Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Master of Technology

in

Computer Engineering

First Year Scheme & Syllabus

(As per AICTE guidelines, with effect from the Academic Year 2022-23)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. Autonomy curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability, problem-solving approach and research ability which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. Number of credits for courses learnt by learners, internships and dissertation is finalized considering the scope of study and the ability that a learner should gain through the programme.

The curriculum has core courses of engineering, specific to the branch. These courses are completed in first year of the engineering programme that enables learners to work on their chosen dissertation topic during their final year. The curriculum planned by the Institute offer flexibility and diversity to learners to choose any set of courses from a basket of professional electives. Learner can also choose to specialize in a domain as per their field of interest. The selection of unique specialization tracks based on recent developments and industrial requirements is a salient feature of this curricula ensuring employability. Each specialization track has mandatory courses positioned and sequenced to achieve sequential and integral learning for the required depth of the specific domain. Learner can choose to complete these courses in first year of the engineering program that enables him/her to prepare for research during their final year. Credits additional to core and professional elective courses, include dissertation, internships, advanced courses in the field of computer engineering, multi- disciplinary courses, special skill development courses and similar knowledge that make learner capable to do further research or work in industrial environment.

Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies
Department of Computer Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

First Year M. Tech. Computer Engineering **Semester: I**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)				Total marks (Passing@45% of total marks)
Code	Name			ISA	MSE	ESE	Lab Work	
CE63	Advanced Data Structure & Algorithms	Theory+ Practical	4	40	20	40	25	125
CE64	HPC, Cluster and Grid Computing	Theory+ Practical	4	40	20	40	25	125
CEXX	Professional Elective-1	Theory+ Practical	4	40	20	40	25	125
CEXX	Professional Elective-2	Theory+ Practical	4	40	20	40	25	125
OEXX*	Open Elective-1	As per course						

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

*Refer to Appendix B for the list of Open Elective (OE) courses. Selection will be based on the subset of OE courses made available by the Institute for the semester.

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@45% of total marks)
Code	Name			ISA	MSE	ESE	
OE04	Sustainability Management	Theory	4	40	30	50	120
OE05	Operation Research	Theory	4	40	30	50	120
OE06	IPR and Patenting	Theory	4	40	30	50	120
OE07	Research Methodology	Theory	4	40	30	50	120
OE15	Teaching Pedagogy & Educational Technology	Theory	4	40	20	40	100
OE13*	Online Course 1 (MOOC)	Theory	2	25	-	25	050
OE14*	Online Course 2 (MOOC)	Theory	2	25	-	25	050

*Online Courses (MOOC) of 2 credits are equivalent to 30 hours course.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Refer Appendix-A for guidelines on Professional Elective Courses and Specialization Certificate

Professional Elective-1 Courses (CEXX)

Course Code	Course Name	Specialization Track Name#
CE71	Probability and Statistics for Data Science	Data Science (DS)
CE75	Smart Sensors and Internet of Things	Internet of Things (IoT)
CE79	Data Encryption and Compression	Computer Security (CSec)

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-2 Courses (CEXX)

Course Code	Course Name	Specialization Track Name#
CE72	Data Preparation and Exploration	Data Science (DS)
CE76	IoT - Application and Communication Protocol	Internet of Things (IoT)
CE80	Ethical Hacking and Digital Forensics	Computer Security (CSec)

#For details of Specialization Certificate, refer Appendix-A

First Year M. Tech. Computer Engineering **Semester: II**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)				Total marks (Passing@45% of total marks)
Code	Name			ISA	MSE	ESE	Lab Work	
CE65	Parallel Algorithms and Programming	Theory+ Practical	4	40	20	40	25	125
CE66	Computational Intelligence	Theory+ Practical	4	40	20	40	25	125
CEXX	Professional Elective-3	Theory+ Practical	4	40	20	40	25	125
CEXX	Professional Elective-4	Theory+ Practical	4	40	20	40	25	125
OEXX*	Open Elective-2	As per course						

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

*Refer to Appendix B for the list of Open Elective (OE) courses. Selection will be based on the subset of OE courses made available by the Institute for the semester.

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@45% of total marks)
Code	Name			ISA	MSE	ESE	
OE04	Sustainability Management	Theory	4	40	30	50	120
OE05	Operation Research	Theory	4	40	30	50	120
OE06	IPR and Patenting	Theory	4	40	30	50	120
OE07	Research Methodology	Theory	4	40	30	50	120
OE15	Teaching Pedagogy & Educational Technology	Theory	4	40	20	40	100
OE13*	Online Course 1 (MOOC)	Theory	2	25	-	25	050
OE14*	Online Course 2 (MOOC)	Theory	2	25	-	25	050

*Online Courses (MOOC) of 2 credits are equivalent to 30 hours course.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Professional Elective-3 Courses (CEXX)

Course Code	Course Name	Specialization Track Name#
CE73	Big Data	Data Science (DS)
CE77	Wireless Access Technologies	Internet of Things (IoT)
CE81	Database Security and Access control	Computer Security (CSec)

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-4 Courses (CEXX)

Course Code	Course Name	Specialization Track Name#
CE74	Natural Language Processing	Data Science (DS)
CE78	IOT and Smart Cities	Internet of Things (IoT)
CE82	Intrusion Detection and Prevention	Computer Security (CSec)

#For details of Specialization Certificate, refer Appendix-A

Detailed syllabus of First Year Semester-I

Course Name: Advanced Data Structure and Algorithms

Course Code: CE63

Category: Core

Preamble:

This course introduces different Advanced Data Structures and aims to provide Mathematical Approach for Analysing the Complexities of Algorithms with their real-life applications.

Pre-requisites:

1. Data Structures
2. Analysis of Algorithms

Course Objective:

- To provide mathematical approach for Analysis of Algorithms.
- To understand advanced data structures and its operations.
- To solve complex problems in real life applications.

Course Outcome:

Learner will be able to:
CO1: Describe analysis techniques for algorithms.
CO2: Appreciate the role of probability and randomization in the analysis of algorithm.
CO3: Identify appropriate data structure and design techniques for different problems.
CO4: Identify appropriate algorithm to be applied for the various application like Max Flow, Linear programming etc.
CO5: Understand Approximation and Optimization Algorithms.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be

approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Fundamental of Algorithms	Complexity: Finding complexity by tree method, master method, proving technique (contradiction, mathematical induction). Amortized analysis- aggregate analysis, accounting analysis, potential analysis dynamic tables	6
2	Probabilistic Analysis and Randomized Algorithm	The hiring problem Indicator random variables, Randomized algorithms Probabilistic analysis and further uses of indicator random variable	6
3	Advanced Data Structure	Introduction to trees and heap Red-Black Trees: properties of red-black trees, Operations on Red-black trees Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps Analysis of all above operations	12
4	Flow N/W Maximum Flow	Shortest Path, The Floyd - Warshall Algorithm, Johnson's Algorithm for sparse graphs, Flow Networks, The Ford-Fulkerson method, Maximum bipartite matching, Push relabel algorithms, The relabel-to-front algorithm.	10
5	Linear Programming	An Introduction to Linear Programming, Flows in networks, Bipartite matching, Duality, Zero- sum games, The simplex algorithm, Post script: circuit evaluation	5
6	Approximation & Optimization Algorithms	Approximation Algorithms: The vertex - cover problem, the travelling salesman problem, the set- covering problem, Randomization and linear programming, The subset- sum problem. Optimization Algorithms: Genetic Algorithm, K- means Algorithm	6
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Programs on Solving Hiring problem.
2.	Program to implement operations on Red black Tree.
3.	Program to implement operations on Red black Tree.
4.	Program on Floyd-Warshall Algorithm for shortest path

Sr No.	Suggested Topic(s)
5.	Program on Johnson's Algorithm for sparse graphs
6.	Program on The Ford-Fulkerson method to determine Maximum Flow.
7.	Program to implement Maximum bipartite matching
8.	Program to implement Simplex Algorithm
9.	Program to implement subset sum problem using Randomization
10.	Program to implement K-Means Algorithm for Optimization.

Text Books:

1. 1.Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithm" PHI, India Second Edition.
2. Horowitz, Sahani and Rajsekaran, "Fundamentals of Computer Algorithm", Galgotia.
3. Harsh Bhasin, "Algorithms – Design and Analysis", Oxford, 2015.

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan," Randomized Algorithm", Cambridge University
2. S. K. Basu," Design Methods and Analysis of Algorithm", PHI
3. Vijay V. Vajirani," Approximation Algorithms", Springer.

Course Name: HPC, Cluster and Grid Computing

Course Code: CE64

Category: Core

Preamble:

Goal of this course is to learn basics of High-Performance Computing, clustering and grid computing, it will cover theoretical and practical knowledge regarding parallel computing, high-performance computing, supercomputers, and the development and performance analysis of parallel applications.

Pre-requisites:

1. Computer Networks
2. Microprocessor
3. Operating Systems

Course Objectives:

- Understand different parallel processing approaches and platforms involved in achieving High Performance Computing.
- Understand design issues and limitations in Parallel Computing.
- Programming using message passing paradigm using open-source APIs, design algorithms suited for Multicore processor and OpenMP.
- Analyse and optimize performance parameters, for cluster and grid computing.

Course Outcome:

Learner will be able to:

CO1: Understand the cluster and grid computers

CO2: Understand task scheduling and resource allocation in cluster and grid environment

CO3: Understand middleware architecture in Cluster and Grid Environment

CO4: Understand the cluster and grid computing platform as an alternative to traditional supercomputers

CO5: Understand the use of Globus tools standards by following Cluster and Grid Systems

CO6: Understand the security aspects while computing with HPC and Grid computing

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction	Introduction to distributed and high-performance computing. Basic terms: distributed computing, HPC, HPCC, network computing, Internet computing, cluster, grid, meta-computing, middleware, etc; milestones of the history, some representative applications Parallel Architectures Classifications SMP, MPP, NUMA, Clusters and Components of a Parallel Machine, Conventional Supercomputers and its limitations, Multi-processor, and Multi Computer based Distributed Systems.	8
2	Cluster and Grid	Cluster Components Processor/machine, High Speed Interconnections goals, topology, latency, bandwidth, Example Interconnect: Myrinet, Inifiniband, QsNet, Fast Ethernet, Gigabit Ethernet, Light weight Messaging system/Light weight communication Protocols, Cluster Middleware Job/Resource Management System, Load balancing, scheduling of parallel processes, Enforcing policies, GUI,	10
3	Introduction to programming tools	Introduction to programming tools such as PVM, MPI, Cluster Operating Systems Examples: Linux, MOSIX, CONDOR, Message passing standards: PVM (Parallel Virtual Machine), MPI (Message Passing Interface)	4
4	Different components of Grid	Grid fabric, Grid middleware, Grid applications and portal, Globus toolkit Ver.2.4, web services, MDS, GRAM, Grid toolkit approach: Globus Hourglass concept, communication, Grid monitoring, Tasks, Types architecture, components, Characteristics of Grid, Computational services, Computational Grids, Data grids/ Storage grids, management, and applications	10
5	Security	Confidentiality, integrity, and availability. Authentication authorization assurance, auditing accounting. Grid security cryptography	5
6	Fault Tolerance	Fault detection and diagnosis of Clusters and Grids. Recent advances in cluster and grid computing. Integrity, Digital	8

Module No.	Module Name	Content	No. of Hours
		Signature, Digital Certificates, Certificate Authority, MD 5, RSA, GSI, GSSAPI, Directory Service, LDAP, GRID FTP, GASS	
Total			**45**

Suggested List of Practicals:

Solve given problems using OpenMP/MPI/OpenCL and compare their performance on CPU.

