semantics of natural language data.
3. **Design** word embedding for neural language modeling.
4. **Design** machine translation and dialogue system.

Course Contents

	Introduction	**8 Hrs**
Module I	Introduction: Computing, Natural Language Processing and Linguistics, Stages of NLP Text Pre-processing: sentence segmentation, Tokenization, feature extraction, issues in tokenization for different languages, word segmentation, text segmentation, normalization, case folding, Morphology, Stemming: Porters Algorithm, lemmatization. Spelling correction - dynamic programming approach for finding edit distance, N-gram Language Modeling- context sensitive spelling correction probabilistic language model, auto completion prediction.	
	Tagging, Syntax and Semantics	**8 Hrs**
Module II	Sequence Labeling for Parts of Speech, HMM for speech tagging, Viterbi Algorithm, Conditional Random Fields. Syntax: Constituency and dependency parsing, Constituency parser -Syntactic structure, Parsing methodology, Different parsing algorithms, Parsing in case of ambiguity, Probabilistic parsing, CKY algorithm, Issues in parsing, Dependency parsing- Syntactic structure, Parsing methodology, Transition-Based Dependency Parsing, Graph-Based dependency parsing, Evaluation, Co-reference resolution Semantics: Word Senses, Word relations, Word similarity and thesaurus methods, Name Entity Recognition, Word sense disambiguation, WordNet. Lexical and Distributional Semantics - Introduction, models of semantics, applications.	
	Neural Language Models, Large Language Models	**8 Hrs**
Module III	Overview of Machine Learning- Basics of Neural Networks, Feedforward neural Network for NLP classification task, word embeddings, Recurrent Neural Networks (RNNs) as language model, Long short-term memory (LSTMs) network	

	Transformers-Self attention network, Large Language Models: with transformers, Generation by sampling, training transformer. Fine-tuning and Masked language models: Bidirectional transformer encoders, training bidirectional encoders, fine tuning language models	
Module IV	**Applications - Machine Translation and Dialogue System**	**8 Hrs**
	Language Divergences and Typology, Machine Translation using encoder decoder, Back-Translation, MT Evaluation Chatbots and Dialogue System: Properties of Human Conversation, Frame-Based Dialogue system, Chatbot, Dialogue system design Transfer learning via Prompting, Chain of Thought Prompting, Tree of Thought Prompting and Instruction Tuning, Retrieval Augmented Generation (RAG) techniques, Using vector datastore for RAG.	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing," 2nd Edition, Prentice Hall, ISBN: 978-0131873216, 2008.
2. Allen James, "Natural Language Understanding," 2nd Edition, Benjamin/Cumming, ISBN: 978-0805303346, 1994.
3. Chris Manning and Hinrich Schuetze, "Foundations of Statistical Natural Language Processing," MIT Press, ISBN: 978-0262133609, 1999.
4. Jacob Perkins, "Python 3 text processing with NLTK 3 cookbook," Packt Publishing Ltd., ISBN: 1782167862, 2014.

Reference Books

1. Jacob Eisenstein. Natural Language Processing, ISBN: 9780262042840 Publisher: The MIT Press, 2019.

Paper References

1. Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin, "Attention is all you need," in Proceedings of the 31st International Conference on Neural Information Processing Systems (NIPS'17),pp. 6000–6010,2017,doi:10.5555/3295222.3295349
2. Pradhan, R., Sharma, D.K., "An ensemble deep learning classifier for sentiment analysis on code-mix Hindi–English data," in *Soft Comput* **27**, 11053 (2023),doi:10.1007/s00500-022-07091-y
3. Jessica López Espejel, El Hassane Ettifouri, Mahaman Sanoussi Yahaya Alassan, El Mehdi Chouham, Walid Dahhane, "GPT-3.5, GPT-4, or BARD? Evaluating LLMs reasoning ability in zero-shot setting and performance boosting through prompts," in Natural Language Processing Journal,Volume 5,2023,doi:10.1016/j.nlp.2023.100032
4. Lee, Jooyoung, Fan Yang, Thanh Tran, Qian Hu, Emre Barut, Kai-Wei Chang and Chengwei Su., "Can Small Language Models Help Large Language Models Reason Better?: LM-Guided Chain-of-Thought," *ArXiv* abs/2404.03414 (2024)
5. Ramchandra Joshi, Rusbabh Karnavat, Kaustubh Jirapure, and Raviraj Joshi. 2020. Domain Adaptation of NMT models for English-Hindi Machine Translation Task : AdapMT Shared Task ICON 2020. In Proceedings of the 17th International Conference on Natural Language Processing (ICON), pages 11–16, Patna, India. NLP Association of India (NLPAI).

6. R. Joshi, "L3cube-mahacorpus and mahabert: Marathi monolingual corpus, marathi bert language models, and resources," in Proceedings of the WILDRE-6 Workshop within the 13th Language Resources and Evaluation Conference, 2022, pp. 97–101
7. Facundo Carrillo, Guillermo A. Cecchi, Mariano Sigman, Diego Fernández Slezak, "Fast Distributed Dynamics of Semantic Networks via Social Media,," Computational Intelligence and Neuroscience, vol. 2015,2015,doi: 10.1155/2015/712835

Relevant MOOCs

1. Course Title: Natural Language Processing Specialization offered by Kaiser, Coursera.
    Link: https://www.coursera.org/specializations/natural-language-processing
2. Course Title: Applied Natural Language Processing offered by Swayam, NPTEL
    Link: https://onlinecourses.nptel.ac.in/noc20_cs87/preview

Other Resources/Links

1. https://www.ibm.com/topics/instruction-tuning
2. https://www.ibm.com/products/watsonx-ai

Hom

MCE1-005D Distributed Operating System		
Teaching Scheme: L: 03 Hrs/week	**Credits :**03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Fundamentals of Operating System

Course Objectives :

Course intends to prepare the students

1. To understand Characteristics and Challenges of distributed systems.
2. To learn process management in distributed operating systems.
3. To study various strategies of Shared Memory and Inter process Communication.
4. To understand Design Principles of Distributed File Management.

Course Outcomes :

At the end of the Course Students will be able to:

1. **Analyze** the challenges in distributed OS.
2. **Demonstrate** the process of communication and synchronization.
3. **Design** application to retrieve the data stored in distributed Memory.
4. **Compare** different File Systems.

Course Contents		
Module I	**Introduction to Distributed Operating System** Fundamentals: Characteristics and challenges of distributed systems. Design issues in distributed operating systems; Architectural models, Desirable features of good global scheduling algorithms, Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach	**8 Hrs**
Module II	**Process Management and Synchronization** Threads and Process, Process States, Scheduling in DOS, Process Migration, Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms	**8 Hrs**
Module III	**Distributed Shared Memory** General Architecture of DSM Systems, Design and Implementation issues in DSM, Consistency Models, Implementing Sequential Consistency Model, Page based distributed shared memory, shared – variable distributed shared memory, object-based distributed shared memory. Replacement Strategy, Thrashing, Heterogeneous DSM, Advantages of DSM.	**8 Hrs**
Module IV	**Distributed File System and Naming** File-Accessing Models, File-Sharing Semantics, File-caching Schemes, File Replication, Fault Tolerance, Atomic Transactions, Design Principles, Naming: Fundamental Terminologies and Concepts, System-Oriented names, Object-Locating Mechanisms, Human-Oriented names, Name cache, Naming and Security. **Case Study :** **F**ile Management in Linux/Windows/Android (EoS)/Andrew File System File Handling System Call implementation in Rust. Real Time Linux(RT Linux).	**8 Hrs**
	Case study of industry relevant /recent trends	**5 Hrs**

Text Books

1. Sinha P. K., "Distributed Operating Systems Concepts and Design," PHI, 1997.
2. Mukesh Singhal and Niranjan Shivaratri, "Advanced Concepts In Operating Systems" , Paperback, July 2017.

Reference Books

1. Tanenbaum A. S., Distributed Operating Systems, Pearson Education India, 1995
2. Ajay D Kshemkalyani, and Mukesh Singhal, Distributed Principles, Algorithms and systems Computing (Reprint -2020)Paperback

Paper References

1. Chia-Han Yang, Valeriy Vyatkin, and Cheng Pang, "Model-Driven Development of Control Software for Distributed Automation: A Survey and an Approach," IEEE Transactions on Systems, Man, and Cybernetics: Systems, Vol. 44, No. 3, March 2014
2. Dacheng Wen, Yupeng Li, Francis C. M. Lau, "A Survey of Machine Learning-Based Ride-Hailing Planning," IEEE Transactions on Intelligent Transportation Systems, DOI:10.1109/TITS.2023.3345174

Relevant MOOCs

1. Cloud Computing and Distributed Systems, Dr. Rajiv Mishra IIT Patna https://nptel.ac.in/courses/106104182
2. Distributed Systems Dr. Rajiv Mishra IIT Patna https://nptel.ac.in/courses/106106168

Other Resources/Links

https://www.rust-lang.org/

MCE1- 006 Laboratory Proficiency - I		
Teaching Scheme: P: 04 Hrs/week	**Credits:** 02	**Examination Scheme:** CIE/TW:- 25 ESE(OR):-25

Prerequisite Courses: Knowledge of programming languages, Basics of Python/R

Course Objectives :

Course intends to prepare the students

1. To explore graph theory in computational problem-solving.
2. To use descriptive statistical measures for conducting statistical inference.
3. To choose appropriate algorithmic strategies while solving problems.
4. To explore Multithreaded and Distributed Algorithms.
5. To learn various data storage methods on cloud
6. To develop IoT applications utilizing embedded devices.
7. To study supervised machine learning techniques.
8. To explore methods for representing and retrieving text documents.
9. To gain insight into the behavioral patterns and profiles of web users.
10. To explore different approaches to Shared Memory and Inter-process Communication.
11. To comprehend the fundamental principles behind designing Distributed File Management systems.
12. To engineer security solutions tailored for real-world applications.

