Annexure-III

M.S. in Artificial Intelligence

Jointly by

Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

&

National Institute of Electronics and Information Technology, Gorakhpur

(An Autonomous Scientific Society of Ministry of Electronics and Information Technology, Government of India)

M. S. – ARTIFICIAL INTELLIGENCE

The horizon trembles with the dawn of a new era, an era where silicon hums with sentience and steel muscles with purpose – the era of Artificial Intelligence. From robotic surgeons wielding scalpels with a surgeon's precision to intelligent assistants anticipating your every need before you even whisper them, AI is no longer a futuristic fantasy, but an intricate thread woven into the fabric of our lives. It has transformed industries, redefined human-machine interaction, and stands poised to revolutionize the very way we experience the world. This is the threshold you stand upon, poised to step into the vanguard of this transformative surge.

The M.S. in Artificial Intelligence program jointly run by Deen Dayal Upadhyaya Gorakhpur University and NIELIT Gorakhpur is your gateway to becoming a leader in this electrifying field. Meticulously crafted by industry titans and academic visionaries, this curriculum transcends mere learning to ignite a deep understanding of AI's core principles. It equips you not just with the tools, but with the power to unlock its boundless potential. You will delve into the mathematical bedrock of machine learning, where equations become more than symbols, but pathways to understanding how intelligent systems learn and evolve from data. You will master the art of supervised learning, wielding regression and classification algorithms as if a sculptor shapes clay, unlocking the power to predict and automate. Unsupervised learning will become your microscope, revealing hidden patterns and insights within sprawling datasets, like detective unearthing secrets in a tangled web of clues. This journey extends beyond algorithms and equations, delving into the ethical compass of AI development. You will learn to navigate the intricate landscape of research methodology and intellectual property rights, ensuring your contributions to this powerful technology are responsible and impactful.

Program Education Objectives (PEO)

PEO1: To equip students with a comprehensive understanding of mathematical foundations, machine learning techniques, and optimization strategies, enabling them to apply this knowledge effectively in solving complex real-world problems.

PEO2: To foster a research-oriented mindset and encourage innovation in the field of machine learning. Graduates should be capable of conducting independent research, contributing to advancements in machine learning techniques, and developing novel solutions to emerging challenges.

PEO3: To promote ethical practices, intellectual property rights awareness, and holistic development. Graduates should possess strong communication skills, an understanding of societal implications, and a commitment to values such as sustainability, social responsibility, and continuous learning.

Program Outcomes (PO)

PO1: Graduates independently solve complex challenges in ML, showcasing research skills and proposing effective solutions.

PO2: Graduates exhibit proficient oral and written skills, empowering them to articulate technical concepts and collaborate effectively within interdisciplinary teams.

PO3: Graduates embrace lifelong learning, adapting to evolving ML trends, technologies, and methodologies for sustained professional development.

PO4: Graduates contribute innovatively to ML, applying advanced algorithms and AI, demonstrating research competence, and fostering technological advancements.

PO5: Graduates uphold ethical standards, respecting intellectual property, considering societal impacts, and responsibly contributing to social, environmental, and ethical considerations.

Course Category Wise Credit Distribution

Category	Credits
Program Core	39
Core Labs	8
Electives	9
Open Electives	6
Project / Dissertation	23
Total	**85**

Course Structure

Semester - I					
S. No.	**Course Code**	**Course Name**	**L**	**P**	**C**
1.	AIL101	Program Core - I Mathematical Foundations for Machine Learning	3	0	3
2.	AIL102	Program Core - II Data Structure using Python	3	0	3
3.	AIL103	Program Core - III Data Mining & Warehousing	3	0	3
4.	AIL104	Program Core - IV Soft Computing	3	0	3
5.	AIL105	Program Core - V Introduction to Artificial Intelligence	3	0	3
6.	AIL106	Program Core - VI Research Methodology and IPR	3	0	3
7.	AIP101	Laboratory - I Python Programming & Data Structure using Python	0	4	2
8.	AIP102	Laboratory - II Data Mining & Soft Computing	0	4	2

Semester - II					
S. No.	**Course Code**	**Course Name**	**L**	**P**	**C**
1.	AIL201	Program Core - VII Machine Learning Techniques	3	0	3
2.	AIL202	Program Core - VIII Deep Learning Techniques	3	0	3
3.	AIL203	Program Core - IX Optimization Techniques	3	0	3
4.	AIL204	Program Core - X Natural Language Computing	3	0	3
5.	AIL205	Program Core - XI Problem Solving Methods in Artificial Intelligence	3	0	3
6.	ACL***	Audit Course	2	0	No Credits
7.	AIP206	Laboratory - III Machine Learning & Deep Learning Lab	0	4	2
8.	AIP207	Laboratory - IV Natural Language Computing & AI Lab	0	4	2
9.	AID208	Mini project with Seminar	0	4	2