Sr No.	Suggested Topic(s)
1.	Matrix-Matrix multiplication – simple algorithm
2.	Sorting – Bitonic/Shell sort/Bucket
3.	All-pairs shortest paths – Dijkstra's algorithm

Text Books:

1. R. K. Buyya, High Performance Cluster Computing: Programming and Applications, PHI , 1999
2. D. Janakiram, Grid Computing, Tata Mcgraw Hill , 2005.
3. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing" . Pearson Education, , Second Edition 2007.
4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, "Heterogeneous Computing with OpenCL", Elsevier, Second Edition, 2013

Reference Books:

1. J. J. Jos & R. K. Buyya, High Performance Cluster Computing: Architecture and Systems, PHI , 1999
2. P. Jalote, Fault Tolerance in Distributed Systems, Prentice Hall, 1994, P. Jalote, Fault Tolerance in Distributed Systems, Prentice Hall, 1994, Prentice Hall , 1994

Course Name: Building Blocks of Artificial Intelligence

Course Code: CE67

Category: AI ML Track

Preamble:

Artificial Intelligence (AI) is transforming industries by enabling machines to perform tasks that traditionally required human intelligence. This course, provides a structured approach to understanding the fundamental concepts, techniques, and applications of AI. The syllabus is designed to progressively build expertise—starting with introductory concepts, moving to intermediate AI techniques, and culminating in real-world applications. Students will gain hands-on experience through programming assignments, case studies, and projects, preparing them for advanced research and industry applications in AI.

Pre-requisites: Machine Learning.

Course Objectives:

- Understand the foundational principles of AI, including problem-solving, search algorithms, and knowledge representation.
- Analyze and implement key machine learning and deep learning techniques for AI applications.
- Evaluate different AI paradigms, including rule-based systems, probabilistic reasoning, and neural networks.
- Apply AI techniques to real-world problems in domains such as computer vision, natural language processing, and robotics.

Course Outcomes:

Learner will be able to:

CO1: Explain the core concepts of AI, including search algorithms, logic, and reasoning techniques.

CO2: Implement and compare different machine learning models for classification, regression, and clustering tasks.

CO3: Design rule-based and probabilistic AI systems for decision-making.

CO4: Apply AI techniques to solve problems in robotics, gaming, and automation.

CO5: Critically analyze ethical considerations and limitations of AI systems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	2	4	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Lab Work	Total
Theory	40	20	40	25	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No	Module name	Content	No of Hours
1	Introduction to Artificial Intelligence	Definition, history, and scope of AI Strong AI vs. Weak AI Turing Test and AI ethics Applications of AI in industry and research	6
2	Problem-Solving and Search Algorithms	Problem-solving agents Uninformed search (BFS, DFS, Uniform Cost Search) Informed search (A*, Greedy Best-First Search) Adversarial search (Minimax, Alpha-Beta Pruning) Constraint Satisfaction Problems (CSP)	7
3	Knowledge Representation and Reasoning	Propositional and First-Order Logic Rule-based systems and expert systems Probabilistic reasoning (Bayesian Networks, Markov Models) Fuzzy logic and its applications	8
4	Machine Learning Fundamentals	Supervised vs. Unsupervised Learning Linear Regression, Logistic Regression Decision Trees, Random Forests Support Vector Machines (SVM) Clustering (K-Means, Hierarchical)	8
5	Evolutionary Algorithms and Swarm Intelligence	Genetic Algorithms (GA) Particle Swarm Optimization (PSO) Ant Colony Optimization (ACO) Applications in optimization and robotics	8
6	AI Applications and Emerging Trends	AI in Game Playing (Chess, Go) AI in Robotics (Path Planning, SLAM) Natural Language Processing (NLP) Basics Ethical AI and Bias Mitigation	8
Total			**45**

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
1.	Implementation of Search Algorithms Task: Implement Breadth-First Search (BFS), Depth-First Search (DFS), and A* algorithm to solve a pathfinding problem (e.g., maze navigation). Expected Outcome: Understand how different search strategies work. Compare efficiency (time and space complexity) of BFS, DFS, and A*.
2.	Solving N-Queens Problem using Constraint Satisfaction Task: Use backtracking and constraint propagation to solve the N-Queens problem. Expected Outcome: • Learn how constraint satisfaction problems (CSPs) work. • Analyze the impact of heuristics (e.g., minimum remaining values) on performance.
3.	Building a Rule-Based Expert System Task: Create a simple expert system (e.g., medical diagnosis or troubleshooting assistant) using if-thenrules. Expected Outcome: • Understand rule-based reasoning in AI. • Experience designing a basic knowledge-based system.
4.	Bayesian Network for Probabilistic Reasoning Task: Implement a Bayesian Network (e.g., disease diagnosis based on symptoms) and performinference. Expected Outcome: • Learn probabilistic reasoning in AI. • Use Bayes' theorem to compute conditional probabilities.
5.	Fuzzy Logic Controller for a Simple System Task: Design a fuzzy logic system (e.g., temperature control or obstacle avoidance). Expected Outcome: • Understand fuzzy logic and its role in AI. • Implement a basic fuzzy inference system.
6.	Supervised Learning: Classification with Decision Trees & SVM Task: Train Decision Trees and SVM classifiers on a dataset (e.g., Iris or Titanic dataset). Expected Outcome: • Compare accuracy and decision boundaries of different classifiers. • Learn feature importance and model interpretability.
7.	Unsupervised Learning: Clustering with K-Means & Hierarchical Clustering Task: Apply clustering algorithms to group data (e.g., customer segmentation). Expected Outcome: • Understand how unsupervised learning works. • Evaluate clustering performance using metrics like silhouette score.
8	Genetic Algorithm for Optimization Task: Solve an optimization problem (e.g., Traveling Salesman Problem or function optimization) using Genetic Algorithms (GA). Expected Outcome: • Learn evolutionary computation techniques.

	• Observe how selection, crossover, and mutation affect convergence.
9	Swarm Intelligence: Particle Swarm Optimization (PSO) Task: Implement PSO to optimize a mathematical function (e.g., Rosenbrock function). Expected Outcome: • Understand swarm intelligence principles. • Compare PSO with GA in terms of convergence speed.
10	AI in Game Playing: Minimax Algorithm for Tic-Tac-Toe Task: Develop an AI agent that plays Tic-Tac-Toe using Minimax with Alpha-Beta pruning. Expected Outcome: • Learn adversarial search techniques. • Analyze how pruning improves computational efficiency.

Text Books:

1. Stuart Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
2. Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer.
3. Elaine Rich & Kevin Knight, *Artificial Intelligence*, McGraw-Hill.
4. Melanie Mitchell, *An Introduction to Genetic Algorithms*, MIT Press.

Reference Books:

1. Nils J. Nilsson, *Principles of Artificial Intelligence*, Morgan Kaufmann.
2. Tom M. Mitchell, *Machine Learning*, McGraw-Hill.
3. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson.
4. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press.

Course Name: Machine Learning and Pattern Recognition

Course Code: CE68

Category: AI ML Track

Preamble:

Machine Learning (ML) and Pattern Recognition (PR) form the backbone of modern artificial intelligence systems, enabling computers to learn from data and make intelligent decisions. This course provides a comprehensive exploration of fundamental ML concepts, statistical pattern recognition techniques, and their practical applications. Structured across six modules, the syllabus progresses from introductory concepts to intermediate algorithms and real-world applications. Through a combination of theoretical foundations, mathematical formulations, and hands-on implementations, students will gain expertise in designing and evaluating ML systems for diverse domains.

Pre-requisites: Machine Learning.

Course Objectives:

- Master the mathematical underpinnings of modern machine learning algorithms.
- Design and implement advanced pattern recognition systems.
- Optimize models for performance, scalability, and interpretability.
- Solve domain-specific problems using tailored ML/PR approaches.

Course Outcomes:

Learner will be able to:

CO1: Derive and implement core ML algorithms from scratch.

CO2: Engineer features for high-dimensional pattern recognition tasks.

CO3: Diagnose and mitigate model limitations (overfitting, bias, concept drift).

CO4: Deploy ML solutions with consideration for computational constraints.

CO5: Critique and adapt published ML research for novel applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	2	4	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Lab Work	Total
Theory	40	20	40	25	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No	Module name	Content	No of Hours
1	Optimization Foundations for ML	Convex vs. non-convex optimization in ML Gradient descent variants (SGD, Adam, RMSProp) Constrained optimization (Lagrange multipliers)	6
2	Advanced Linear Models	Kernelized regression (Ridge, Lasso path algorithms) Bayesian linear regression Generalized Linear Models (GLMs)	7
3	Modern Classification Paradigms	Margin-based classifiers (SVMs with custom kernels) Calibration of probabilistic classifiers Multiclass and multilabel strategies	8
4	Feature Learning Systems	Manifold learning (Isomap, LLE) Sparse coding and dictionary learning Automated feature engineering (TPOT, FeatureTools)	8
5	Structured Prediction	Conditional Random Fields (CRFs) Structured SVM Factor graphs and message passing	8
6	Robust ML Systems	Adversarial robustness Model monitoring and drift detection Federated learning constraints	8
Total			**45**

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
1.	**Optimization Benchmarking** **Task:** Implement SGD, Adam, and L-BFGS optimizers from scratch to train logistic regression. **Outcome:** • Compare convergence rates on different loss landscapes • Understand optimizer hyperparameter sensitivity
2.	**Bayesian Linear Regression** **Task:** Develop Bayesian linear regression with evidence approximation. **Outcome:** • Generate predictive uncertainty intervals • Demonstrate automatic relevance determination (ARD)
3.	**Custom Kernel SVM** **Task:** Design domain-specific kernels (e.g., string kernels for text). **Outcome:** • Benchmark against RBF kernel • Visualize kernel-induced feature spaces
4.	**Manifold Learning for Sensor Data** **Task:** Apply Isomap/LLE to wearable device time-series. **Outcome:** • Recover latent movement patterns • Compare with PCA reconstruction error
5.	**Sparse Coding for Images** **Task:** Learn dictionary atoms from natural images. **Outcome:** • Reconstruct images with varying sparsity • Visualize learned Gabor-like filters
6.	**CRF for Document Analysis** **Task:** Implement linear-chain CRF for receipt parsing. **Outcome:** • Achieve >90% F1 on field extraction • Analyze label transition probabilities
7.	Generate FGSM/PGD attacks on CNN classifiers. **Outcome:** • Quantify accuracy drop under attack • Implement defensive distillation
8	**Concept Drift Detection** Task: **Build drift detectors for streaming data.** Outcome: **Detect simulated drift in financial data** **Compare Page-Hinkley vs ADWIN methods**
9	**Federated Learning Simulation** **Task:** Train CNN across distributed medical datasets. **Outcome:**

	• Analyze accuracy vs privacy tradeoffs • Implement secure aggregation
10	**Production ML Pipeline** **Task:** Containerize model serving with monitoring. **Outcome:** • Deploy as microservice with Prometheus • Log drift metrics over simulated months

Text Books:

1. Kevin P. Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press.
2. Mehryar Mohri, Afshin Rostamizadeh & Ameet Talwalkar, *Foundations of Machine Learning*, MIT Press.
3. Bernhard Schölkopf & Alexander J. Smola, *Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond*, MIT Press.
4. David Barber, *Bayesian Reasoning and Machine Learning*, Cambridge University Press.

Reference Books:

1. Shai Shalev-Shwartz & Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press.
2. Trevor Hastie, Robert Tibshirani & Jerome Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
4. Richard O. Duda, Peter E. Hart & David G. Stork, *Pattern Classification*, Wiley-Interscience.

Course Name: Probability and Statistics for Data Science

Course Code: CE71

Category: Professional Elective

Preamble:

This required course for the M.Tech. with specialization in Data Science should be taken in the first year of study. It covers fundamental concepts in probability and statistics from a data-science perspective.

Pre-requisites:

1. Engineering Mathematics
2. Probability and Statistics

Course Objectives:

- To understand basic statistical foundations for roles of Data Scientist.
- To develop problem-solving skills.
- To infer about the population parameters using sample data and perform hypothesis testing.
- To understand importance and techniques of predicting a relationship between data and determine the goodness of model fit.