Course Outcomes :

At the end of the Course Students will be able to

1. **Apply** Graph theory for problem modeling and resolution.
2. **Analyze** population characteristics through central tendency, dispersion, and relationships.
3. **Apply** problem-solving skills to address real-world business challenges and decision-making scenarios.
4. **Implement** Multithreaded and Distributed Algorithms to solve given problems.
5. **Use** appropriate data storage techniques on Cloud, based on Cloud application.
6. **Implement** IoT applications leveraging embedded devices.
7. **Apply** classification and regression methods for real world applications.
8. **Evaluate** methods for representing and retrieving text documents.
9. **Design** web user behavioral patterns and profiles through the analysis of web transactions.
10. **Implement** Process Management System Calls using C/Rust.
11. **Develop** an application for accessing data stored across distributed environments.
12. **Apply** cryptographic techniques and tools for problem-solving applications.

All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the dataset/code/write up is not the same.

Mathematical foundations for Computing

1.
   a. Write a program to represent users' information in social networks using graphs. Find the number of associations of each user.

   <div align="center">OR</div>

   b. Design an algorithm to organize the sequence of courses within engineering programs, leveraging graph theory to account for the prerequisite dependencies among courses.

2. Write a program in the language of your choice to calculate measures of central tendency, dispersion and relationship of given data.

Advanced Algorithm

1. a) Write a program to find the longest common subsequence using dynamic programming.

   OR

   b) Design an algorithm for randomized quicksort to mitigate the worst-case time complexity of conventional Quicksort.

2. a) Design and implement a multithreaded merge-sort algorithm.

   OR

   b) Given a social network represented as a graph, where nodes are users, and edges represent connections (friendship). Write a program to find the shortest path between two users using appropriate algorithms.

IoT Architecture & Protocols

1. Design and develop a home automation security system using embedded devices.
2. Design and develop a remote health monitoring system using IoT devices and ThingSpeak cloud.

Information security

3. Implement the Diffie-Hellman Key Exchange mechanism using HTML & JavaScript. Consider the end user as one of the parties (Alice) & the JavaScript application as another party (bob). Also demonstrate MITM (man in the middle attack) on it

1. a) Write a program for Elliptic curve cryptography.

   OR

   b) Write a program to apply Advanced Encryption Standard (AES) Algorithm for a practical application like URL Encryption

Machine Learning

1. Download Email spam classification dataset from Kaggle https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv
   Email Spam detection has two states: a) Normal State – Not Spam, b) Abnormal State – Spam. Use K-Nearest Neighbors and Support Vector Machine to classify the email. Extract confusion matrix from the test results and compare the performance of both.
2. Download Housing Rent Prediction Dataset from Kaggle and predict the house rent using regression.
   https://www.kaggle.com/datasets/iamsouravbanerjee/house-rent-prediction-dataset/

Natural Language Processing

1. Implement complete natural language processing pipeline for Indic language text input.
2. Implement Conversational interface (chatbot) using python.

Distributed Operating System

1. Develop a program in C or Rust to implement Process Management System Calls, which enable the creation, manipulation, and control of processes within an operating system environment.
2. Design and implement a Distributed File System (DFS) like Hadoop Distributed File System (HDFS), capable of storing and managing large volumes of data across multiple nodes in a distributed environment.
3. Mini Project (Based on Core and Elective)

MCE1- 007 Research and Technical Communication Lab		
Teaching Scheme: P: 02 Hrs/Week	**Credits:** 01	**Examination Scheme:** CIE/TW:- 25

Prerequisite Courses: Basic statistics

Course Objectives:
Course intends to prepare the students
1. To understand research papers.
2. To formulate research questions and hypotheses and derive research objectives.
3. To enhance proficiency in both verbal and written presentation abilities.
4. To get familiar with research proposals and patent writing.

Course Outcomes:
At the end of the Course Students will be able to
1. **Analyse** the published research paper.
2. **Analyse** research data using relevant statistical techniques.
3. **Interpret** the research findings.
4. **Apply** research findings through written reports and oral presentations.

1. Reviewing Research papers
    a. Write a set of research questions for the case study of your interested topic. Construct the set of research objectives from the set of questions.
    b. Utilize academic search tools to extract pertinent journal papers. Engage in comprehensive reading of the paper, focusing on the following aspects: major contribution, datasets utilized, methodology employed, analysis and outcomes, conclusions drawn, and any limitations identified. Post-review, articulate the research question believed to have been addressed by the author. Evaluate whether the paper effectively substantiates its conclusions in addressing the question.

2. Literature Review Quality and research proposal
    a. Select a journal paper within your engineering discipline and provide a detailed summary of its literature review section, comprising 400 to 500 words. Evaluate the quality and relevance of the papers cited within the review, assessing the commentary on their contributions to the broader field. Additionally, analyze any notable omissions of papers that hold significant importance within the field.
    b. Craft a new research proposal based on insights gleaned from a chosen published journal paper. Focus specifically on scrutinizing the discussion and conclusion sections of the paper to identify suggestions for future research endeavors.

3. Data modeling and statistical review
    a) Download a set of weather data from the Internet covering the temperature and atmospheric pressure over a five days period. Present the data using 2D and 3D plots, and so deduce if the weather conditions are trending either higher or lower over these five days period.
    b) Numerical modeling: Find a research paper that employs numerical modeling to validate experimental findings. Compare and contrast the differences observed between the experimental and modeling results. Evaluate whether the authors have provided insights into the accuracy of both the experimental and modeling methodologies. Provide recommendations for enhancing the quality of the modeling techniques presented in the paper.
    c) Statistical review: Within your engineering domain, examine a published paper incorporating statistical analysis. Draft a concise report delineating the statistical methods employed. Proposed enhancements to the statistical analysis. Recommend additional parameters that

could have been captured during data acquisition and elucidate how to analyze the comprehensive dataset to ascertain the influence and statistical significance of these supplementary measurements.

4. Research Paper analysis
　1. Note the keywords and type them into one of the web-based academic search engines (e.g. googlescholar.com).
　　　i. Does the original article appear in the search results?
　　　ii. Compare the citations of this paper with those from the most highly cited paper in the search results?
　　　iii. If this paper was published before your original article, is it cited in your article? Do you think this high-cited paper should have been listed as a reference in your original article? Give reasons for your decision.
　2. How many citations does this article have?
　3. Have the same authors published further work in this field?
　　　i. How many citations does this highly cited article have?

5. Research proposal: Generate a novel research proposal based on an existing published journal paper by following these steps:
　a. Begin with an introduction that outlines the research problem and objectives.
　b. Provide background information and rationale to contextualize the proposed research.
　c. Detail the methodology, including research design, data collection methods, and analytical techniques.
　d. Write a research plan and budget requirements.
　e. Summarize the conclusions drawn from the existing paper and propose areas for future research.
　f. Compile a bibliography listing all the references cited in the proposal.

6. Patent claims identification
Examine a journal article within your field that was published around five years ago. Analyze the paper's key findings and identify significant outcomes. Structure these outcomes in a format akin to patent claims, ensuring they represent novel advancements not readily deduced from prior research.

MCE1- 008 Programming Proficiency Lab		
Teaching Scheme: P: 02 Hrs/Week	**Credits**: 01	**Examination Scheme:** CIE/TW:- 25

Prerequisite Courses: Basic programming

Course Objectives:

Course intends to prepare the students
1. To study Python/R programming.
2. To study use of Python/R programming in various Applications such as File Handling, Web Scraping, Data Preprocessing, Data Visualization, Natural Language Processing, Machine Learning, Graphical User Interface.
3. To explore functions in Python/R for evaluating performance of the designed model.

Course Outcomes:

At the end of the Course Students will be able to
1. **Apply** Python/R programming in various domains such as File Handling, Web Scraping, Data Preprocessing, Data Visualization, Natural Language Processing, Machine Learning, Graphical User Interface etc.
2. **Implement** a program for Data Preprocessing and Data visualization**.**
3. **Develop** GUI in Python/R /Java Programming.
4. **Analyze** the performance of the designed model .

1.
   A. Write a program to list all regional language names and number of related articles in the order they appear on wikipedia.org.
   B. Write a program to download all the images from a given webpage url.