Semester - III					
S. No.	**Course Code**	**Course Name**	**L**	**P**	**C**
1.	AIL301	Program Core - XII Artificial Intelligence and Knowledge Representation	3	0	3
2.	AEL***	Program Elective - III	3	0	3
3.	AEL***	Program Elective - IV	3	0	3
4.	AEL***	Program Elective - V	3	0	3
5.	OEL***	Open Elective - I	3	0	3
6.	AID302	Dissertation - I	0	12	6

Semester - IV					
S. No.	**Course Code**	**Course Name**	**L**	**P**	**C**
1.	AIL401	Program Core - XIII Video Analytics using AI	3	0	3
2.	OEL***	Open Elective - II	3	0	3
3.	AID402	Dissertation - II	0	30	15

Elective Courses

S. No.	Course Code	Course Name	L	P	C
1.	AEL201	Design Thinking	3	0	3
2.	AEL202	Advanced Algorithms and Analysis	3	0	3
3.	AEL203	Data Warehousing and Pattern Mining	3	0	3
4.	AEL204	Big Data Analytics	3	0	3
5.	AEL205	Information Retrieval	3	0	3
6.	AEL206	Pattern Recognition	3	0	3
7.	AEL207	Introduction to High Performance Computing	3	0	3
8.	AEL208	Computer Vision	3	0	3
9.	AEL209	Social Media Analytics	3	0	3
10.	AEL210	Blockchain	3	0	3
11.	AEL211	Healthcare Data Analytics	3	0	3
12.	AEL212	Cognitive Systems	3	0	3

Audit Courses

S. No.	Course Code	Course Name	L	P	C
1.	ACL201	English for Research Paper Writing	2	0	No Credits
2.	ACL202	Disaster Management	2	0	
3.	ACL203	Sanskrit for Technical Knowledge	2	0	
4.	ACL204	Value Education	2	0	
5.	ACL205	Constitution of India	2	0	
6.	ACL206	Pedagogy Studies	2	0	
7.	ACL207	Stress Management by Yoga	2	0	
8.	ACL208	Personality Development through Life Enlightenment Skills	2	0	

Open Electives

S. No.	Course Code	Course Name	L	P	C
1.	OEL201	Business Analytics	3	0	3
2.	OEL202	Industrial Safety	3	0	3
3.	OEL203	Operations Research	3	0	3
4.	OEL204	Cost Management of Engineering Projects	3	0	3
5.	OEL205	Composite Materials	3	0	3
6.	OEL206	Waste to Energy	3	0	3

Core Subjects

Program Core - I

Subject Code	AIL101
Course Name	Mathematical Foundations for Machine Learning
Credits	3

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Understand the fundamental mathematical principles and theories relevant to machine learning.
2. Apply mathematical concepts to analyze and interpret machine learning algorithms and models.
3. Develop a proficiency in using mathematical tools and techniques to design, implement, and optimize machine learning algorithms.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Set Theory, Relations and Functions, Combinatorics, Graph Theory, Propositional Logic, Predicate Logic, Mathematical Induction, Recurrence Relations, Discrete Probability, Number Theory, Permutations and Combinations, Discrete Structures, Lattices, Boolean Algebra, Algorithms and Complexity Theory.	8
Unit 2: Algebraic Structures, Groups, Rings, Fields, Partial Orders, Posets, Homomorphisms, Isomorphisms, Substructures, Quotient Structures, Fundamental Theorem of Homomorphisms, Fundamental Theorem of Isomorphisms, Direct Products, Cosets and Lagrange's Theorem, Normal Subgroups, Factor Groups, Field Extensions, Algebraic Closure, Galois Theory.	10
Unit 3: Introduction to Automata Theory, Finite Automata, Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), Regular Languages, Regular Expressions, Context-Free Languages, Context-Free Grammars, Pushdown Automata (PDA), Turing Machines, Chomsky Hierarchy, Pumping Lemma, Myhill-Nerode Theorem, Closure Properties of Regular and Context-Free Languages.	10
Unit 4: Decidability and Undecidability, Church-Turing Thesis, Recursively Enumerable Languages, Halting Problem, Reducibility, Post Correspondence Problem, Computability Theory, Universal Turing Machine, Rice's Theorem, Formal Languages and Their Applications, Lexical Analysis, Syntax Analysis, Parsing Techniques, Compiler Design.	10
Unit 5: Propositional Calculus, First-order Logic, Predicate Calculus, Inference Rules, Resolution, Semantic Tableaux, Logical Equivalence, Normal Forms, Quantifiers, Model Theory, Soundness and Completeness, Automated Reasoning, Knowledge Representation, Ontologies, Expert Systems, Logical Agents.	10

COURSE OUTCOME

1. Proficiency in fundamental mathematical concepts.
2. Gain insight into advanced mathematical topics relevant to machine learning.
3. Enhancement of their critical thinking skills and develop the ability to approach machine

learning problems.