Course Outcome:

Learners will be able to:
CO1: Develop various visualizations of the data in hand.
CO2: Analyse a real-world problem and solve it with the knowledge gained from sampling and probability distributions.
CO3: Analyse large data sets and perform data analysis to extract meaningful insights.
CO4: Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
CO5: Fit a regression model to data and use it for prediction.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

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Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction	Data and Statistics: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Statistical Inference, Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing Quantitative Data, Cross Tabulations and Scatter Diagram. Descriptive Statistics: Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables	7
2	Probability	Probability: Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem. Discrete Probability Distributions Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution. Continuous Probability Distributions: Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution	8
3	Sampling and Sampling Distributions	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling. Interval Estimation: Population Mean: Known, Population Mean: Unknown, Determining the Sample Size, Population Proportion.	4
4	Hypothesis Tests	Developing Null and Alternative Hypotheses, Type I	4

Module No.	Module name	Content	No. of Hours
		and Type II Errors, Population Mean: Known Population Mean: Unknown Inference About Means and Proportions with Two Populations-Inferences About Population Variances, Inferences About a Population Variance, Inferences About Two Population Variances. Tests of Goodness of Fit and Independence, Goodness of Fit Test: A Multinomial Population, Test of Independence.	
5	Regression	Simple Linear Regression: Simple Linear Regression Model, Regression Model and Regression Equation, Estimated Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Model Assumptions, testing for Significance, Using the Estimated Regression Equation for Estimation and Prediction Residual Analysis: Validating Model Assumptions, Residual Analysis: Outliers and Influential Observations. Multiple Regression: Multiple Regression Model, Least Squares Method, Multiple Coefficient of Determination, Model Assumptions, Testing for Significance, Categorical Independent Variables, Residual Analysis.	8
6	Time Series Analysis and Forecasting	Time Series Patterns, Forecast Accuracy, Moving Averages and Exponential Smoothing, Trend Projection, Seasonality and Trend and Time Series Decomposition. Nonparametric Methods: Sign Test, Wilcoxon Signed-Rank Test, Mann-Whitney-Wilcoxon Test, Kruskal-Wallis Test, Rank Correlation.	5
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Perform different types of analysis on two E-commerce Datasets. 1. Univariate 2. Bivariate 3. Multivariate Compare the inference between both the datasets
2.	Determination of sample size for the 1000 students (dataset marks) and perform 1. Random Sampling 2. Stratified Sampling

3.	Create tabular machine-learning datasets from the textual data
4.	Perform Linear regression and prediction on the datasets downloaded from the datasets repository. Example Airline dataset. Predict when a flight in delayed.
5.	Perform multiple regression and prediction on the datasets downloaded from the datasets repository. Example Uber Fares Dataset. predict the fare for Uber Rides
6.	Perform test statistics using Python.

Text Books:

1. Data Science from Scratch, FIRST PRINCIPLES WITH PYTHON, O'Reilly, Joel Grus
2. Data Science from Scratch (oreillystatic.com)
3. Practical Time Series Analysis, Prediction with statistics and Machine Learning, O'Reilly, Aileen Nielsen [DOWNLOAD] O'Reilly Practical Time Series Analysis PDF (lunaticai.com)
4. R for data science: Import, Tidy, Transform, Visualize, And Model Data, O'Reilly , Garrett Grolemund, Hadley Wickham
5. Python for Data Analysis, 2nd Edition, O'Reilly Media, Wes McKinney

Reference Books:

1. Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson
2. Storytelling with Data: A Data Visualization, Guide for Business Professionals, Wiley Publications, Cole Nussbaumer Knaflic
3. Probability and Statistics for Engineering and the Sciences, Cengage Publications Jay L. Devore

Course Name: Data Preparation and Exploration

Course Code: CE72

Category: Professional Elective

Preamble:

Learners will learn how to prepare data for visualization, perform exploratory data analysis and develop meaningful data visualization. They will work with variety of real-world data sets and learn how to prepare data sets for analysis by cleaning and reformatting.

Pre-requisites:

1. Python

Course Objectives:

- To prepare data for analysis to uncover interesting structure and unusual observations.
- To learn data exploratory analysis techniques for appropriate analysis and to define what we would expect to see in the data.
- To interpret the results of visual inference and assess the strengths and adequacy of data analysis.

Course Outcomes:

Learners will be able to:
CO1: Find out how analysts decide which data to collect for analysis.
CO2: Learn about structured and unstructured data, data types, and data formats.
CO3: Learn how to gather and prepare data for analysis.
CO4: Identify and apply various data cleaning techniques.
CO5: Learn data exploratory analysis techniques.
CO6: Apply visualization techniques on datax.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Data types and structures	How to generate data and how analysts decide which data to collect for analysis. Structured and unstructured data, data types, and data formats	6
2	Bias, credibility, privacy, ethics, and access	When data analysts work with data. Identify different types of bias in data and how to ensure credibility in data. Explore open data and the relationship between and importance of data ethics and data privacy.	7
3	Data Gathering and Preparation	Data Munging, Wrangling, Data formats, parsing and transformation, Scalability, and real-time issues	8
4	Data Cleaning	Consistency checking, Heterogeneous and missing data, Data Quality, Data Transformation, and segmentation	8
5	Exploratory Analysis	Descriptive and comparative statistics, Clustering and association, Hypothesis generation	8
6	Visualization	Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity	8
Total			**45**

Suggested List of Practicals:

Programming assignments based on following topics to be performed using data analysis tool like R

Sr No.	Suggested Topic(s)
1.	Handling Structured and Unstructured data
2.	Handling different types of bias in data
3.	Perform credibility analysis of data
4.	Data Wrangling
5.	Data Transformation

6.	Data Cleaning
7.	Performing Exploratory Data Analysis (EDA)
8.	Data Vizualization and Analysis

Text Books:

1. Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.

Reference Books:

1. Data Preparation for Data Mining by Dorian Pyle, Morgan Kaufmann Publishers, Inc.

Course Name: Smart Sensors and Internet of Things

Course Code: CE75

Category: Professional Elective

Preamble:

This course introduces learners an overview of concepts, main trends and challenges of Internet of Things. Develop the ability to use Internet of Things related software and hardware technologies. And provide the knowledge of data management business processes and analytics of IoT

Pre-requisites:

1. Basic programming knowledge
2. Basics of wireless networks

Course Objectives:

- To provide knowledge on Sensor Principles.
- To provide familiarity with different sensors and their application in real life.
- To develop necessary technical skill to select suitable smart sensors, components of IOTs with associated knowledge of interface electronics and signal conditioning

Course Outcome:

Learners will be able to:
CO1: Ability to identify, formulate suitable sensors for engineering applications
CO2: Explain and interpret the Internet of Things concepts and challenges.
CO3: Experiment with the software and hardware IoT Technologies.
CO4: Understand data management and business processes and analytics of IoT
CO5: Design and develop small IoT applications to create smart objects

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction to Internet of Things and smart sensors	IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects.	10
2	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Interfacing.	6
3	IoT Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others.	7
4	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT	6
5	Data Management, Business Process and Analytics	Data Management, Business Process in IoT, IoT Analytics, Creative Thinking Techniques, Modification, Combination Scenarios, Decentralized and Interoperable Approaches, Object – Information Distribution Architecture, Object Naming Service (ONS), Service Oriented Architecture, Network of Information, Etc.	12
6	Application and Use Cases	Concrete Applications and Use – Cases of Web Enabled Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. M2M, Industrial IoT Applications.	4
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Starting Raspbian OS, Familiarising with Raspberry Pi Components and interface, Connecting to ethernet, Monitor, USB.

Sr No.	Suggested Topic(s)
2.	Displaying different LED patterns with Raspberry Pi.
3.	Displaying Time over 4-Digit 7-Segment Display using Raspberry Pi
4.	Raspberry Pi Based Oscilloscope
5.	Controlling Raspberry Pi with WhatsApp.
6.	Setting up Wireless Access Point using Raspberry Pi
7.	Fingerprint Sensor interfacing with Raspberry Pi
8.	Raspberry Pi GPS Module Interfacing
9.	IoT based Web Controlled Home Automation using Raspberry Pi
10.	Visitor Monitoring with Raspberry Pi and Pi Camera
11	Interfacing Raspberry Pi with RFID.
12	Building Google Assistant with Raspberry Pi.
13	Installing Windows 10 IoT Core on Raspberry Pi

Text Books:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi ,Wiley .
3. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti

Reference Books:

1. The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.
2. IoT –From Research and Innovation to Market development, River Publication by Ovidiu Vermesan and Peter Friess.

Course Name: IoT- Application and Communication Protocol

Course Code: CE76

Category: Professional Elective

Preamble:

The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The purpose of this course is to impart knowledge on IoT Architecture and various protocols, study their implementations and applications.

Pre-requisites:

1. Wireless sensor network
2. Mobile computing

Course Objectives:

- To equip learners with the fundamental knowledge and basic technical competence in the field of Internet of Things (IoT)
- Introduce multiple way of data communication and networking.
- Identify the IoT networking components with respect to OSI layer

Course Outcome:

Learners will be able to:
CO1: Understand the basics of IoT and communication protocols
CO2: Understand design methodology and hardware platforms involved in IoT
CO3: Understand the different Data link and network layer protocols involved in IoT
CO4: Understand the different transport and session protocols involved in IoT
CO5: Design of Secured IoT applications
CO6: Design IoT Applications using appropriate protocols.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction	IoT architecture outline, standards - IoT Technology Fundamentals- Devices and gateways, IoT Sensors, Sensors for IoT Applications, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics. Sensors for IoT Applications	6
2	IoT Reference Architecture	Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints	8
3	IoT Data link layer and Network layer protocols	PHY/MAC Lay'er(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP	12
4	IoT Transport layer and session layer protocols	Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT	8
5	IoT service layer protocol and security protocol	Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4 , 6LoWPAN, RPL, Application Layer	6
6	Application in IoT	IOT Applications. IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipment's, Industry 4.0 concepts. Case study on: Lighting as a service, Intelligent Traffic systems, Smart Parking and Smart water management.	5
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Study of various development boards, concepts & pin configurations
2.	Switch based LED counter using Tinkercad simulation tool.

Sr No.	Suggested Topic(s)
3.	Obstacle detection using IR sensor using Tinkercad simulation tool.
4.	Write a program on arduino or raspberry pi to subscribe to MQTT broker for temperature data and print it
5.	Write a program on arduino/Raspberry pi to send data to thingspeak
6.	To interface bluetooth with arduino/raspberry pi and write a program to send sensor data to smartphone using bluetooth
7.	Smart Environment System simulation using MATLAB and SIMULINK
8.	Smart Liquid Level Detector simulation and analysis of data using MATLAB and SIMULINK
9.	Smart Wall Socket Simulation using MATLAB and SIMULINK

Text Books:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The EvolvingWorld of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications ,2016
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2015.

Reference Books:

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things",ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014

Course Name: Data Encryption and Compression

Course Code: CE79

Category: Professional Elective

Preamble:

This course introduces learners to process image and video signals which is incredibly important skill to master for engineering learners. The course focusses on details of cryptographic systems as well to make learners aware of the details regarding various encryption algorithms used.

Pre-requisites:

1. Advanced Data Structures and Algorithms
2. Cryptography and Network Security

Course Objectives:

- Understanding of data compression methods for text, images, video, and audio.
- Understand the concepts of cryptography and different algorithms to provide system security.
- Learn the various types of cyber-attacks and methods to mitigate them.

Course Outcome:

Learners will be able to:

CO1: Apply various techniques for text compression and evaluate performance of the coding techniques.

CO2: Explain digital audio, perceptual audio coding and MPEG audio compression standard.

CO3: Describe different lossless and lossy image and video compression techniques and standards.

CO4: Differentiate between symmetric and asymmetric cryptography and describe different symmetric cryptographic techniques and standards.

CO5: Describe different algorithms under public key cryptography and methods that provide the goals of integrity, authentication and non-repudiation

CO6: Explain network security facilities designed to protect a computer system from security threats and ethical issues related to computer and network security.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Data Compression	Loss less compression, Lossy compression, measure of performance, modelling and coding, different types of models, and coding techniques. Minimum variance Huffman coding, extended Huffman coding, Adaptive Huffman coding. Arithmetic coding, Dictionary coding techniques, LZ 77, LZ 78, LZW.	6
2	Audio Compression	High quality digital audio, frequency and temporal masking, lossy sound compression, μ-law and A-law companding, and MP3 audio standard	6
3	Image and Video Compression	PCM, DPCM JPEG, JPEG –LS, and JPEG 2000 standards, Intra frame coding, motion estimation and compensation, introduction to MPEG - 2 H-264 encoder and decoder	5
4	Data Security	Data Security Concepts, Security goals, cryptography, stenography cryptographic attacks, services and mechanics, Block Cipher and Encryption Link State and Distance Vector algorithms, Routing in the Internet RIP, OSPF, and BGP	10
5	Number Theory and Asymmetric Key Cryptography	Number Theory and Asymmetric Key Cryptography Public Key Encryption and RSA, Cryptographic Data Integrity Algorithms, Message integrity, message authentication, MAC, hash function, HMAC, and digital signature algorithm	10
6	System Security	Malware, Intruders, Intrusion detection system, firewall design, antivirus techniques, digital Immune systems, biometric authentication, and ethical hacking.	8
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Programs on Huffman Coding.
2.	Program to implement text compression technique LZW.