2.
   A. Write a program to perform various data preprocessing operations such as handling missing values, one hot encoding, label encoding & data normalization on the following dataset.
   Dataset: https://rb.gy/ppmnxv
   B. Write a program to reduce the number of features in the following dataset while preserving most of the important information. Use techniques such Principal Component Analysis (PCA), t-distributed Stochastic Neighbor Embedding (t-SNE), or feature selection methods like Recursive Feature Elimination (RFE) for this purpose.
   Dataset: https://shorturl.at/aejsM.

3.
   A. Write a program to visualize educational data such as student performance, attendance, and learning outcomes to identify areas for improvement, track progress over time, and personalize learning experiences.
   B. Design a data visualization dashboard to analyze the monthly sales performance of a retail store over the past year. The dashboard should include visualizations of total sales, average sales per day, and sales trends over time. Additionally, it should identify the best and worst performing months and provide insights into factors affecting sales fluctuations.

4.
   A. Write a program to explore different tokenization techniques such as whitespace tokenization, word tokenization, or sentence tokenization.
   B. Write a program to implement the Porter Stemmer algorithm for Stemming.

5.
   A. Write a program to predict the house price using a regression algorithm in machine

learning. Evaluate the performance of the model using various performance metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Huber Loss & R2 score. Link to dataset: https://rb.gy/ppmnxv

B. Write a program to split the Iris flower dataset into 80% train data and 20% test data. Fit the data into the Naive Bayes model for training and testing. Plot the Confusion Matrix. Evaluate the performance using various performance metrics such as Accuracy, Precision, Recall & F1 Score

6.

A. Write a program to design a BMI (Body Mass Index) calculator application using tkinter library in Python / shiny library in R where users can input their height and weight, and the application calculates and displays their BMI along with a corresponding interpretation (e.g., underweight, normal weight, overweight).

B. Build a simple calculator application using the tkinter library in Python / shiny library in R that performs basic arithmetic operations such as addition, subtraction, multiplication, and division. The application should have a user interface with buttons for numeric input and operations. (Graphical User Interface)

Text Books

1. Reema Thareja, "Python Programming Using Problem Solving Approach," Oxford University Press, ISBN 13: 978-0-19-948017-6
2. R. Nageswara Rao, "Core Python Programming," Dreamtech Press; Second edition ISBN-10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL
3. Andrie de Vries, "R for Dummies,"2nd edition (21 July 2015), ISBN-101119055806

Reference Books

1. Martin C. Brown, "Python: The Complete Reference," McGraw Hill Education, ISBN-10: 9789387572942, ISBN-13: 978-9387572942, ASIN: 9387572943
2. Romano Fabrizio, "Learning Python," Packt Publishing Limited, ISBN: 9781783551712, 1783551712
3. Paul Barry, "Head First Python- A Brain Friendly Guide," SPD O'Reilly, 2nd Edition, ISBN:978-93-5213-482-3

Relevant MOOCs Courses

1. SWAYAM - Programming in Python by Dr. Rizwan Rehman, Dibrugarh University.
   https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2. NPTEL - The Joy of Computing using Python by Prof. Sudarshan Iyengar, IIT Ropar
   https://onlinecourses.nptel.ac.in/noc24_cs57/preview
3. IBM - Data Visualization using python.
   https://cognitiveclass.ai/courses/data-visualization-python
4. NPTEL - Introduction to R Software by Prof. Shalabh | IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc19_ma33/preview
5. Getting Started with Competitive Programming,IIT Gandhinagar
   https://nptel.ac.in/courses/106106231

Semester II

Semester II

MCE2-009 Cloud Computing		
Teaching Scheme: L: 03 Hrs/week	**Credits:** 03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Knowledge of data structures, networking, and operating systems.

Course Objectives :

Course intends to prepare the students
1. To study fundamental concepts of cloud computing.
2. To understand the implementation of virtualization in cloud computing.
3. To learn the application and security of cloud computing.
4. To study risk management in cloud computing.
5. To understand the advanced technologies in cloud computing.

Course Outcomes:

At the end of the Course Students will be able to
1. **Compare** private, public and hybrid cloud computing environments.
2. **Analyze** KVM, XEN virtualization technology.
3. **Analyze** security issues in AWS services.
4. **Evaluate** DevOps application using Docker and Container tools**.**
5. **Develop** reusable, maintainable, and scalable infrastructure Code by Terraform.

Course Contents

Module I	**Fundamentals of Cloud Computing** Overview of cloud computing concepts. Types of cloud services: IaaS, PaaS, SaaS Advantages and disadvantages of cloud computing. cloud services: IaaS, PaaS, SaaS and basic cloud security. Public, private, and hybrid cloud community cloud Multi-cloud and Inter-cloud strategies. AWS Fundamentals:- Overview of Amazon Web Services (AWS) Setting up an AWS account. Overview of AWS services (EC2, S3, RDS, VPC, IAM)	**8 Hrs**
Module II	**AWS Databases and Networking and Security** AWS Databases:- EC2 (Elastic Compute Cloud) for virtual servers,S3 (Simple Storage Service) for object storage, EBS (Elastic Block Store) for block storage, RDS (Relational Database Services), Network and Security:- VPC (Virtual Private Cloud) for networking, IAM (Identity and Access Management) for security. Security Groups and Network ACLs, Auto Scaling and Load balancing.	**8 Hrs**

Module III	**Mastering DevOps**
	DevOps Basics and Introduction to Docker:-
	Understanding DevOps principles and practices: Version Control Systems (e.g., Git)
	    Introduction to Docker and containerization, Docker architecture and components
	    Implementing Docker, Docker for networking and storage, Docker Compose for multi-container applications.
		8 Hrs

	Infrastructure as Code (IaC) and Terraform	
Module IV	Introduction to Infrastructure as Code (IaC) with Terraform - Terraform syntax and configuration files- Provisioning and managing infrastructure resources with Terraform - Terraform state management and workspaces- Best practices for using Terraform in production environments.	**8 Hrs**
	Case Study: Implementing Virtual Machine Replication using KVM, Xen.	**5 Hrs**

Text Books
1. A. Srinivasan, J. Suresh, "Cloud Computing: A Practical Approach for Learning and Implementation," Pearson, ISBN: 978-81-317-7651-3.
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing," McGraw Hill Education, ISBN: 13:978-1-25-902995-0.
3. Anthony T.Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing a practical approach, TATA McGraw- Hill, New Delhi, 2010.

Reference Books
1. James Bond, "The Enterprise Cloud," O'Reilly Media, Inc. ISBN: 9781491907627.
2. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more," Wiley Publications, ISBN: 978-0-470-97389-9.
3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach,"The McGraw-Hill, 2010.(Repeated: already in Textbooks)
4. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture, Applications," Cambridge University Press, ISBN: 9780511778476
5. Tim Mather, Subra K, Shahid L., "Cloud Security and Privacy," Oreilly, ISBN-13 978-81-8404-815

Paper References
1. Serhiy Kozlov, "AWS: Overview of Security Processes whitepaper," September 25, 2020. Whitepaper. https://www.romexsoft.com/blog/aws-overview-of-security-processes-whitepaper/#Database_Services
2. David Max, " Unlocking The Secrets: AWS Whitepapers That Simplify Cloud Computing," July 7 2023. https://www.temok.com/blog/aws-whitepapers/

Relevant MOOCs
https://nptel.ac.in/courses/106104182

Other Resources/Links -
1. https://www.redhat.com/en/topics/cloud-computing/public-cloud-vs-private-cloud-and-hybrid-cloud
2. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-291r2.pdf

MCE2-010 Applied Deep Learning

Teaching Scheme: L: 04 Hrs/week	Credits:04	Examination Scheme: ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Artificial Neural Networks as prerequisite Knowledge along with queuing systems

Course Objectives :

Course intends to prepare the students
1. To understand the basics of deep neural networks.
2. To understand the convolution and recurrent neural networks.
3. To get insights into deep generative models.
4. Selection of an effective deep learning model.

Course Outcomes:

At the end of the Course Students will be able to:
1. **Develop** deep learning applications using Tensorflow, Keras, PyTorch.
2. **Analyze** the bias variance tradeoff and its impact on model performance.
3. **Apply** Padding, Strides and Local Response Normalization techniques to enhance model performance.
4. **Compare** bidirectional RNN, Encoder and Decoder sequence models.
5. **Develop** GAN application using google TF-GAN Library.

Course Contents

Module I	**Foundations of Deep learning**	8 Hrs
	Limitations of machine learning, Introduction to deep learning. History of deep learning, advantages and challenges of deep learning. Bias variance tradeoff, hyper parameters, under/overfitting regularization, Learning representations of data, Common Architectural Principles of Deep Network, Architecture Design, Applications of Deep learning, Working of deep learning models. **Case Study** : TensorFlow, Keras, PyTorch, Caffe, Shogun.	
Module II	**Deep Neural Networks(DNNs)**	10 Hrs
	Introduction to Neural Networks :The Biological Neuron, The Perceptron, Multilayer Feed-Forward Networks, Feed-Back Networks, Training Neural Networks :Backpropagation and Forward propagation, Activation Functions :Linear ,Sigmoid, Tannh, Hard Tanh, SoftMax, Rectified Linear, Loss Functions :Loss Function Notation , Loss Functions for Regression, Loss Functions for Classification, Loss Functions for Reconstruction, Hyperparameters : Learning Rate, Regularization, Momentum, Sparsity, Deep Feedforward Networks – Example of X-OR, Hidden Units, cost functions, error backpropagation, Gradient-Based Learning, Implementing Gradient Descent, Vanishing and Exploding gradient descent. Case Study : Applications of Deep Neural Networks.	
	Convolution Neural Network(CNN)	

Module III	Introduction, CNN architecture overview, The Basic Structure of a Convolutional Network, Padding, Strides, Typical Settings, The ReLU layer, Pooling, Fully Connected Layers, The Interleaving between Layers, Local Response Normalization, epoch of CNN. Case Study : Evaluation of Training and Analysis of a Convolutional Network.	**8 Hrs**
Module IV	**Recurrent Neural Networks(RNN)**	**14 Hrs**
	Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs. Deep Generative Models :Introduction to deep generative model, Boltzmann Machine, Restricted Boltzman Machines, Binary RBM and Gaussian RBM, Deep Belief Networks, Generative adversarial network (GAN), Identify problems that GANs can solve discriminator network, generator network, types of GAN, the advantages and disadvantages of common GAN loss functions.	
	Case studies: Applications of CNN and RNN models for various computer vision and Natural Language Processing (NLP) problems. Applications of GAN networks using Google TF- GAN Library	**5 Hrs**

Text Books
1. Goodfellow, I., Bengio, Y.,Courville, A, ―Deep Learning, MIT Press, ISBN: 9780262035613, 2016.
2. Patterson, Josh, and Adam Gibson. Deep learning: A practitioner's approach. " O'Reilly Media, Inc.," 2017.
3. Charu Agarwal, " Neural Networks and deep learning," Springer Nature, latest edition, ISBN : 978-3-031-29641-3, 2023.
4. Buduma, Nithin, Nikhil Buduma, and Joe Papa. Fundamentals of deep learning. " O'Reilly Media, Inc.," 2022.
5. Chollet, Francois, "Deep learning with Python," Manning Publications, ISBN 9781617294433, November 2017.
Reference Books
1. Ritesh Bhagwat, Mahla Abdolahnejad, "Applied Deep Learning with Keras: Solve complex real-life problems with the simplicity of Keras," 1st Edition, Packt Publication, Apr 24, 2019.
2. Seth Weidman, "Deep Learning from Scratch: Building with Python from First Principles," O'Reily, Greyscale Indian Edition, ISBN: 935213902X, Sept. 22, 2019,
3. Francois Duval, "Deep Learning for Beginners, Practical Guide with Python and Tensorflow," CreateSpace Independent Publishing Platform, ISBN:1982027177, 2017.
Paper References
1. Iqbal H. Sarker, "Deep Learning: A Comprehensive Overview on Techniques, Taxonomy, Applications and Research Directions"', SN Computer Science (2021) 2:420 https://doi.org/10.1007/s42979-021-00815-1
2. Laith Alzubaidi, Jinglan Zhang, Amjad J. Humaidi et al, "Review of deep learning: concepts, CNN architectures, challenges, applications, future Directions," Journal of Big Data (2021) 8:53, https://doi.org/10.1186/s40537-021-00444-8
3. Pan Lu1, Liang Qiu1, Wenhao Yu, et al, "A Survey of Deep Learning for Mathematical

Reasoning," https://github.com/lupantech/dl4math, Proceedings of the 61st Annual Meeting of the Association for Computational Linguistics, Vol 1: Long Papers, pages 14605–14631

4. Y Yoshua Bengio, Yann Lecun, and Geoffrey Hinton, **"Deep learning for AI,"** Communications of the **ACM**, vol. 64, no. 7, July 2021, doi.org/10.1145/3448250
5. Brian R. Bartoldson , Bhavya Kailkhura , Davis Blalock, "Compute-Efficient Deep Learning: Algorithmic Trends and Opportunities**,"** ACM Journal of Machine Learning Research 24 (2023) 1-77.

Relevant MOOCs Course

1. https://www.my-mooc.com/en/categorie/deep-learning.
2. https://onlinecourses.nptel.ac.in/noc22_cs22/preview.

Other Resources/Links

1. http://csis.pace.edu/ctappert/cs855-18fall/DeepLearningPractitionersApproach.pdf   (not accessible)
2. https://www.dkriesel.com/_media/science/neuronalenetze-en-zeta2-1col-dkrieselcom.pdf

MCE2-011 Program Electives II

MCE2-011A Edge Computing and IoT Application		
Teaching Scheme: L: 03 Hrs/week	**Credits** :03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Computer Networks, Internet of things(IoT)

Course Objectives :

Course intends to prepare the students
1. To understand and compare working principles of cloud, edge and fog computing.
2. To study edge computing architectures and enabling technologies.
3. To study real-world use cases of edge computing in IoT including autonomous vehicles, industrial automation, and smart cities.

Course Outcomes:

At the end of the course students will be able to
1. **Differentiate** between edge, fog and cloud computing in the context of IoT applications.
2. **Design** the architecture of edge-enabled systems for IoT applications.
3. **Design** applications in cloud-edge-IoT environments.
4. **Demonstrate** different deployment models, such as fog computing, mobile edge computing.

Course Contents		
Module I	**Fundamentals of Edge Computing**	
	Overview of cloud, edge and fog computing, cloud computing architectures, SaaS, PaaS, EaaS, limitations of cloud supported IoT applications, advantages and applications of edge computing, edge computing architectures, challenges and limitations of edge computing, recent trends in edge computing, Cloud-Edge-Fog comparison.	**8 Hrs**
Module II	**Edge and Fog Computing Architectures**	
	Evolution of IoT edge computing capabilities, edge-IoT integration, mapping of Edge Computing Architectures(ECA) to IoT layer models, ECA and IoT limitations and challenges, introduction to edge devices, overview of fog computing, fog computing architectures, characteristics of fog computing, applications, limitations, and challenges of fog computing, fog computing platforms.	**8 Hrs**
Module III	**Enabling Technologies for Edge Computing**	
	Introduction to MQTT and Kafka for end-to-end edge pipeline, containerization at the edge, cloudlet, mobile edge computing, machine learning for edge: sensor data in predictive maintenance, image classifier and self-driving cars.	**8 Hrs**
Module IV	**Advanced Topics in Edge Computing & IoT**	
	Security concerns in edge computing, lightweight edge clouds, Cloud-Fog-Edge enabled analytics, edge and fog intelligence, cognitive IoT applications using edge and fog computing for vision, speech, text.	**8 Hrs**
	Case study:- Case study of industry relevance /Recent trend	**8 Hrs**

Text Books
1. Perry Lea, "IoT and Edge Computing for Architects," Second Edition, Packt Publishing, 2020, ISBN: 9781839214806.
2. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, "Edge Computing: Fundamentals, Advances and Applications," CRC Press, 2021, ISBN: 9781000483598, 1000483592.
3. David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge," Microsoft Azure, ISBN: 978-1484245354.

Reference Books
1. Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), "Fog and Edge Computing: Principles and Paradigms," Wiley, 2019, ISBN: 978-1-119-52498-4.
2. Anwesha Mukherjee (editor) Debashis De (editor) Rajkumar Buyya (editor), "Mobile Edge Computing," Springer, 2021, ISBN: 978-3-030-69892-8.

Paper Reference
1. Bourechak, Amira, Ouarda Zedadra, Mohamed Nadjib Kouahla, Antonio Guerrieri, Hamid Seridi, and Giancarlo Fortino. "At the confluence of artificial intelligence and edge computing in iot-based applications: A review and new perspectives." Sensors 23, no. 3 (2023): 1639.
2. Kong, Xiangjie, Yuhan Wu, Hui Wang, and Feng Xia. "Edge computing for internet of everything: A survey." IEEE Internet of Things Journal 9, no. 23 (2022): 23472-23485.
3. Laroui, Mohammed, Boubakr Nour, Hassine Moungla, Moussa A. Cherif, Hossam Afifi, and Mohsen Guizani. "Edge and fog computing for IoT: A survey on current research activities & future directions." Computer Communications 180 (2021): 210-231.
4. Bermejo, Belen, and Carlos Juiz. "Improving cloud/edge sustainability through artificial intelligence: A systematic review." Journal of Parallel and Distributed Computing 176 (2023): 41-54.

Relevant MOOCs
1. Edge Computing, Prof. Rajiv Misra , IIT Patna https://onlinecourses.nptel.ac.in/noc24_cs66/preview

Other Resources/Links
1. Edge computing technologies for Internet of Things: a primer - ScienceDirect
2. Edge-Computing Architectures for Internet of Things Applications: A Survey - PMC (nih.gov)
3. Edge computing technologies for Internet of Things: a primer (sciencedirectassets.com)
4. Shaping the Future of IoT with Edge Intelligence	How Edge Computing (taylorfrancis.com)
5. Fog computing security challenges and future directions- IEEE Xplore Full-Text PDF
6. A Review on Fog Computing: Architecture, Fog with IoT, Algorithms and Research Challenges - ScienceDirect
7. Edge-Computing Architectures for Internet of Things Applications: A Survey - PMC (nih.gov)

MCE2-011B Information Retrieval and Web Mining		
Teaching Scheme:	Credits:03	Examination Scheme:

L: 03 Hrs/week		ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Database Management System, Data Structures and Algorithms, Probability and statistics

Course Objectives :

Course intends to prepare the students
1. To explore various document representation and retrieval methods.
2. To understand query formulation, evaluation and feedback relevance.
3. To study Supervised and Unsupervised learning Method for text analysis and retrieval.
4. To understand behavioral patterns and profiles of web users.