Sr No.	Suggested Topic(s)
3.	Demonstration of Lossy and Lossless compression.
4.	Program on Jpeg compression.
5.	Simulation of RIP using CISCO packet tracer
6.	Program on RSA and distributed RSA.
7.	Simulation of MAC
8.	Case study on security for setting firewall.
9.	Program to implement different transposition technique
10.	Simulation of digital signature

Text books:

1. Khalid Sayood , 3rd Edition, |Introduction to Data Compression|, Morgan Kauffman.
2. Mark Nelson, Jean-Loup Gailly,||The Data Compression Book||, 2nd edition, BPB Publications.
3. William Stallings ,|Cryptography and Network Security Principles and Practices 5th Edition||, Pearson Education.
4. Behrouz A. Forouzan, |Cryptography and Network Security||, Tata McGraw-Hill.

Reference Books:

1. The Data Compression Book – Mark Nelson.
2. Data Compression: The Complete Reference – David Salomon.
3. Introduction to Data Compression – Khalid Sayood, Morgan Kaufmann Publishers.

Course Name: Ethical Hacking and Digital Forensics

Course Code: CE80

Category: Professional Elective

Preamble:

Ethical hacking and Digital evidence feature in just about every part of our personal and business lives. Legal and business decisions hinge on having timely data about what people have done. This course provides understanding of how to conduct investigations to correctly gather, analyse and present digital evidence to both business and legal audiences. It also outlines the tools to locate and analyse digital evidence on a variety of devices, how to keep up to date with changing technologies, and laws and regulations in digital forensics.

Pre-requisites:

1. System security

Course Objectives:

- Understand the concepts of Ethical Hacking and Digital Forensics, various tools and methodologies used in Digital Forensics and concepts of Mobile Forensics.
- Apply Digital Forensics tools to generate Forensic report which can be used for legal or administrative cases.

Course Outcome:

Learners will be able to:
CO1: Understand the fundamentals of Ethical Hacking.
CO2: Understand the fundamentals of Digital Forensics.
CO3: Achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system, mobile, email etc.
CO4: Investigate attacks, IDS, technical exploits and router attacks and "Trap and Trace" computer networks.
CO5: Investigate attacks on Mobile devices.
CO6: Apply digital forensic knowledge to use computer forensic tools and investigation report writing.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Ethical Hacking Methodology	Introduction, Steps of Ethical Hacking: Planning, Reconnaissance, Scanning, Exploitation, post exploitation and result reporting. Ethical Hacking Tool: Metasploit	6
2	Introduction to computer forensics and Digital Forensics	Computer Forensics Fundamentals, Types of Computer Forensics Technology – Types of Computer Forensics Systems-Data Recovery and Evidence Collection– Forensic duplication and preservation of DE, Understanding Computer Investigation. Digital Forensic, Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics	9
3	Computer Forensics Tools	Evaluating Computer Forensics Tool Needs, Types of Computer Forensics Tools, Tasks Performed by Computer Forensics Tools, Tool Comparisons, Other Considerations for Tools, Computer Forensics Software Tools, Command-Line Forensics Tools, UNIX/Linux Forensics Tools, Other GUI Forensics Tools, Computer Forensics Hardware Tools, Forensic Workstations, Using a Write-Blocker.	9
4	Network Forensics	Technical Exploits and Password Cracking, Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks, Analysing Network Traffic, Collecting Network based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	9
5	Mobile Device Forensics	Crime and mobile phones, evidence, forensic procedures, files present in SIM cards, device data, external memory dump, and evidence in memory card, operator's networks.	6
6	Forensic Investigation	Report: Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for	6

Module No.	Module name	Content	No. of Hours
	Report and Forensic Tools	writing a forensic report. Computer Forensic Tools: need and types of computer forensic tools, task performed by computer forensic tools. Study of open-source Tools like SFIT, Autopsy etc. to acquire, search, analyse and store digital evidence	
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Vulnerability scanning using namp, Nessus, Nikto.
2.	Performing a penetration testing using Metasploit.
3.	Analysing Digital Evidences Using Win Hex/ helix3pro.
4.	Exploring Router and VLAN security, setting up access lists using Cisco Packet tracer(student edition)
5.	Exploring VPN security using Cisco Packet tracer(student edition)
6.	Analysis of network traffic using open source tools like Snort
7.	Install and use a security app on an Android mobile (e.g. Droidcrypt)
8.	Explore forensics tools in Kali Linux for acquiring, analyzing and duplicating data: dd, dcfldd, foremost, scalpel, debugfs, wireshark, tcptrace, tcpflow
9.	Analysis of forensic images using open source tools like Autopsy, like SIFT, FKT Imager
10.	Use Password cracking using tools like John the Ripper/Cain and Abel/ Ophcrack to detect weak passwords.

Text Books:

1. Jason Luttgens, Matthew Pepe, Kevin Mandia, “Incident Response and computer forensics”,3rd Edition Tata McGraw Hill, 2014.
2. Nilakshi Jain, Dhananjay Kalbande, ”Digital Forensic : The fascinating world of Digital Evidences” Wiley India Pvt Ltd 2017.

Reference Books:

1. Cory Altheide, Harlan Carvey ”Digital forensics with open source tools “Syngress Publishing, Inc. 2011.
2. Chris McNab, Network Security Assessment, By O’Reily.

3. Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
4. Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations". Cengage Learning, 2014
5. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
6. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Detailed syllabus of First Year Semester-II

Course Name: Parallel Algorithms and Programming

Course Code: CE65

Category: Core

Preamble:

The goal of the course is to introduce the students, Principles, methodologies and technologies in parallel algorithms and programming. With the help of different tools, it provides algorithm analysis, algorithm design, algorithm optimized, algorithm implementation and evaluation working, and helps in developing the programming ability of student strategies.

Pre-requisites:

1. Computer Network
2. Advance operating system
3. Microprocessor

Course Objectives:

- To understand the concept of parallel algorithms and programming
- To design and understand the performance of parallel algorithm computing resources.
- To understand and analyze performance using Algorithms concepts.
- To develop programs using parallel algorithm concept.

Course Outcome:

Learners will be able to:

CO1: Understand different parallel processing approaches and platforms involved in Achieving Performance.

CO2: Understand design Issues and limitations in Parallel Algorithm.

CO3: Understand and enable matrix multiplication and solving linear system.

CO4: Analyze and optimize performance parameters.

CO5: Understand and enabled combinational search methods for parallel algorithms.

CO6: Learn to programming using message passing paradigm using opensource APIs, design algorithms suited for Multicore processor using OpenCL, OpenMP.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction	History. Parallel architecture, simple parallel arrays, processor Array , Parallel architecture ,multiprocessor. Parallel algorithm design Elements, task/channel models. Fosters design methodology	06
2	Parallel Algorithm Design	Introduction Boundary value problems: - partition, communication, mapping analysis , finding the maximum, N-body problem, adding data inputs, Ford algorithm	08
3	Matrix Multiplication	Introduction, Sequential matrix multiplication: - Iterative Row-oriented algorithm, recursive block-oriented Algorithm,Row-wise block stripped parallel algorithm, Cannon Algorithm	08
4	Solving linear System	Introduction, terminology ,back substitution ,sequential algorithm, row-orientation parallel algorithm, Gaussian elimination,-sequential parallel, row-orientation ,column -orientation algorithm, Sorting, quick sort, bucket sort.	08
5	Combinational Search	Introduction , Divide and conquer, parallel back track search ,Branch and bound, searching game trees, parallel alpha-beta search :-parallel algorithm search,arallel binary tree, parallel graph tree ,technologies, Firewalls and Routers,	08
6	Programming using Message Passing Paradigm	Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programming Installation and Configuration.	07
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Use and configuration of MPI /open
2.	Sorting Shell /quick sort using parallel alogrithm
3.	Using ford algorithm write program
4.	Using concept of matrix write program for multiplication
5.	Write program Using concept of cannon algoithm

Text Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.

References:

1. Laurence T. Yang, Minyi Guo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
3. https://cse.iitkgp.ac.in/~debdeep/courses_iitkgp/PAlgo21
4. https://www.ques10.com/p/36530/explain-the-various-types-of-parallel-programming-/
5. https://www.spiceworks.com/tech/iot/articles/what-is-parallel-processing/
6. https://www.coursera.org/learn/scala-parallel-programming

Course Name: Computational Intelligence

Course Code: CE66

Category: Core

Preamble:

This course introduces learners to various computational intelligence techniques. Learners will become familiarized with Neural Network, Fuzzy logic & Evolutionary techniques. Course will also offer in- depth understanding to apply computational Intelligence to different applications.

Pre-requisites:

1. Soft Computing
2. Mathematics
3. Artificial Intelligence

Course Objectives:

- To explore the various computational intelligence techniques
- To become familiarize with Neural Network, Fuzzy Logic and Evolutionary techniques.
- To learn to apply computational intelligence to different applications.

Course Outcome:

Learner will be able to:

CO1: Understand the importance of computational Intelligence.
CO2: Examine the nature of problem and find suitable Artificial Neural Network techniques to solve it.
CO3: Understand operations and properties of Fuzzy Sets.
CO4: Compare and contrast traditional algorithms with nature inspired algorithms.
CO5: To apply the concepts of natural immune system using rule-based machine learning and develop artificial immune system.
CO6: Design and implement various intelligent systems.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction to Computational Intelligence paradigms	Artificial Neural Networks, Fuzzy Systems, Genetic Algorithms, Swarm Intelligence, Artificial Immune System, Applications.	6
2	Artificial Neural Networks	Basic models of ANN: NN Architecture, MP Neuron, Linear separability, activation functions, types of learning. Learning Rules: Hebbian, Perceptron, Delta, Winner- take all. Supervised NN: Perceptron Network: SDPTA, SCPTA, MCPTA, Adaline networks.	12
3	Fuzzy Logic & Rough Set Theory	Fuzzy Relations and Fuzzy Rules Fuzzy Rules, Modus Ponens and Inference Defuzzification and its Types Fuzzy Inference Systems & Design of Fuzzy Controller Introduction to Rough Sets	11
4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples. Swarm Intelligence: Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social-Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO. Ant Algorithm: Simple Ant Colony Optimization	10
5	Applications	Typical applications of Fuzzy Inference system, Character Recognition, Colour Recipe prediction- Single MLP approach, ANT algorithm/Swarm Intelligence – TSP, Best path Finding	6
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Create a perceptron with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weights
2.	Write a program to implement artificial neural network without back propagation. Write a program to implement artificial neural network with back propagation.
3.	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
4.	Implement travelling salesperson problem (TSP) using genetic algorithms.
5.	Implement Particle Swarm Optimization algorithm for given initial positions, velocity and best positions of all particles
6.	To do comparative study of all the variants of Particle Swarm Optimization algorithms.
7.	To do case study of Vehicle routing problem with pick-up and delivery (VRPPD) based on Ant colony optimization algorithm.
8.	To do case study of Natural immune system and Artificial Immune Models
9.	To do the case study of Optimization using Clonal Selection Algorithm.

Text Books:

1. Andries P. Engelbrecht, Computational Intelligence - An Introduction, John Wiley pub
2. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
3. Samir Roy, Udit Chakraborty "Introduction to Soft Computing" Pearson Education India.
4. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House
5. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
6. S. Rajasekaran and G.A. Vijaylakshmi Pai. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.