Course Outcomes :

At the end of the Course Students will be able to
1. **Apply** and **analyze** various document representation and retrieval methods.
2. **Evaluate** language model and query performance for information retrieval.
3. **Apply** classification and clustering methods on text documents and evaluate the performance.
4. **Identify**, **assess**, and **design** behavioral patterns and profiles of the web by studying web user transactions.

Course Contents

Module I	**Introduction** Overview of text retrieval systems: Boolean retrieval, the term vocabulary and postings list, Dictionaries and tolerant retrieval, Index construction and compression, Retrieval models and implementation: Vector Space Models, Vector Space Model, TF-IDF Weight. Case Study: Information retrieval and question answering: A case study on COVID-19	**8 Hrs**
Module II	**Language Models, Query Expansion and feedback evaluation** Probabilistic models: statistical language models, Okapi/BM25, Language models for information retrieval, KL-divergence, Smoothing, Query expansion and feedback: Relevance feedback, pseudo relevance feedback, Query Reformulation, Computing scores in a complete search system, Evaluation in information retrieval.	**8 Hrs**
Module III	**Text classification & Text clustering** **Text classification & Text clustering**: The text classification problem, Naive Bayes text classification, Vector-space clustering: Partition based clustering algorithm, K-means algorithm, Hierarchical clustering, EM algorithm, Performance analysis. **Ethical Issues in IR:** Privacy, Fairness, Fake news and disinformation, Filter bubble, Viewpoint diversity, fostering extremism, Internet addiction.	**8 Hrs**
Module IV	**Social Network Analysis & Web usage Mining** **Social Network Analysis**: Centrality, Prestige, Co-Citation and Bibliographic Coupling: Co-Citation, Bibliographic Coupling, Page Ranking: PageRank Algorithm, Strengths and Weaknesses of PageRank, Timed PageRank and Recency Search. **Web Usage Mining**: Key Elements of Web Usage Data Pre-Processing, Data Modeling for Web Usage Mining, Discovery and Analysis of Web Usage Patterns: Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Association and Correlation Analysis, Analysis of Sequential and	**8 Hrs**

	Navigational, Classification and Prediction based on Web User Transactions. web usage mining tool	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, " Introduction to Information Retrieval," Cambridge University Press. 2008. http://nlp.stanford.edu/IR-book/information-retrieval-book.html
2. Ricardo Baeza -Yates and Berthier Ribeiro – Neto, "Modern Information Retrieval: The Concepts and Technology behind Search" 2nd Edition, ACM Press Books 2011.
3. Bing Liu, "Web data Mining: exploring hyperlinks, contents and usage data," Springer, second edition-2011

Reference Books
1. Cheng Xiang Zhai, "Statistical Language Models for Information Retrieval," Synthesis Lectures Series on Human Language Technologies, Morgan & Claypool Publishers, 2008.
2. W. Bruce Croft, Donald Metzler, and Trevor Strohman, "Search Engines - Information Retrieval in Practice," Cambridge University Press, 2009. ISBN 9781598295900.
3. G. Kowalski, M.T. Maybury, "Information storage and Retrieval System theory and implementation," Kluwer Academic Publishers 2nd edition, 2002, ISBN: 0-306-47031-4.

Paper References
1. T. Shaik, Thanveer and Tao, Xiaohui and Li, Yan and Dann, Christopher and McDonald, Jacquie and Redmond, Petrea and Galligan, Linda, "A Review of the Trends and Challenges in Adopting Natural Language Processing Methods for Education Feedback Analysis," in IEEE Access, May 2022, vol. 10, pp. 56720-56739. doi: 10.1109/ACCESS.2022.3177752.
2. Wayne Xin Zhao, Jing Liu, Ruiyang Ren, and Ji-Rong Wen. 2024. Dense Text Retrieval Based on Pretrained Language Models: A Survey. ACM Trans. Inf. Syst. 42, 4, Article 89 (July 2024), 60 pages. https://doi.org/10.1145/3637870.
3. Edward Kai Fung Dang, Robert Wing Pong Luk, and James Allan. 2021. A Comparison between Term-Independence RetrievalModels for Ad Hoc Retrieval. ACM Trans. Inf. Syst. 40, 3, Article 62 (July 2022), 37 pages. https://doi.org/10.1145/3483612.

Relevant MOOCs Course
1. Business Analytics & Text Mining Modeling Using Python by Dr. Gaurav Dixit IIT Roorkee https://onlinecourses.nptel.ac.in/noc19_mg47/preview
2. Natural Language processing :Prof. Pushpak Bhattacharyya IIT Bombay https://nptel.ac.in/courses/106101007

Other Resources/Links
1. C.J. Rijsbergen, "Information Retrieval," (http://www.dcs.gla.ac.uk/Keith/Preface.html)
2. Special interest group on Information retrieval (https://dl.acm.org/sig/sigir)
3. https://www.cs.cmu.edu/~dst/WordEmbeddingDemo/tutorial.html
4. https://www.searchenginejournal.com/semantic-search-how-it-works-who-its-for/438960/
5. https://aws.amazon.com/what-is/retrieval-augmented-generation

MCE2-011C Multimodal Computing

Teaching Scheme: L: 03 Hrs/week	**Credits**: 03	Examination Scheme: ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Basics of data structure, Algorithms, Programming

Course Objectives :
Course intends to prepare the students
1. To introduce fundamentals of multimodal computing.
2. To elaborate different multimodal learning paradigms.
3. To learn and analyze different multimodal learning strategies.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Comprehend** complex concepts better when exposed to multiple modalities.
2. **Apply** knowledge across contexts with deeper understanding.
3. **Express** themselves using various mediums, improving communication skills.

Course Contents

	Introduction to Multimodal computing	
Module I	Multimodality introduction, Overview of human communication practices from a multimodal perspective, need of multimodal computing, Need of Multimodal Behaviors & signals, Modes of Multimodal Learning (speech, audio, written and print, illustrations), Multimodal Machine learning and Artificial Intelligence, Applications of MM, Limitations of MM.	**8 Hrs**
	Text Processing in Multimodal computing	
Module II	Overview of text processing techniques-tokenization, stemming, lemmatization, handling noisy and unstructured text.NLP fundamentals, large language models (BERT, GPT), Multimodal fusion methods, Visual text analysis, transfer learning across modalities, Applications.	**8 Hrs**
	Speech Processing in Multimodal computing	
Module III	Overview of speech processing, Digital Signal processing basics, STFT (Short time Fourier transform). **Acoustic Phonetics and Articulatory Phonetics, Speech Prosody, Speech Prosody Modeling (Fujisaki Model) Automatic speech recognition- Hidden Markov models, Speech synthesis -text to speech and speech to text, applications.**	**8 Hrs**
	Image & Video processing in Multimodal computing	
Module IV	Overview of multimodal learning and visual data, Image Representation ways-pixel values, histograms, deep features, Extraction of features from images using CNN activations, texture descriptors, applications, limitations. Overview of video processing in MM, Video compression, motion estimation, temporal modeling, video denoising, stabilization, summarization techniques, applications, case studies.	**8 Hrs**
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Multimedia Computing, Gerald Friedland, Ramesh Jain, Cambridge University Press, 2014, ISBN 0521764513, 9780521764513

2. Multimedia : Computing, Communications and Applications, Ralf Steinmetz, Klara NaHrstedt, Pearson, 2012

Reference Books

1. Akkus, Cem, et al. "Multimodal deep learning." arXiv preprint arXiv:2301.04856 (2023).

Paper References

1. Bayoudh, K., Knani, R., Hamdaoui, F. et al. A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets. Vis Comput 38, 2939–2970 (2022). https://doi.org/10.1007/s00371-021-02166-7
2. P. Xu, X. Zhu and D. Clifton, "Multimodal Learning With Transformers: A Survey" in IEEE Transactions on Pattern Analysis & Machine Intelligence, vol. 45, no. 10, pp. 12113-12132, 2023.
3. Ngiam, Jiquan, et al. "Multimodal deep learning." Proceedings of the 28th international conference on machine learning (ICML-11). 2011.