References:

1. Fuzzy sets, fuzzy membership functions, fuzzy characteristics, fuzzy operations (D'Morgans Theorem) be quickly revised from [5]-2.2,2.3(Transformation excluded), 2.4.
   See NPTEL Video lectures of Prof. Laxmidhar Behra on Intelligent Systems and Control – Module 2.
2. http://www.eecs.ceas.uc.edu/~mazlack/dbm.w2011/Komorowski.RoughSets.tutor.pdf

Course Name: Deep and Reinforcement Learning

Course Code: CE69

Category: Elective

Preamble:

The recent advancements in artificial intelligence have positioned Deep Learning and Reinforcement Learning as core technologies powering innovations across domains such as robotics, healthcare, autonomous systems, and game AI. This course aims to build foundational understanding and practical proficiency in both deep and reinforcement learning. It begins with fundamental concepts of neural networks, progresses through advanced architectures and learning algorithms, and culminates in real-world applications and case studies. With a balanced focus on theory, mathematics, coding, and use-case integration, the course prepares students to engage in advanced AI research or apply these techniques in industry settings.

Pre-requisites:

3. Artificial Intelligence

4. Machine Learning

Course Objective:

By the end of the course, students will be able to:

1. Understand the fundamental concepts, mathematics, and building blocks of deep learning and reinforcement learning.
2. Design and implement various deep learning architectures and optimization strategies.
3. Apply reinforcement learning algorithms to sequential decision-making problems.
4. Evaluate and deploy deep RL systems in practical applications such as robotics, NLP, and gaming.

Course Outcome:

Upon successful completion of this course, students will be able to:

1. Analyze and explain the working principles of neural networks and deep learning models.
2. Implement and optimize convolutional, recurrent, and transformer-based architectures.
3. Apply value-based and policy-based reinforcement learning techniques to solve complex tasks.
4. Develop and test deep RL agents using simulation environments like OpenAI Gym or Unity ML-Agents.
5. Integrate deep learning and reinforcement learning in application domains like computer vision, natural language processing, and robotics.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Foundations of Deep Learning	▪ Introduction to AI, ML, and Deep Learning ▪ Biological neuron vs. artificial neuron ▪ Perceptron and multi-layer perceptron ▪ Activation functions (ReLU, Sigmoid, Tanh, Softmax) ▪ Loss functions and backpropagation ▪ Gradient descent and optimization basics ▪ Overfitting, underfitting, bias-variance tradeoff ▪ Regularization (Dropout, L1/L2)	7
2	Deep Neural Network Architectures	▪ Convolutional Neural Networks (CNNs) • Convolution, pooling, padding • CNN applications in image classification ▪ Recurrent Neural Networks (RNNs) • RNNs, vanishing gradient problem • LSTM and GRU ▪ Batch normalization and residual connections ▪ Introduction to frameworks (TensorFlow, PyTorch)	7

3	Reinforcement Learning Fundamentals	• Overview of RL and Markov Decision Processes (MDPs) • Agent-environment interface • Reward signal, policy, value functions • Monte Carlo methods • Temporal Difference (TD) learning • Dynamic programming approaches • Exploration vs. exploitation strategies (ε-greedy, UCB)	8
4	Deep Reinforcement Learning	· Q-Learning and Deep Q Networks (DQN) · Experience replay and target networks · Policy gradient methods · Actor-Critic architectures · Proximal Policy Optimization (PPO), A3C · Stability and convergence issues · Tools and platforms (OpenAI Gym, Stable Baselines)	8
5	Applications of Deep Learning	· NLP applications: • Word embeddings (Word2Vec, GloVe) • Transformers, BERT, GPT overview · Computer Vision applications: • Object detection (YOLO, Faster R-CNN) • Image segmentation (U-Net, Mask R-CNN) · Autoencoders and generative models (GANs, VAEs)	7
6	Applications of Reinforcement Learning	· Game playing agents (Atari, AlphaGo overview) · Robotics: • Motion planning • Reward shaping and safety · Finance: portfolio optimization · Healthcare: personalized treatment plans · Case studies and recent research trends in Deep RL · Project planning and presentation on real-world RL tasks	8
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	**Implement a Multilayer Perceptron (MLP)** using NumPy or PyTorch for classification on MNIST or Iris dataset.
2.	**Build and train a Convolutional Neural Network (CNN)** for image classification using the CIFAR-10 or Fashion-MNIST dataset.
3.	**Text Sentiment Classification using LSTM/RNN** on the IMDB or Twitter dataset using TensorFlow/Keras.
4.	**Apply Transfer Learning using Pre-trained Models (e.g., VGG16, ResNet)** for a custom image classification task.
5.	**Implement Q-Learning** on a simple environment like FrozenLake using OpenAI Gym.
6.	**Train a Deep Q-Network (DQN)** on CartPole or MountainCar environment using PyTorch and experience replay.
7.	**Implement Policy Gradient (REINFORCE) Algorithm** for learning a policy in the LunarLander environment.
8.	**Train an Actor-Critic agent using Proximal Policy Optimization (PPO)** on BipedalWalker or Pendulum.
9.	**Develop a Generative Adversarial Network (GAN)** to generate images using MNIST or Fashion-MNIST dataset.
10.	**Mini Project / Case Study** combining deep learning and reinforcement learning on a real-world application (e.g., robotics simulation, stock trading, or game AI).

Text Books:

1. **Ian Goodfellow, Yoshua Bengio, Aaron Courville** – *Deep Learning*, MIT Press
2. **Richard S. Sutton and Andrew G. Barto** – *Reinforcement Learning: An Introduction* (Second Edition), MIT Press

Reference Books:

1. **Francois Chollet** – *Deep Learning with Python*, Manning
2. **Sebastian Raschka, Yuxi Liu, Vahid Mirjalili** – *Deep Learning with PyTorch*, Packt Publishing
3. **Maxim Lapan** – *Deep Reinforcement Learning Hands-On*, Packt
4. **Nikhil Buduma and Nicholas Locascio** – *Fundamentals of Deep Learning*, O'Reilly
5. **Alexander Zai and Brandon Brown** – *Deep Reinforcement Learning in Action*, Manning
6. **Aurélien Géron** – *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, O'Reilly

Course Name: Bio-inspired Artificial intelligence

Course Code: CE70

Category: Elective

Preamble:

Bio-Inspired Artificial Intelligence is an interdisciplinary field that draws inspiration from biological systems to develop robust, adaptive, and intelligent algorithms. Mimicking behaviors from nature—such as swarming, evolution, neural communication, and immune response—this course introduces students to a class of AI models and optimization techniques that are dynamic, distributed, and scalable. The course offers both theoretical understanding and hands-on exposure to key algorithms like Genetic Algorithms, Swarm Intelligence, Artificial Neural Networks, and Artificial Immune Systems, with real-world problem-solving applications.

Pre-requisites:

1. Artificial Intelligence

Course Objective:

By the end of the course, students will be able to:

1. Understand the foundational principles of biological systems that inspire computational intelligence.
2. Explore bio-inspired models such as evolutionary algorithms, swarm intelligence, and artificial immune systems.
3. Apply bio-inspired techniques to optimization, classification, and control problems.
4. Develop solutions to real-world problems using bio-inspired AI frameworks.

Course Outcome:

Upon successful completion of this course, students will be able to:

1. Explain and compare different bio-inspired computing models and their biological analogies.
2. Implement algorithms such as Genetic Algorithms, Particle Swarm Optimization, and Ant Colony Optimization.
3. Solve complex optimization and classification problems using bio-inspired approaches.
4. Design hybrid and adaptive systems using principles from neural networks, evolution, and natural selection.
5. Apply bio-inspired models in fields such as robotics, networking, data mining, and control systems.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

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ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction to Bio-Inspired Intelligence	• Historical background and biological foundations of AI • Nature-inspired computing: adaptive, decentralized, emergent behavior • Overview of key paradigms: evolution, swarm behavior, immunity, neural mechanisms • Characteristics and applications of bio-inspired systems	8
2	Artificial Neural Networks (ANN)	• Biological neural systems vs. artificial neurons • Perceptron, MLP, activation functions • Backpropagation algorithm • Training strategies and applications • Limitations and motivation for other bio-inspired models	7
3	Evolutionary Computation and Genetic Algorithms	• Biological evolution, natural selection • Representation (chromosomes), population, fitness function • Genetic operators: selection, crossover, mutation • Convergence, schema theorem, elitism • Applications in optimization and learning	8

4	Swarm Intelligence	▪ Principles of swarm behaviour: self-organization, stigmergy ▪ Particle Swarm Optimization (PSO) ▪ Ant Colony Optimization (ACO) ▪ Firefly and Bat algorithms (overview) ▪ Comparisons and applications in engineering	8
5	Artificial Immune Systems & Hybrid Models	▪ Biological immune system modeling ▪ Negative selection, clonal selection, immune networks ▪ Hybrid models: Neuro-evolution, hybrid GA-PSO ▪ Adaptive and self-configuring systems	7
6	Applications and Case Studies	▪ Optimization problems: TSP, scheduling, feature selection ▪ Control systems and robotics ▪ Wireless sensor networks and routing ▪ Data mining and machine learning integration ▪ Research trends and ethical considerations in bio-AI	7
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Implement an MLP using back propagation for binary or multi-class classification
2.	Implement a basic Genetic Algorithm to solve a function optimization problem
3.	Solve the Travelling Salesman Problem using Genetic Algorithms
4.	Simulate Particle Swarm Optimization on a multi-modal function
5.	Implement Ant Colony Optimization to solve a shortest-path problem
6.	Compare convergence behavior of GA and PSO on benchmark functions
7.	Implement Artificial Immune System for anomaly detection
8.	Solve a parameter tuning or feature selection problem using bio-inspired techniques

9.	Build a hybrid GA-ANN or PSO-ANN model for classification or regression
10.	Mini Project: Real-world problem using any bio-inspired approach (e.g., job scheduling, load balancing, route optimization)

Text Books:

3. Dario Floreano and Claudio Mattiussi – *Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies*, MIT Press
4. S. N. Sivanandam and S. N. Deepa – *Introduction to Genetic Algorithms*, Springer

Reference Books:

1. Kenneth A. De Jong – *Evolutionary Computation: A Unified Approach*, MIT Press
2. Marco Dorigo and Thomas Stützle – *Ant Colony Optimization*, MIT Press
3. James Kennedy and Russell C. Eberhart – *Swarm Intelligence*, Morgan Kaufmann
4. Dipankar Dasgupta – *Artificial Immune Systems and Their Applications*, Springer
5. David E. Goldberg – *Genetic Algorithms in Search, Optimization, and Machine Learning*, Pearson

Course Name: Big Data

Course Code: CE73

Category: Professional Elective

Preamble:

In today's data-driven world, the ability to process and analyze vast amounts of data efficiently is crucial for organizations. This course on Big Data Analytics aims to provide students with a comprehensive understanding of Big Data technologies and tools. Through a combination of theoretical concepts and practical hands-on exercises, participants will learn about various components of the Hadoop ecosystem, including HDFS, MapReduce, Apache Sqoop, NoSQL databases like HBase, Apache Hive, and Apache Spark.

Pre-requisites:

1. Data Structures
2. Analysis of Algorithms

Course Objective:

- To introduce the fundamental concepts and characteristics of Big Data
- To provide an in-depth understanding of Hadoop Distributed File System (HDFS)
- To explore the MapReduce programming model for distributed computing
- To enable students to work with Apache Sqoop, HBase and Hive tools.
- To provide hands-on experience with Apache Spark for fast and efficient data processing

Course Outcome:

Learner will be able to:
CO1: Understand the challenges and characteristics of Big Data and Describe the architecture and components of Hadoop.
CO2: Implement and optimize MapReduce programs to perform distributed computing tasks.
CO3: Use Apache Sqoop for importing and exporting data between Hadoop and relational databases.
CO4: Design and work with NoSQL databases, particularly HBase, for storing and retrieving Big Data efficiently.
CO5: Query and analyze Big Data using Apache Hive, leveraging its SQL-like language (HQL).
CO6: Utilize Apache Spark for processing large-scale data in-memory, enabling faster and more efficient analytics.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Big Data	1.1 Understanding the concept of Big Data Characteristics and challenges of Big Data 1.2 Introduction to Hadoop and its ecosystem 1.3 Limitation of Hadoop	6
2	HDFS & MapReduce	2.1 Hadoop Distributed File System (HDFS) architecture 2.2 Components of HDFS 2.3 Introduction to MapReduce programming model 2.4 MapReduce workflow and phases.	10
3	Apache Sqoop	3.1 Importing and exporting data between Hadoop and relational databases 3.2 Incremental data imports and data transformations 3.3 Integration of Sqoop with other Hadoop ecosystem tools	5
4	NoSQL databases - HBase	4.1 Overview of HBase architecture and data model 4.2 CRUD operations and data manipulation in HBase 4.3 HBase schema design and best practices	6
5	Apache Hive	5.1 Hive data model and schema design 5.2 Hive Query Language (HQL) for data querying and analysis 5.3 Working with partitions, buckets, and external tables in Hive 5.4 Hive Optimazation	8
6	Apache Spark	6.1 Spark architecture and components 6.2 Spark RDD (Resilient Distributed Datasets) and transformations 6.3 Spark SQL for structured data processing	10
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Set up a Hadoop cluster and verify its functionality.
2.	Create directories and files in HDFS and perform read/write operations.
3.	Develop and execute a simple MapReduce program to count word occurrences in a text file.
4.	Import data from a relational database into HDFS using Sqoop.
5.	Export data from HDFS to a relational database using Sqoop.
6.	Perform incremental data imports and data transformations using Sqoop.
7.	Install and configure HBase on a Hadoop cluster.
8.	Create HBase tables and perform CRUD operations on them.
9.	Design an HBase schema for a given use case and perform queries and scans on the HBase table.
10.	Create a Hive table, load data into it, and define partitions and buckets for efficient storage.
11.	Write and execute HQL queries for data querying and analysis on Hive tables.
12.	Optimize Hive queries using techniques such as indexing, partitioning, and performance tuning.
13.	Create and manipulate RDDs using Spark.
14.	Use Spark SQL to process structured data and perform SQL-like queries on Spark DataFrames.

Textbooks:

1. "Hadoop: The Definitive Guide" by Tom White
2. "Data-Intensive Text Processing with MapReduce" by Jimmy Lin and Chris Dyer
3. "Learning Spark: Lightning-Fast Data Analytics" by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia

Reference Books:

1. Hadoop MapReduce Cookbook" by Srinath Perera and Thilina Gunarathne
2. "Apache Hive Cookbook" by Hanish Bansal and Saurabh Chauha "Mastering Apache Spark" by Mike Frampton and Aurobindo Sarkar

Course Name: Natural Language Processing

Course Code: CE74

Category: Professional Elective

Preamble:

This course introduces learners to various techniques for natural language processing. Learners will become familiarized with Morphological analysis, syntactic and semantic analysis of text. Course will also offer in-depth understanding of Natural language processing applications like Machine translation, Question answering system, etc.

Pre-requisites:

1. Theory of Computer Science
2. Compiler Construction
3. Machine Learning

Course Objective:

- To understand the concepts of natural language processing.
- To develop skills of finding solutions and building software using natural language processing techniques.

Course Outcome:

Learner will be able to:
CO1: Understand the importance of Natural language processing
CO2: To design language model for word level analysis for text processing.
CO3: To design various POS tagging techniques and parsers.
CO4: To design, implement and test algorithms for semantic and pragmatic analysis.
CO5: To formulate the discourse segmentation and anaphora resolution.
CO6: To apply NLP techniques to design real world NLP applications.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction to NLP	Generic NLP system, Levels of NLP, Ambiguity in Natural language, stages in NLP, Challenges of NLP, Applications of NLP	02
2	Lexical Analysis	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST), Morphological parsing with FST, Lexicon free FST Porter stemmer. Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance. N –Grams- N-gram language model, Smoothing, N-gram for spelling correction.	08
3	Syntax Analysis	Part-Of-Speech tagging (POS)- Tag set for English (Penn Treebank), Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures. Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	10
4	Semantics and Pragmatics	Lexical Semantics, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), WSD using Supervised, Unsupervised and Dictionary approach, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.	08
5	Discourse Analysis and Lexical	Discourse –reference resolution, reference phenomenon, Discourse segmentation, Coherence –	08

Module No.	Module name	Content	No. of Hours
	Resources	Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution, syntactic & semantic constraints on co reference	
6	Applications	Machine translation, Information retrieval, Cross Lingual Information Retrieval (CLIR), Question answers system, categorization, summarization, sentiment analysis.	09
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Pre-processing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2.	Morphological Analysis
3.	N-gram model
4.	Anaphora resolution
5.	Mini Project based on Application mentioned in Module 6

Text Books:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018
2. Christopher D.Manning and Hinrich Schutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
4. Daniel and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Second Edition, Prentice Hall of India, 2008.

Reference Books:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing
3. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012

Course Name: Wireless Access Technologies

Course Code: CE77

Category: Professional Elective

Preamble:

In an era where wireless communication has become ubiquitous, powering everything from personal devices to critical infrastructure, understanding the intricacies of wireless access technologies is paramount. This graduate-level course is designed to delve into the advanced principles, latest standards, and cutting-edge technologies that define today's wireless access networks. It aims to equip students with both the theoretical foundations and practical skills necessary to innovate and excel in the fast-evolving field of wireless communications.

Pre-requisites:

- Signals and systems
- Digital communications
- Wireless communications

Course Objective:

- To understand the fundamental concepts related to access technologies.
- To understand the current and emerging wired and wireless access technologies.
- To understand the knowledge about the cable modems.
- To study and exposure to different systems standards for next generation access
- technologies.
- To study about the broadband wireless technologies

Course Outcome:

Learner will be able to:
CO1: To be able to explore the fundamental concepts and emerging broadband technologies.
CO2: To be able to design the systems meeting out the requirements of the recent standards.
CO3: To be able to design the cable modem in next generation Access technologies.
CO4: To be able to analyze the systems standards for next generation access technologies.
CO5: To be able to explore the various services of wireless broadband technologies.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Review Of Access Technologies	Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.	9
2	Digital Subscriber Lines	Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison	9
3	Cable MODEM	Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.	9
4	Fiber Access Technologies	Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.	9
5	Broadband Wireless	Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS).	9
Total			**45**

Text and References books:

1. Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999.
2. Glen Carty, "Broadband Networking",Mc Graw Hill,2002.
3. Steven Gorshe, Arvind Raghavan, Thomas Starr, Stefano Galli, "Broadband Access: Wireline and Wireless - Alternatives for Internet Services", John Wiley & Sons, 2014.
4. Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and Cable Modems”, John Wiley & Sons, 2000.
5. Walter J Woralski, “ADSL and DSL Technologies”, McGraw Hill Computer Communication Series, Second Edition Oct 2001

Course Name: IOT and Smart Cities

Course Code: CE78

Category: Professional Elective

Preamble:

In this course, the important sensors, associated interface electronics, signal conditioning, technology of smart sensors and IOT for the measurement and monitoring of vital environmental parameters will be studied.

Pre-requisites:

Applied Physics, Embedded System, Sensor Technology

Course objectives:

- The objective of this course is to Select the right sensor for a given application.
- To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterised, and analysed.
- Introduce evolution of internet technology and need for IoT.
- Discuss on IoT reference layer and various protocols and software
- Evaluate the wireless technologies used in IoT.

Course Outcomes:

Learner will be able to:
CO1: Create analytical design and development solutions for sensors

CO2: Select appropriate sensors for the given application development.

CO3: Evaluate performance characteristics of different types of sensors

CO4: Design and develop IoT based sensor systems

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	2	3	1

Evaluation Scheme:

Head of learning	ISA	MSE	ESE	Total
Theory	40	20	40	100
Practical	25	-	-	25

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Sensor characteristics	Definitions, terminology, classification, Static vs dynamic properties of transducers, Transfer functions, Ideal and realistic transducer models, Resolution, linearization, dynamic range, detection threshold, Selectivity & sensitivity, Calibration, Errors of the experimental measurements, Noise: electronics, environmental & internal	8
2	Physical Principle of Sensing	Capacitance, Magnetism, Induction, Resistance, Piezoelectric effect, Pyroelectric effect, Hall effect, Thermoelectric effect, Temperature and thermal properties of materials and heat transfer, Optics, Fiber optics and waveguides	8
3	Sensor Interface and Applications	Input characteristics of interface circuits, Amplifiers, Light to voltage converters, Capacitance to voltage converters, Bridge Circuits, Excitation circuits. Case Studies: Inertial Sensors (Accelerometer & gyroscope), Healthcare Sensors (Glucometer, ECG & MRI), Smart building Sensors (Smoke & occupancy sensors)	8
4	Introduction to IoT	Introduction to Internet of Things: Characteristics of IoT, Design principles of IoT, IoT Architecture and Protocols, Enabling Technologies for IoT, IoT levels and IoT vs M2M.IoT Design Methodology: Design methodology, Challenges in IoT Design, IoT SystemManagement, IoT Servers..Basics of Arduino: Introduction to Arduino, Arduino IDE, Basic Commands for Arduino, Connecting LEDs with Arduino, Connecting LCD with Arduino.	8
5	IoT point to point communication technologies	IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA,Lifi,Wifi)	7
6	IoT application and its Variants	Case studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0,IoT standards.	6
Total			**45**

Suggested list of Practicals:

1. Implementation of Signal Conditioning Circuits
2. Sensor interfacing using off-the-shelf components.
3. Performance Analysis of Optical Link with Different Detectors
4. Performance Analysis of Soliton Communication System
5. Effect of cross phase modulation on WDM system
6. Mitigation of Four wave mixing by NZ-DSF fiber
7. Performance Analysis of Optical Amplifier

8. Performance Analysis of DWDM System

Text Books:

1. Jacob Fraden, (2010), Handbook of Modern Sensors, 5th Edition, Springer.

2. J. W. Gardner, (1996), Microsensors, Principles and Applications, 1 st Edition, Wiley.

3. S. M. Sze, (1994), Semiconductor Sensors, 1 st Edition, Wiley.

4. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016.

5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Aves and, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014

Reference Books:

1. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014.
2. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
3. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.

Course Name: Database security and access control

Course Code: CE81

Category: Professional Elective

Preamble:

This course aims to provide students with a comprehensive understanding of the principles, techniques, and best practices related to securing and controlling access to databases. Students will gain knowledge and skills in designing secure database systems, implementing access control mechanisms, detecting, and preventing security breaches, and managing user privileges

Pre-requisites:

1. DBMS

Course Objective:

- To introduce the fundamental concepts and principles of database security.
- To explore different types of security threats and vulnerabilities in database systems.
- To examine access control models and mechanisms for protecting data in databases.
- To understand encryption techniques for securing data at rest and in transit.
- To learn about authentication and authorization mechanisms in database systems
- To study techniques for auditing and monitoring database activities to detect security breaches.

Course Outcome:

Learner will be able to:
CO1: Understand the fundamental concepts and principles of database security and access control.
CO2: Understand the access control model.
CO3: Apply appropriate access control mechanisms to protect sensitive data and prevent unauthorized access.
CO4: Identify potential security threats and vulnerabilities in database systems.
CO5: Use tools and techniques for auditing and monitoring database activities to detect and respond to security incidents.
CO6: Evaluate and select appropriate encryption and authentication mechanisms for securing data.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Database Security	Overview of database security, Importance of database security, Threats and vulnerabilities in database systems, Security goals: confidentiality, integrity, and availability	6
2	Access Control Models and Mechanisms	Discretionary access control (DAC), Mandatory access control (MAC), Role-based access control (RBAC), Attribute-based access control (ABAC), Access control lists (ACLs), Privileges and permissions.	8
3	Authentication and Authorization	User authentication techniques, Password policies and management, multi-factor authentication, Single sign-on (SSO), Authorization and access rights, Role-based authorization	8
4	Encryption and Data Protection	Encryption concepts and algorithms, Symmetric and asymmetric encryption, Secure key management, Database-level encryption, Transparent data encryption (TDE), Secure Socket Layer/Transport Layer Security (SSL/TLS)	10
5	Auditing and Monitoring	Auditing and logging concepts, Audit trails and log management, Database activity monitoring (DAM), Intrusion detection and prevention systems (IDPS), Security Information and Event Management (SIEM)	8
6	Security Best Practices and Standards	Secure database design principles, Secure coding practices for databases, Patch management and vulnerability assessment, Database hardening techniques, Compliance with relevant security standards.	5
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Setting Up Secure Database Environment

Sr No.	Suggested Topic(s)
2.	Creating and managing user roles and permissions
3.	Configuring audit policies and rules
4.	Detecting and investigating suspicious activities.
5.	Configuring secure communication protocols (SSL).
6.	Conducting vulnerability assessments for databases.
7.	Managing encryption keys and certificate
8.	Implementing strong user authentication mechanisms.
9.	Case Study: Identifty database attacks and prevention technique

Textbooks:

1. William Stallings and Lawrie Brown, “Computer Security: Principles and Practice” pearson

Reference Books:

1. Hassan A. Afyouni, “Database Security and Auditing: Protecting Data Integrity and Accessibility"", Cengage Learning
2. Tom Slodichak, Himanshu Gupta “Database Security and Encryption: A Practical Approach", CRC Press.