Relevant MOOCs Course

1. Digital Speech Processing - Course (nptel.ac.in) Prof. Shyamal Kumar Das Mandal ,IIT Kharagpur
2. Multimodal Literacies: Communication and Learning in the Era of Digital Media | Coursera

Other Resources/Links

1. An Introduction to Multimodal Models - Comet
2. A Gentle Introduction to Multiple-Model Machine Learning - MachineLearningMastery.com
3. Chapter 3 Multimodal architectures | Multimodal Deep Learning (slds-lmu.github.io)
4. Multimodal Learning | SpringerLink
5. Multimodal interaction: A review - ScienceDirect

MCE2-011D Advanced Compilers		
Teaching Scheme: L:03 Hrs/week	**Credits** :03	**Examination Scheme:** ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Knowledge of Automata Theory and Languages

Course Objectives :

Course intends to prepare the students

1. To understand the structure of compilers.
2. To learn different ways of intermediate representation and Code generations.
3. To learn the optimization methods and LLVM framework.

Course Outcomes:

At the end of the Course Students will be able to:

1. **Understand** the architecture of advanced compilers, including the various phases of compiler.
2. **Apply** advanced parsing techniques to analyze and transform source code.
3. **Apply** optimization techniques to enhance the performance of generated code.
4. **Analyze** how semantic errors impact program behavior and correctness.
5. **Evaluate** the effectiveness of different compiler optimization strategies in terms of code size, speed, and memory usage.
6. **Design** and **Implement** a compiler for a specific language, incorporating advanced features and optimizations.
7. **Understand** the basic workflows and concepts associated with using LLVM tool.

Course Contents

Module I	**Introduction** Overview of compilation. Phases of Compiler, Lexical Analysis, Syntax analysis, Different types of Parsers. Predictive Parsing, LR parsing, Using Parser Generators, Parser error recovery. Semantic analysis: Type checking. Type checking Declaration and Expressions. Syntax-directed translation.	**8 Hrs**
Module II	**Intermediate Representations and Code Generation** Introduction, Three address code generation, Control Flow Graphs, Intermediate representations trees, Translation into trees, declaration, Building a Simple Compiler Front end. Code generation: Introduction, Target Machine Description, instruction selection, pipelining and instruction scheduling. Peep-Hole Optimization.	**8 Hrs**
Module III	**Code Optimization** Intro to code optimization. DFA basics. Program representations for optimization. SSA form. SSA-enabled optimizations: conditional constant propagation, value numbering, partial redundancy elimination. SSA construction and destruction algorithms.	**8 Hrs**
Module IV	**Types of Compilation and LLVM** Just in-time Compilation, Garbage collection in Compiler, Parallelizing Compilers, Domain Specific Language Compilation. Intro to LLVM framework, Hands on Exercise with LLVM, Custom Compiler development using LLVM. Case study: Recent trends in compiler design for high performance computing and message passing machines and scalable shared	**8 Hrs**

	memory machines. Case study: Compiler design for high performance computing and message passing machines and scalable shared memory machines	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Dick Grune, Kees van Reeuwijk, Henri E. Bal, Ceriel J.H. Jacobs, Koen Langenhoven, "Modern Compiler Design", 2016 , ISBN:9781493944729, 149394472X
2. Ken Kennedy, Randy Allen," Optimizing Compilers for Modern Architectures: A Dependence-based Approach",2001
3. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques, and Tools", Pearson Edition, ISBN 81-7758-590
4. Michael Wolfe, "High-Performance Compilers for Parallel Computing", Pearson Edition 1995,**ISBN**-13: 978-0805327304

Reference Books
1. Steven S. Muchnik. Advanced Compiler Design and Implementation. Harcourt Asia Private Ltd, 2000.
2. Y. N. Srikant and P. Shankar (Ed.) The Compiler Design Handbook: Optimizations and Machine Code Generation. CRC Press, 2002.

Paper References:
1. David Kaeli ACM Transactions on Architecture and Code Optimization, Volume 21, no.2 (June 2024). https://dl.acm.org/toc/taco/2024/21/2

Relevant MOOCs
1. Compiler design, Prof. Santanu Chattopadhyay, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs07/preview

MCE2-011E Applied Security

Teaching Scheme: L: 03 Hrs/week	Credits: 03	Examination Scheme: ISE: 20 Marks CIE:30 Marks ESE:50 Marks

Prerequisite: Basics of computer Network Model, Information Security

Course Objectives :

Course intends to prepare the students

1. To State controls to protect against program flaws in execution– operating system support & administrative control
2. To learn about security threats posed by e–mails.
3. To learn Tools used in Computer Forensics and Cyber Applications.
4. To identify various challenges in real-world applications of Blockchain.

Course Outcomes:

At the end of the Course Students will be able to:

1. **Summarize** countermeasures to protect from the threats posed by e–mail systems & understand Internet Security
2. **Write** preventive measures by identifying different cyber attacks
3. **Indicate** usage of forensic linguistic in solving cases
4. **Analyze** the need and feasibility of using blockchain technology in real–world applications

Course Contents

Module I	**Securing Computer Network** Taxonomies of vulnerabilities, attacks & mitigation for: Physical / DLL (Data Link Layer) /Network / Transport / Application layer: viz; Security at Network Layer (IPSec = IP Security), Security at Transport Layer (SSL = Secure Sockets Layer & TLS = Transport Layer Security), Security at Application Layer (PGP = Pretty Good Privacy, S/MIME = Secure/Multipurpose Internet Mail) Electronic Mail Security & e–mail (electronic mail) crime investigation RFC2822. IDS (Intrusion Detection System), IPS (Intrusion Prevention System). Router security: default setting Case studies: Fingerprints & Iris Scans. fail2ban, Snort / design honeypot.	**9 Hrs**
Module II	**Security in Computing** Program Security: Secure Programs– Secure coding ISO standard 5000, Non–malicious Program Errors, Targeted Malicious Code, Control against program threats. Trusted Operating System Design & Access Control in OS, Database Security: security requirements & sensitive data	**8 Hrs**
Module III	**Administering Security** Security Planning, Risk Analysis, Organizational Security Policies, Physical Security, Legal, Privacy & Ethical issues in computer security. Cost of Cybercrimes & IPR (Intellectual Property Rights) issues– Lessons for Organizations. Issues in Security Management. Computer Management in a practical way. Exemplar: Case studies of Ethics.	**8 Hrs**
	Information Security in AI	**7 Hrs**

Module IV	Data Security in AI: Data Security: Protecting data used for AI training and operation from unauthorized access, tampering, and theft. - Encryption: Ensuring data is encrypted both in transit and at rest to prevent unauthorized access. - Access Control: Implementing strict access controls to limit who can view or manipulate data. Privacy in AI - Privacy: Safeguarding the privacy of individuals whose data is used by AI systems. - Data Minimization: Using only the minimum amount of data necessary for AI training and operation. - Differential Privacy: Applying techniques to ensure that individual data points cannot be inferred from the output of an AI system.	
	Case study on application of Block chain Technology	**5 Hrs**

Text Books
1. Charles P.Pfleeger, Shari Lawrence Pfleeger, 'Security in Computing', Pearson Education, 3rd edition,
2. William Stallings, 'Cryptography & Network Security, Principles & Practice', Pearson, 7th edition, ISBN: 978–1–292–15858.
3. Nina Godbole, Sunita Belapure, 'Cyber Security– Understanding Cyber Crimes, Computer Forensics & Legal Perspectives', Wiley, India, First edition = 2011, ISBN: 978–81–265–2179–1.
4. Bill Nelson, Amelia Phillips & Christopher Steuart, "Guide to Computer Forensics & Investigations," 4th edition, Cengage Learning. ISBN: 978–81–315–1946–2.
5. Martin Quest,"Blockchain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bitcoin and Other Crypto currencies," Create Space Independent Publishing Platform, 2018, ISBN-1719197091.
6. Imran Bashir,"Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained," 2nd Edition, Packt Publishing, 2018. ISBN-1788839048.
Reference Books
1. Jan L. Harrington, 'Network Security A Practical Approach', Elsevier
2. Bruice Schneier , Applied Cryptography– Protocols, Algorithms and Source code in C, 2nd edition, Wiley Indian Edition, India Pvt Ltd, ISBN 978–81–265–1368–0.
3. Nina Godbole, 'Information Systems Security– Security Management, Metrics, Frameworks & Best Practices', Wiley India, ISBN: 978–81–265–1692–6
4. Antoon W. Rufi, 'Network Security 1 & 2 Companion Guide', Cisco Networking Academy Program, Low Price Edition, Pearson Education. ISBN: 81–317–0892–6
5. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Blockchain ABeginner's Guide to Building Blockchain Solutions," 2018
6. Chris Dannen, "Introducing Ethereum and Solidity," Foundations of Crypto currency andBlockchain Programming for Beginners.
Paper References

1. Abebe Abeshu and Naveen Chilamkurti; Deep learning: The frontier for distributed attack detection in fog–to–things computing. IEEE Communications Magazine, 56(2):169–175, 2018.
2. B. Li, P. Liu and L. Lin, 'A Cluster-Based Intrusion Detection Framework for Monitoring the Traffic of Cloud Environments', 2016 IEEE 3rd International Conference on Cyber Security and Cloud Computing (CSCloud), Beijing, China, 2016, pp. 42-45, doi: 10.1109/CSCloud.2016.43
3. Geet Shingi, Preeti A. Jain, Harsh Saglani; 'Segmented Federated Learning for Adaptive Intrusion Detection System', July 2021, DoI: https://doi.org/10.48550/arXiv.2107.00881

Relevant MOOC

1. Ethical Hacking Prof. Indranil Sen Gupta, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc19_cs68/preview
2. Cyber Security and Privacy Prof. Saji K Mathew, IIT Madras https://onlinecourses.nptel.ac.in/noc23_cs127/preview
3. Blockchain and its Applications Prof. Sandip Chakraborty, Prof. Shamik Sural , IIT Kharagpur
    https://onlinecourses.nptel.ac.in/noc22_cs44/preview

Other Useful Resources/Links

1. https://ocw.mit.edu/courses/
2. https://users.cs.fiu.edu/~prabakar/cen5079/Common/textbooks/Mastering_Blockchain_2nd_Edition.pdf
3. https://www.lopp.net/pdf/princeton_bitcoin_book.pdf
4. https://www.blockchainexpert.uk/book/blockchain-book.pdf

MCE2-013 Laboratory Proficiency – II		
Teaching scheme: P: 6 Hrs/week	**Credits**: 03	**Examination Scheme:** CIE/TW:- 50 Marks ESE(OR):-50 Marks

Prerequisite: Knowledge of programming languages, Basics of Python/R/Java

All assignments are compulsory. Each student should implement the assignments individually. Laboratory teachers should make sure that the dataset/code/write up is not the same.

Course Objectives:
Course intends to prepare the students
To study various cryptographic techniques for solving real world problems.
1. To explore cloud-edge-IoT environment and the architecture of edge-enabled systems for IoT applications.
2. To study neural language modeling for analyzing syntax, semantics of natural language data.
3. To design software architecture for a selected software system.
4. To learn different phases of compiler and LLVM framework.
5. To learn preventive measures by identifying different cyber-attacks.
6. To understand the need and feasibility of using blockchain technology in real-world applications.
7. To understand the convolution and recurrent neural networks.
8. To get insights into deep generative models

Course Outcomes:
At the end of the Course Students will be able to:
1. **Utilize** cryptographic techniques effectively to address real-world challenges.
2. **Create** applications tailored for the cloud-edge-IoT environment and develop architectural designs for edge-enabled systems in IoT.
3. **Examine** syntax and semantics of natural language data and implement neural language modeling techniques.
4. **Apply** acquired knowledge with a deeper understanding across various contexts.
5. **Evaluate** and **incorporate** quality attributes into the software architecture design process for a chosen software system.
6. **Implement** loop restructuring and code optimization techniques compiler.
7. **Formulate** preventive measures against various cyber-attacks through proactive identification.
8. **Assess** the necessity and viability of integrating blockchain technology into practical applications.
9. **Implement** and **evaluate** deep generative models and CNN/RNN.

Cloud Computing
1. Build your own cloud management system using the libvirt API 2. Build your own container using Linux namespaces and cgroups
Applied Deep Learning
1. Develop an application using Deep GAN for multimedia image processing 2. Hand written digit recognition using CNN/RNN
Edge Computing & IoT Applications
1. a) Setup edge-cloud-IoT environment and develop a data analytics application in the above set-up using open IoT/IIoT datasets. OR

b) Setup edge-cloud-IoT environment and develop an application using lightweight machine learning models for edge enabled IoT systems.
2. Develop an edge-enabled application for real-time monitoring, video analytics, or sensor data processing.

Information Retrieval and Web Mining
1. Consider 10 documents. Construct a count of each document term and return the top 10 frequently occurring terms in the document collection using the TF-IDF score. Find similarity between documents using different similarity measures. Construct a graph for zips and heaps law. Evaluate the performance of similarity measures using precision, recall and F measure.
2. Develop a program to construct a social network graph and calculate the PageRank scores for each node in a given graph and display the score of each node for each iteration of the PageRank algorithm computation.

Multi Modal Computing
1. Develop a customer service chatbot using speech recognition and text analysis to provide a more natural and efficient user experience.
2. Design and develop a system that can recognize traffic signs such as speed limit, signals and directional indicators using Convolutional Neural network.

Advanced Compilers
1. Write a program to demonstrate loop restructuring in C/C++.
2. Write a program to implement code optimization.

Applied Security
1. Develop data visualization of last few years breach record
OR
1. Write a program to analyze e–mail header.
2. Develop a decentralized app for real-world application using blockchain.

MCE2-014 Skills Enhancement Lab		
Teaching Scheme: P: 02 Hrs/week	**Credits**: 01	**Examination Scheme:** CIE/TW:- 25 Marks

Prerequisite:

Course Objectives
1. To solve and devise solutions to a range of elementary real-world problems.
2. To explore and apply key concepts in logical thinking to business problems.
3. To enable students to critically analyze material (information) to evaluate evidence, construct reasoned arguments, and communicate inferences and conclusions.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Develop** problem-solving skills and critical thinking abilities in the context of recruitment aptitude tests.
2. **Exhibit** advanced skills of interview, debating and discussion **or** Perform verbal and nonverbal communication behaviors that illustrate self-efficacy

Guidelines for conduction and evaluation of the laboratory sessions:
Students will be encouraged to study and prepare for the contents relevant to the modules-Quantitative Aptitude, Logical Reasoning and Technical communication.
Evaluation can be in terms of practice tests/ mock tests/ MCQ based tests, Group discussion, Mock interview, and presentation

	Quantitative Aptitude	
Module I	Percentage; Profit/ Loss; Simplification and Approximation: Decimal fractions, Square Roots & Cube Roots; Average; Ratio and Proportion: Partnerships; Age; Mixture and alligation; Number Series; Arithmetic: Time and work, Time, Distance and Speed, Boats and streams; Data Interpretation: Pie chart, Bar chart, Table chart.	**8 Hrs**
	Logical Reasoning	
Module II	Distance and direction; Blood relation: Linear inequalities; Ranking arrangement; Coding decoding: Chinese/ Symbolic, Number, Symbolic, Miscellaneous, Letter; Syllogism; Seating arrangement; Puzzle; Input- Output; Alphabetic series; Statements and assumptions; Statements and conclusions	**8 Hrs**
	Technical Communication	
Module III	Vocabulary building; Oral Communication and Speaking Techniques; Group Discussions– dynamics of group discussion, Lateral thinking, Brainstorming and Negotiation skills; Meetings– making meeting effective, chairing a meeting, decision making, seeking opinions, interrupting, and handling interruptions, clarifications, closure Agenda, Minute writing; Presentation skills; Interview skills– formal & informal interviews, concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele and video-conferencing.	**8 Hrs**

Text Books
1. R. S. Aggarwal, Quantitative Aptitude (Fully solved), Reprint 2016, S. Chand Publishing.
Reference Books
1. Simon Sweeny, "Communicating in Business," Second Edition, Cambridge University Press.

2. M. Ashraf Rizvi, "Effective Technical Communication," Tata McGraw-Hill Publishing Company Ltd. 2005.
3. Andrea J. Rutherford, "Basic Communication Skills for Technology," 2nd Edition, Pearson Education, 2007.
4. Meenakshi Raman & Sangeeta Sharma, "Technical Communication," Oxford University Press, 2011.

Relevant MOOCs

1. English Language for Competitive Exams, IIT Madras
   https://nptel.ac.in/courses/109106116
2. Employment Communication A Lab based course, IIT Kharagpur
   https://nptel.ac.in/courses/109105144

Other Resources/Links

MCE2-015 Seminar-I		
Teaching Scheme: P: 04 Hrs/week	**Credit :**02	**Examination Scheme:** CIE/TW:- 50 Marks ESE/(OR):-25Marks

Course Objectives:
1. To deepen students' understanding of advanced topics, emerging trends, and recent developments in computer engineering.
2. To enhance students' research skills, including literature review, experimental design, data collection and analysis, and interpretation of results, in the context of computer engineering research.
3. To improve students' ability to communicate technical concepts effectively through written reports, oral presentations, and technical documentation, targeting both technical and non-technical audiences.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Conduct** thorough literature surveys confined to the domain of choice.
2. **Develop** presentation skills to **deliver** the technical contents.
3. **Prepare** the report of the technical research domain.

The student shall have to deliver the seminar I in semester II on a topic approved by guide and authorities. It is recommended to allot a guide to the student since the commencement of semester I. The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. It is recommended that seminar shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected or domain of interest.

It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain. Thorough literature study based on the broad identified topic has to be carried out. This practice will eventually lead to convergence of the efforts for the dissertation.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research & innovation. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.
The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in the seminar logbook approved by the department.

Semester III

Semester – III

MCE3-018 Indian Knowledge System and Human Values		
Teaching Scheme: L: 01 Hrs/week P: 02 Hrs/week	**Credits**: 02	**Examination Scheme:** CIE:30 Marks CEI/TW:20 Marks

Prerequisite:

Course Objectives :

Course intends to prepare the students

Study/Explore/Understand the significance of IKS for a sustainable environment, love for nature, holistic ways of living, and health conscious that ultimately leads to quality life for everyone in the plane.

1. To preserve and showcase the depth and breadth of Indian knowledge for a sustainable society and future generations.
2. To explore research in the area of Mindfulness for Sustainable Health.
3. To help the students to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
4. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity.