Course Name: Intrusion Detection and Prevention

Course Code: CE82

Category: Professional Elective

Preamble:

The goal of the course is to introduce the students to principles, methodologies and technologies used in intrusion detection and prevention systems. With the help of tools, it provides analysis, mitigation of intrusion and helps in preventing the same using effective strategies.

Pre-requisites:

1. Computer Network
2. Cyber Security

Course Objective:

- To understand the vulnerabilities and detection techniques of various attacks
- To understand the network intrusion detection & prevention mechanisms
- To understand the countermeasures of various information security attacks
- To design / make use of a typical intrusion detection system

Course Outcome:

Learner will be able to:
CO1: Design and implement Intrusion Detection System
CO2: Understand classes of attacks on computer systems.
CO3: Identify various types of IDS of signature based and anomaly-based techniques to solve problems related to intrusion detection and prevention.
CO4: Employ ID&PS specific feature extraction techniques.
CO5: Interpret and analyze intrusion detection and prevention logs, alerts, and reports to detect security incidents and potential vulnerabilities.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
3	2	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Lab Work	Total
Theory + Practical	40	20	40	25	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination
ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction	History of Intrusion detection, Audit, Concept and definition, Internal and external threats to data, attacks, Key functions of IDPS technologies-Common Detection methodologies-Signature & Anomaly based Detection,	4
2	Intrusion Detection Systems Principles	Stateful protocol analysis Types of IDS, Information sources Host based information sources, Network based information sources.	5
3	IDS Technologies	Components & Architecture-Typical components, Network Architectures Security capabilities - Information gathering capabilities, logging capabilities, detection & prevention capabilities. Intrusion Prevention Systems, Network protocol based IDS, Hybrid IDS, Analysis schemes, thinking about intrusion. A model for intrusion analysis, techniques Responses requirement of responses, types of responses mapping responses to policy Vulnerability analysis, credential analysis non credential analysis	9
4	Network Based IDS	Networking Overview-OSI layers. Components and Architecture - Typical components, Network architectures and sensor locations. Security capabilities Wireless IDPS-Wireless Networking overview-WLAN standards & components. Components Network Behavior analysis system.	9
5	Host Based IDS	Components and Architecture-Typical components, Network architectures, Agent locations, host architectures. Security capabilities-Logging, detection, prevention, and other capabilities. Using & Integrating multiple IDPS technologies-Need for multiple IDPS technologies, integrating different IDPS technologies-Direct & Indirect IDPS integration other technologies with IDPS capabilities. Network Forensic Analysis Tool, Anti-	9

		malware technologies, Firewalls and Routers,	
6	IDS Tool : SNORT IDS	Introduction to Snort, Working with Snort Rules, Snort configuration, Snort with MySQL, Running Snort on Multiple Network Interfaces, Snort Modes Snort Alert Modes, Snarf with Snort, Agent development for intrusion detection, Architecture models of IDS and IPS.	9
Total			**45**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Use of Wire shark Tool
2.	Set up Snort and study the logs.
3.	Setting up personal Firewall using iptables
4.	SQL injection attack, Cross-Cite Scripting attack simulation
5.	Case Study /Seminar: Topic beyond syllabus related to topics covered.

Text and References books:

1. Carl Endorf, Eugene Schultz and Jim Mellander —" Intrusion Detection & Prevention", 1st Edition, Tata McGraw-Hill, 2006

2. Christopher Kruegel,Fredrik Valeur, Giovanni Vigna: —Intrusion Detection and Correlation Challenges and Solutions, 1st Edition,Springer, 2005.

3. Karen Scarfone, Peter Mell," Guide to Intrusion Detection and Prevention Systems (IDPS)", NIST special publication, 2007

4. Kerry J Cox , Christopher Gerg," Managing Security with Snort and IDS Tools", O'Reilly, 2007.

5. Rafeeq Rehman : — Intrusion Detection with SNORT, Apache,MySQL, PHP and ACID,|| 1st Edition, Prentice Hall , 2003

6. Stephen Northcutt, Judy Novak : —Network Intrusion Detection||, 3rd Edition, New Riders Publishing, 2002.

Detailed syllabus of Open Elective

Course Name: Sustainability Management

Course Code: OE04

Category: Open Elective

Preamble:
This course explores corporate sustainability from the perspective of large, multinational corporations. Focus is on the management tools available to corporations and how they can drive sustainability into a company at all levels, providing a balance between environmental stewardship, social well-being, and economic prosperity.

Objectives:
1. The importance to each individual corporate entity of corporate sustainability.
2. Key drivers and inhibitors, both external and internal to the corporation, of the natural environmental and social aspects of corporate sustainability.
3. The roles of social and natural environmental risk, and product and process innovation, in developing corporate sustainability.

Course Outcome: Student will be able to:
1. Define sustainability and identify major sustainability challenges.
2. Identify, act on, and evaluate their professional and personal actions with the knowledge and appreciation of interconnections among economic, environmental, and social perspectives.
3. Recognize the global implications of their actions.
4. Apply concepts of sustainable development to address sustainability challenges in a global context.

Course Scheme:

Contact Hours	Credits Assigned
Theory	Theory
4	4

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	40	30	50	120

Detailed Syllabus

Module no	Module Name	Content	No of Hours
1	Introduction to Sustainability Management	Meaning, definition, dimensions of sustainability, value of sustainability, framework for business sustainability Understanding the Sustainability Challenge- The Systemic Level and Business Level, Their Implications for business.	12

Module no	Module Name	Content	No of Hours
2	Importance of Corporate Sustainability	Assessing the Strategic Opportunity, Managing Sustainability Transitions across Business Functions, successful cases of organizations focusing on a business model designed around sustainability principles and mind-sets.	12
3	Seizing the Strategic Opportunity	Managing Sustainability Transitions across Business Functions, the challenges related to the management of the integration of sustainability-related processes in business organizations.	12
4	Stakeholder Engagement	Multilateral engagement, Government engagement, NGO's – influence and engagement, Trade associations (WBCSD), Stakeholder interests and engagement	12
5	Transitioning Organizations to Sustainable Enterprises	Developing the Road-Map, Approach the challenge of developing a roadmap to realize the stakeholder value creation potential in sustainability transitions at three different levels, initiatives related to transformational change in the organizations.	12
Total			**60**

Textbooks:

1. Corporate Sustainability in Practice: A Guide for Strategy Development and Implementation by Paolo Taticchi, Melissa Demartini
2. Corporate Sustainability, Social Responsibility and Environmental Management: An Introduction to Theory and Practice with Case Studies by Mark Anthony Camilleri.

Reference-Books:

1. How to Succeed as an Independent Consultant by Holtz, Herman.
2. Strategy for Sustainability: A Business Manifest by Adam Werbach.

E- Resources:

1. Global Journal of Management and Business Research: D Accounting and Auditing
2. Indian Journal of Finance - http://www.indianjournaloffinance.co.in/
3. IVEY Business Journal- https://iveybusinessjournal.com/publication/corporate-sustainability-what-is-it-and-where-does-it-come-from/

OE14:

1. https://www.coursera.org/learn/corp-
2. https://www.edx.org/course/introduction-to-corporate-sustainability-social-in
3. https://www.classcentral.com/course/corp-sustainability-10667

Course Name: Operation Research

Course Code: OE05

Category: Open Elective

Pre-requisites:

- Mathematics

Course Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Course Outcome:

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems. Understand the applications of integer programming and a queuing model and compute important performance measures.

Course Scheme:

Contact Hours	Credits Assigned
Theory	Theory
4	4

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	40	30	50	120

Detailed Syllabus

Module	Detailed Content	Hours
1	**Introduction to Operations Research** • Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming** • Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, SimplexMethod	13

	Penalty Cost Method or Big M-method, Two Phase Method,Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem** • Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the steppingstone method and MODI method. **Assignment Problem** • Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines	
	Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem** • Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	05
2	**Queuing models** • Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	09
3	**Simulation** • Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	10
4	**Dynamic programming** • Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	08
5	**Game Theory** • Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	10
6	**Inventory Models** • Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05
	Total	**60**

Textbooks and References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Name: IPR and Patenting

Course Code: OE06

Category: Open Elective

Preamble: This course aims to help learners understand IPR and its management. It will introduce the learners to different types of IPR and patenting processes for innovation and commercialization of the IPR. The learners will also learn about the various strategies to manage and protect the IPR.

Course Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as international treaty procedures
- To get acquainted with Patent search and patent filing procedures and applications.
- To familiarize with the IPR Management and Commercialization Process.

Course Outcome:

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity-building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting
- Apply the IPR understanding in policy design, NDA Forms, Contributing to Standards and other processes.

Course Scheme:

Contact Hours	Credits Assigned
Theory	Theory
4	4

Assessment Guidelines:

ISA	MSE	ESE	Total
40	30	50	120

Detailed Syllabus

Module	Detailed Content	Hours
1	**Importance of IPR in Modern Global Economic Environment** • Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	5
2	**Enforcement of Intellectual Property Rights** • Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR** • Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	10
3	**Emerging Issues in IPR** • Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	5
4	**Basics of Patents** • Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	10
5	**Patent Rules** • Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treatieswhere India is a member (TRIPS agreement, Paris convention	10

	etc.) **Procedure for Filing a Patent (National and International)** • Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases** Important websites, Searching international databases	
6	**IPR Management** • IPR management Strategies, IPR Commercialization Strategies • IPR Dispute and Negotiation strategies • Participation in Standards and Public Funding • IPR Policymaking and developing innovation eco-system	5
Total		**45**

Guidelines to conduct practical/home assignment sessions:

- An individual or a group of two students will conduct the capstone project.
- To encourage project-based learning in the curriculum, students may select one of the subjects of their choice after the subject in charge reviews and approves it.
- Each individual l/team will conduct a rigorous literature survey of the IPR Subject by reading and understanding at least 3-5 Patent/IPR papers from current, high-quality national/international Patents/IPR search engines. The list of documents surveyed must be documented.
- The project assessment for term work will be done at least twice a semester, and it will involve giving a presentation to the faculty in charge or a panel of expert members.

Deliverables of the capstone project by the student or the group:

Sr. No	Deliverables	Hours in Practical Session	Hours as a home assignment
1	A report summarizing the findings of the literature survey.	3	3
2	Prior Artwork	3	3
3	Preparing own IPR and Other Reading Material	3	3
4	Final Draft with application	3	3
5	Detailed synopsis of the submitted application	3	3
Total		**15**	**15**

Skill Set (H, M, L)

1. Building your IPR Understanding (H)
2. Learning different tools (H)
3. Analysis of the Prior Art Work (M)

Tool Set:

1. Search Engines
2. Assessment/Feedback/Survey

Module Mapping:

Module	Skill Set	Tool Set
Module 1	1	-
Module 2	1	-
Module 3	1	-
Module 4	1,2,3	1,2
Module 5	1,2,3	1,2
Module 6	2,3	1,2

Recommended Online Courses:

1. https://l2proindia.com/index.php#item1 (GOI and Qualcomm Course)
2. https://onlinecourses.swayam2.ac.in/aic24_ge17/preview (Swayam)
3. https://welc.wipo.int/ipedu/ (WIPO Portals)
4. https://www.youtube.com/@turnipinno/videos (Turnip)

Textbooks and References:

1. Rajkumar S. Adukia, 2007, *A Handbook on Laws Relating to Intellectual PropertyRights in India*, The Institute of Chartered Accountants of India
2. Keayla B K, *Patent system and related issues at a glance*, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, *Intellectual Property Law in India*, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, *Intellectual Property and HumanDevelopment: Current Trends and Future Scenario*, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right*, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, *The enforcement of Intellactual Property Rights: A Case Book*, 3rdEdition, WIPO

7. Prabhuddha Ganguli, 2012, *Intellectual Property Rights*, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, *Intellectual Property Rights*, 1stEdition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, *Intellectual Property Rights*, 2nd Edition,Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, *Fundamentals of IPR for Engineers*, 1stEdition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, *A Manual on Intellectual Property Rights*.
12. Mathew Y Maa, 2009, *Fundamentals of Patenting and Licensing for Scientists and Engineers*, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** *IPR: Drafting, Interpretationof Patent Specifications and Claims***,** New India Publishing Agency
14. Vivien Irish, 2005, *Intellectual Property Rights for Engineers*, IET
15. Howard B Rockman, 2004, *Intellectual Property Law for Engineers and scientists*,Wiley- IEEE Press
16. Mathew Y Maa, 2009, *Fundamentals of Patenting and Licensing for Scientists and Engineers*, World Scientific Publishing Company
17. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** *IPR: Drafting, Interpretationof Patent Specifications and Claims***,** New India Publishing Agency
18. Vivien Irish, 2005, *Intellectual Property Rights for Engineers*, IET
19. Howard B Rockman, 2004, *Intellectual Property Law for Engineers and scientists*,Wiley-IEEE Press

Course Name: Research Methodology

Course Code: OE07

Category: Open Elective

Preamble:

This course is to make the students understand the importance of research and various methods that researcher used to investigate problems. The course will also help the students to make meaningful decisions.