Course Outcomes :

At the end of the Course Students will be able to
1. **Differentiate** between harmonious and disharmonious living
2. **Contribute** in developing solutions to social problems leading to peaceful life.
3. **Demonstrate** Holistic perspective towards life..

Course Contents		
Module I	**Indian Knowledge System – An Introduction:** What is IKS? Why do we need IKS? Organization of IKS Historicity of IKS Some salient aspects of IKS.	2 **Hrs**
Module II	**Students can select any one from A/B/C** **A.** Introduction to Linguistics, Phonetics, Word generation, Computational aspects, Mnemonics Recursive operations, Rule-based operations, Sentence formation, Verbs and prefixes, Role of Sanskrit in natural language processing. **B.** Introduction to health, Āyurveda: approach to health, Sapta-dhātavaḥ : seven-tissues, Role of agni in health, Tri-doṣas , Āyurveda: definition of health, Psychological aspects of health ,Disease management elements , Dinacaryā: daily regimen for health & wellness, Importance of sleep, Food intake methods and drugs , Approach to lead a healthy life, Indian approach to psychology, The tri guṇa system & holistic picture of the individual, The Nature of Consciousness, Consciousness studies and issues. **C.** Indian scheme of knowledge, The knowledge triangle , Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality , Attributes – the properties of substances and Action – the driver of conjunction and disjunction , Sāmānya, viśēṣa,	5 **Hrs**

	samavāya , Pramāṇa – the means of valid knowledge , Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge , Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhanta: established tenets in a field of study. Case Study : **Societal Problem Solving :** Smart City**,** Town Planning, Health Care Systems, etc.	
Module III	**Value Education and Harmony in Human being**	**6 Hrs**
	Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Program to ensure self-regulation and Health.	
Module IV	**Harmony in the Family, Society and Nature**	**5 Hrs**
	The Basic Unit of Human Interaction, Values in Human–to–Human Relationship, Nine universal values in relationships viz. Trust, Respect, Affection, Care, Guidance, Reverence, Glory, Gratitude, Love. Understanding Harmony in Society, Vision for the Universal Human Order, Human Order Five Dimension.. Understanding Harmony in Nature, self–regulation & mutual fulfillment among the Four orders of Nature, Realizing Existence as coexistence at all levels holistic perception of harmony in existence.	
	Case Studies of industry relevance/recent trends	**5 Hrs**

Text Books
1. Kapur K and Singh A. K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla.
2. Introduction to IKS: Concepts and Applications by Prof. B Mahadevan, IIM Bengaluru
3. AK Pathak, Science and Technology in India, Anshika prakashan pratapgarh, 2016.
4. R P Kulkarni, Glimpse of Indian Engineering and Technology (Ancient & Medieval period, Munshiram Manoharlal Publishers Pvt. Ltd. 2018.
5. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.
6. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978–93–87034–47–1.

Reference Books
3. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
4. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. On Education – J Krishnamurthy
7. Rediscovering India – by Dharampal Hind Swaraj or Indian Home Rule – by Mohandas K. Gandhi.

MOOC Courses:
5. Indian Knowledge System(IKS): Concepts and Applications in Engineering By Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan | Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore Link of the Course: https://onlinecourses.swayam2.ac.in/imb23_mg53/preview
6. Indian Knowledge System(IKS): Humanities and Social Sciences By Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore. https://onlinecourses.swayam2.ac.in/imb23_mg55/preview

ACTIVITY BASED LEARNING (SUGGESTED ACTIVITIES IN CLASS)
1. Presentation Participation individually and in teams.
2. Extempore, Impromptu small talks
3. Quizzes/Assignment /Seminars/Group discussions.

MCE3-019 Internship/Field Study		
Teaching Scheme: P: 08 Hrs/week	**Credit** :04	**Examination Scheme:** CIE/TW:- 50 Marks ESE(OR):- 50 Marks

Course Objectives:
Course intends to prepare the students
1. To identify the problem in the domain of interest.
2. To learn to communicate in a scientific language through collaboration with a guide.
3. To work in a professional environment.

Course Outcomes:
At the end of the Course Students will be able to
1. **Conduc**t literature survey confined to the domain of choice
2. **Develo**p presentation skills to deliver the technical contents
3. **Create** report of the technical research domain
4. **Analyze** the findings and work of various authors confined to the chosen domain

Conduction guidelines

Industry or research internship should include partial/complete project implementation. The preferences/choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/choices. Students should be allocated to the research guide in the first semester itself and the same guide should be continued for the**:** Industry Internship-I/ In house Research Project –I. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

MCE3-020 Seminar - II		
Teaching Scheme: P: 04 Hrs/week	**Credit** :02	**Examination Scheme:** CIE/TW:- 50 Marks ESE(OR):-50 Marks

Course Objectives:
Course intends to prepare the students
1. To develop students' ability to critically analyze complex problems in computer engineering and devise innovative solutions by applying theoretical knowledge and practical skills.
2. To enhance students' research skills, including literature review, experimental design, data collection and analysis, and interpretation of results, in the context of computer engineering research.
3. To improve students' ability to communicate technical concepts effectively through written reports, oral presentations, and technical documentation, targeting both technical and non-technical audiences.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Use** multiple thinking strategies to examine multidisciplinary domains.
2. **Identify** research findings of literature survey.
3. **Analyze** and **demonstrate** the findings and work of various authors confined to the chosen domain.
4. **Furnish** the report of the technical research domain.

The student shall have to deliver the seminar II in semester III on a topic approved by guide and authorities. It is appreciated if a student has already selected the domain of his/her dissertation work and identified the literature confined to the domain and thorough literature study based on the identified topic has been carried out. This practice will eventually lead to convergence of the efforts for the dissertation work. The meticulous analyses of the literature can be part of the seminar.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancements, future trends, applications and research & innovations. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.

The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner. The students are expected to validate their study undertaken by publishing it at standard platforms. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in the seminar logbook approved by the department.

MCE3-021 Dissertation Stage -I

Teaching Scheme: P: 08 Hrs/week	Credit: 04	Examination Scheme: CIE/TW:- 50 Marks ESE(OR):-50 Marks

Course Objectives:
Course intends to prepare the students
1. To identify the domain of research.
2. To formulate research problems with the help of the guide/mentor elaborating the research.
3. To acquire information and identify scope for the dissertation work.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Conduct** thorough literature surveys confined to the domain of choice.
2. **Analyze** the findings, work of various authors confined to the chosen domain and **define** scope of the dissertation work.
3. **Design** the system and **prepare** the technical report of the dissertation work.
4. **Develop** presentation skills to deliver the technical contents.

Guidelines

Dissertation Stage – I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/SRS/UML Diagrams /ERD/block diagram/ PERT chart) and Layout & Design of the Set-up.

The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit approved and certified Dissertation Stage-I report in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

The dissertation stage - I work will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journals.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines in the dissertation workbook approved by the department.

Semester IV

Semester – IV

MCE4-022 Seminar-III		
Teaching Scheme: P: 08 Hrs./week	**Credit**: 04	**Examination Scheme:** CIE/TW:- 50 Marks ESE(OR):-50 Marks

Course Objectives:
Course intends to prepare the students
1. To identify the domain of research
2. To learn to communicate in a scientific language through collaboration with a guide.
3. To categorize the research material confined to the domain of choice
4. To work in professional environment

Course Outcomes:
At the end of the Course Students will be able to:
1. **Conduct** thorough literature surveys confined to the domain of choice.
2. **Develop** presentation skills to deliver the technical contents.
3. **Furnish** the report of the technical research domain.
4. **Analyze** the findings and work of various authors confined to the chosen domain.

Conduction guidelines

Industry or research internship should include partial/complete project implementation. The preferences/choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/choices. Students should be allocated to the research guide in the first semester itself and the same guide should be continued for the**:** Industry Internship-I/ In house Research Project – I. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

MCE4-023 Dissertation Stage -II		
Teaching Scheme: P: 32 Hrs./week	**Credit**: 16	**Examination Scheme:** CIE/TW:- 100 Marks ESE(OR):-50 Marks

Course Objectives:
Course intends to prepare the students
1. To follow SDLC meticulously and meet the objectives of proposed work.
2. To test rigorously before deployment of the system.
3. To validate the work undertaken.
4. To consolidate the work as a furnished report.

Course Outcomes:
At the end of the Course Students will be able to:
1. **Demonstrate** a depth knowledge of the domain of choice.
2. **Analyze** findings, **evaluate** and **present** the results and their interpretation.
3. **Prepare** an independent dissertation report, resulting in publication.
4. **Demonstrate** an ability to **present** and **defend** dissertation work to a panel of experts.

Guidelines

In Dissertation Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of selection of technology, installations, implementations, testing, results, measuring performance, discussions using data tables as per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions. The student shall prepare a certified final report of Dissertation in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

The dissertation stage - II work will be assessed by a panel of examiners of which one is necessarily an external examiner. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journals.

The student has to exhibit the continuous progress through regular reporting, presentations, and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. It is recommended to continue with guidelines and formats as mentioned in the Dissertation Workbook approved by the department.

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