Pre-requisites:

1. Quantitative Techniques
2. Operations and production management

Course Objective:

- To understand importance of research and various methods that researcher used to investigate problems.
- To write research proposals.
- To perform enriched data collection and analysis.
- To write detailed research reports.

Course Outcome:

Learner will be able to:
CO1: Understand the importance of research and various methods that researcher used to investigate problems.

CO2: Apply Modern Analytical tools for Business Management Decisions.

CO3: Derive strategies from the research.

CO4: Understand the challenges in collecting the data collection and analysis.

CO5: Interpret the data to make meaningful decisions.

Course Scheme:

Contact Hours	Credits Assigned
Theory	Theory
4	4

Assessment Guidelines:

Head of Learning	ISA*	MSE	ESE	Total
Theory	40	30	50	120

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

ISA*: Specific rubric for the 40 marks of the In-Semester Assessment (ISA) will be, as stated by the course teacher in their Academic Administration Plan (AAP) for the current half of the academic year.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Research	Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research; Research applications in social and business sciences; Features of a Good research study	4
2	Research Problem and Formulation of Research Hypotheses	Defining the Research problem; Management Decision Problem vs Management Research Problem; Problem identification process; Components of the research problem; Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal- Contents of a research proposal and types of research proposals.	6
3	Research Design	Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design	6
4	Primary and Secondary Data	Classification of Data; Secondary Data: Uses, Advantages, Disadvantages, Types and sources; Primary Data Collection: Observation method, Focus Group Discussion, Personal Interview method	4
5	Attitude Measurement and Scaling	Types of Measurement Scales; Attitude; Classification of Scales: Single item vs Multiple Item scale, Comparative vs non-Comparative scales, Measurement Error, Criteria for Good Measurement	6
6	Questionnaire Design	Questionnaire method; Types of Questionnaires; Process of Questionnaire Designing; Advantages and Disadvantages of Questionnaire Method	4
7	Sampling and Data Processing	Sampling concepts- Sample vs Census, Sampling vs Non Sampling error; Sampling Design- Probability and Non Probability Sampling design; Determination of Sample size- Sample size for estimating population mean,	6

		Determination of sample size for estimating the population proportion Data Editing- Field Editing, Centralized in house editing; Coding- Coding Closed ended structured Questions, Coding open ended structured Questions; Classification and Tabulation of Data.	
8	Univariate and Bivariate Analysis of Data	Descriptive vs Inferential Analysis, Descriptive Analysis of Univariate data- Analysis of Nominal scale data with only one possible response, Analysis of Nominal scale data with multiple category responses, Analysis of Ordinal Scaled Questions, Measures of Central Tendency, Measures of Dispersion; Descriptive Analysis of Bivariate data	6
9	Testing of Hypotheses	Concepts in Testing of Hypothesis – Steps in testing of hypothesis, Test Statistic for testing hypothesis about population mean; Tests concerning Means- the case of single population; Tests for Difference between two population means; Tests concerning population proportion- the case of single population; Tests for difference between two population proportions.	6
10	Chi-square Analysis	Chi square test for the Goodness of Fit; Chi square test for the independence of variables; Chi square test for the equality of more than two population proportions	4
11	Analysis of Variance	Completely randomized design in a one-way ANOVA; Randomized block design in two way ANOVA; Factorial design	4
12	Research Report Writing and Ethics in research	Types of research reports – Brief reports and Detailed reports; Report writing: Structure of the research report- Preliminary section, Main report, Interpretations of Results and Suggested Recommendations; Report writing: Formulation rules for writing the report: Guidelines for presenting tabular data, Guidelines for visual Representations. Meaning of Research Ethics; Clients Ethical code; Researchers Ethical code; Ethical Codes related to respondents; Responsibility of ethics in research	4
Total			**60**

Text and References books:

1. Business Research Methods – Cooper Schindler
2. Research Methodology Methods & Techniques – C.R.Kothari
3. Statistics for Management – Richard L Levin.

Course Name: Teaching Pedagogy and Educational Technology

Course Code: OE15

Category: Open Elective

Preamble:

The rapid progress of the Internet and allied technologies, emphasis on outcome-based education, the importance of participative learning, and changing student expectations demand rapid development of engineering faculty teaching competencies. Further, the growing heterogeneous capabilities and motivations of students are giving rise to more diverse learning needs, which require changes in the existing paradigms of engineering education. Today, faculty members must adopt more flexible and student-centric paradigms and focus on developing students' attributes. We propose a four-credit course on teaching pedagogy and Educational Technology to train upcoming or budding faculty members in new and impactful education techniques.

Pre-requisites: N/A

Course Outcome:

Students will be able to:

1) Understand university teaching and its requirements.
2) Apply the different teaching strategies and develop their lesson plan.
3) Apply different ICT tools in teaching.
4) Apply different Assessment methodologies for effective education.
5) Develop their MOOC.
6) Apply gamification to education courses.

Course Scheme:

Contact Hours	Credits Assigned
Theory	Theory
4	4

Examination Scheme:

ISA	MSE	ESE	Total
40	20	40	100

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	University Teaching	What is university teaching, and how is it different from other teaching? What are the various theories/schools of thought for Teaching? Different Taxonomies and their Applications. What is education accreditation? NEP 2020	10
2	Teaching Leadership and Strategies	Developing Lesson Plans, Setting Labs/Practicals, PBL, Developing *Course Outcomes* of a subject, Think Pair Share Flipped Classroom, Collaborative learning, TBL, etc. Career path for teaching and mentoring.	8

3	ICT Tools	Digital Teaching Techniques, Generative AI tools, Digital lab journal alternative to lab notebook, Plicker, Crossword Mobile test, Beyond classroom activities, simulation tools, open-source tools, etc.	6
4	Assessment Methods	Formative and summative assessments, Evaluation Models and Different Types of Examinations, setting up surveys, setting rubrics, designing assessment methods, Festival of examination,etc.	6
5	Designing MOOC	Introduction to MOOC, Elements of MOOC, Development of MOOC-tools,setting up a MOOC using Moodle, Develop your Open Educational Resources (OERs).	6
6	Gamification	What are gamifications? Types of games, designing principles of games, use of games in education.	4
Total			**40**

Guidelines to conduct practical/home assignment sessions:

1. The capstone project will be conducted by an individual or a group of two students.
2. To encourage project-based learning in the curriculum, students may select one of the subjects of their choice after a review and approval by the subject in charge.
3. Each team will do a rigorous literature survey of the MOOC Subject by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.
4. The project assessment for term work will be done at least twice a semester by giving a presentation to the faculty in charge or a panel of expert members.

Deliverables of the capstone project by the student or the group:

Sr. No	Deliverables	Hours in Practical Session	Hours as a home assignment
1	A report summarizing the findings of the literature survey.	2	5
2	Content Development	2	5
3	Preparing Assessment and Other Reading Material	2	5
4	Final Deployment of the Course	2	10
5	Detailed synopsis of the implemented MOOC	2	5
Total		**10**	**30**

Skill Set (H, M, L)

1. Building your course (H)
2. Learning different tools (H)
3. Analysis of the Course and Feedback (M)

Tool Set

1. ICT
2. Moodle

3. Assessment/Feedback/Survey

Module Mapping

Module	Skill Set	Tool Set
Module 1	1,2	-
Module 2	1,2	-
Module 3	1.2,3	1,2,3
Module 4	1,2,3	1,2,3
Module 5	1,2,3	1,2,3
Module 6	2,3	1,3

Recommended Online Courses:

- IITBombayX Courses: https://courses.iitbombayx.in/dashboard
- University Teaching by The University of Hong Kong, Coursera.
- Assessment in Higher Education by Erasmus University Rotterdam, Coursera.

Reference Books:

1. "The Cambridge Handbook of the Learning Sciences" (2nd Edition) edited by R. Keith Sawyer. Publisher: Cambridge University Press, 2014 ISBN: 978-1107626577
2. "Design for How People Learn" by Julie Dirksen. Publisher: New Riders, 2nd Edition, 2015, ISBN: 978-0134211282
3. "E-Learning by Design" by William Horton. Publisher: Wiley, 2nd Edition, 2011 ISBN: 978-0470900024
4. "Integrating Technology in the Classroom: Tools to Meet the Need of Every Student" by Boni Hamilton. Publisher: International Society for Technology in Education, 2015,ISBN: 978-1564843642
5. "The SAGE Handbook of Digital Technology Research" edited by Sara Price, Carey Jewitt, and Barry Brown.Publisher: SAGE Publications Ltd, 2013,ISBN: 978-1446200476.

Note: This list, while comprehensive, is not exhaustive. Educational Technology is broad and constantly evolving, with new research, theories, and technologies emerging regularly. These texts provide a strong foundation, but engaging with current journals, conferences, and professional networks is essential for staying up to date.

Appendix-A

Guidelines for Professional Elective Courses and Specialization Certificate

Professional Elective courses are designed to meet industrial requirements. All learners must opt for 4 professional elective courses as a part of requirement for M.Tech. degree.

Specialization Certificate is introduced in order to build competency of learners in the chosen domain. Department of Computer Engineering offers the following specialization tracks:

1. Artificial Intelligence (AI)
2. Data Science (DS)
3. Internet of Things (IoT)
4. Computer Security (CSec)

Learners can take courses from any track. **However, if learners complete all Professional Elective Courses from the same chosen track, they will be eligible to receive a Specialization Certificate from the Institute.**

Learners who choose professional elective courses from different specialisation tracks will not be eligible for a Specialization Certificate.

It should be noted that there are no additional credit requirements for these specialisations.

DS track: Courses to be chosen for specialization in Data Science

Preferred Semester	Course Code	Course Name
I	CE71	Probability and Statistics for Data Science
I	CE72	Data Preparation and Exploration
II	CE73	Big Data
II	CE74	Natural Language Processing

IoT track: Courses to be chosen for specialization in Internet of Things

Preferred Semester	Course Code	Course Name
I	CE75	Smart Sensors and Internet of Things
I	CE76	IoT - Application and Communication Protocol
II	CE77	Wireless Access Technologies
II	CE78	IOT and Smart Cities

CSec track: Courses to be chosen for specialization in Computer Security

Preferred Semester	Course Code	Course Name
I	CE79	Data Encryption and Compression
I	CE80	Ethical Hacking and Digital Forensics
II	CE81	Database Security and Access control
II	CE82	Intrusion Detection and Prevention

Appendix B

Courses under Open Elective (OE) Category

Sr. No.	Course Code	Course Name	Hours Per Week		Credits	Preferred Semester
			Theory	Practical		
1	OE04	Sustainability Management	4	-	4	-
2	OE05	Operation Research	4	-	4	-
3	OE06	IPR and Patenting	4	-	4	-
4	OE07	Research Methodology	4	-	4	-
5	OE15	Teaching Pedagogy & Educational Technology	4	-	4	-
6	OE13*	Online Course 1 (MOOC)	As per course		2	-
7	OE14*	Online Course 2 (MOOC)	As per course		2	-

*Online Courses (MOOC) of 2 credits is equivalent to 30 hours course.