Recommended Readings

1. "Mathematics for Machine Learning" by Marc Peter Deisenroth, A Aldo Faisal, and Cheng Soon Ong
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
4. "Introduction to Probability" by Joseph K. Blitzstein and Jessica Hwang

Program Core - II

Subject Code	AIL102
Course Name	Data Structure using Python
Credits	3

COURSE OBJECTIVE
After completion of this course, students should be able to: 1. Develop students' programming skills in Python. 2. Enhance students' problem-solving abilities through hands-on exercises and projects. 3. Provide students with opportunities to apply data structures and algorithms to practical programming tasks.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Python Programming: Python Basics, Data Types & Variables, Control Flow (if-else, loops), Functions, Modules and Packages, File Handling, Exception Handling, Object-Oriented Programming in Python, Inheritance, Polymorphism, Encapsulation, Abstraction, Python Libraries and Frameworks.	8
Unit 2: Data Structures in Python: Lists, Tuples, Sets, Dictionaries, Stacks, Queues, Linked Lists, Trees, Binary Search Trees (BST), Graphs, Heaps, Hash Tables, Arrays, Time and Space Complexity Analysis, Circular Buffers, Deques.	10
Unit 3: Advanced Data Structures: Balanced Trees (AVL Trees, Red-Black Trees), Priority Queues, Disjoint Sets, Trie, Segment Trees, Fenwick Trees (Binary Indexed Trees), Bloom Filters, Skip Lists, Suffix Trees, B-trees, B+ Trees, Radix Trees, K-d Trees, Patricia Tries, Rope Data Structures.	10
Unit 4: Algorithmic Techniques in Python: Sorting Algorithms (Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort), Searching Algorithms (Linear Search, Binary Search), Recursion, Dynamic Programming, Greedy Algorithms, Divide and Conquer, Backtracking.	10
Unit 5: Python Libraries: Algorithms NumPy, pandas, matplotlib, scikit-learn, TensorFlow, PyTorch, NetworkX, SciPy, BeautifulSoup, NLTK, Django, Flask, SQLAlchemy, pytest, OpenCV, Plotly, Seaborn, NLTK, Statsmodels.	10

COURSE OUTCOME
1. Understanding Python Programming languages. 2. Demonstration of a thorough understanding of various data structures. 3. Enhancement of their problem-solving abilities through hands-on exercises and projects. 4. Ability to analyze the time and space complexity of algorithms and data structures.

Recommended Readings

1. "Problem Solving with Algorithms and Data Structures using Python" by Bradley N. Miller and David L. Ranum
2. "Python Data Structures and Algorithms" by Benjamin Baka
3. "Data Structures and Algorithms in Python" by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser

4. "Data Structures and Algorithms Using Python" by Rance D. Necaise

Program Core - III

Subject Code	AIL103
Course Name	Data Mining & Warehousing
Credits	3

COURSE OBJECTIVE

After completion of this course, students should be able to:

1. Introduce students to the fundamental concepts, processes, and methodologies of data mining.
2. Familiarize students with the concepts and architecture of data warehouses, data marts, and online analytical processing (OLAP) systems.
3. Provide students with practical experience in designing and implementing pattern mining.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Introduction to Data Mining and Warehousing Overview of data mining and warehousing, Historical development, Importance in decision-making, Basic concepts in data mining, Data preprocessing techniques, Data warehouse architecture, OLAP (Online Analytical Processing) fundamentals.	7
Unit 2: Data Preprocessing and Cleaning Data cleaning techniques, Data integration and transformation, Handling missing and noisy data, Dimensionality reduction methods, Feature selection and extraction, Data discretization techniques.	7
Unit 3: Data Mining Techniques Classification and prediction techniques, Association rule mining, Clustering algorithms, Sequential pattern mining, Text mining methods, Web mining techniques, Social media analytics.	8
Unit 4: Advanced Topics in Data Mining Ensemble methods, Deep learning for data mining, Stream mining, Big data analytics, Spatial data mining, Temporal data mining, Imbalanced data analysis, Ethical considerations in data mining.	12
Unit 5: Data Warehousing and Business Intelligence Data warehouse design and implementation, ETL (Extract, Transform, Load) process, Multidimensional modeling, Data mart design, Reporting and visualization tools, Business intelligence applications, Data mining in business decision-making.	14

COURSE OUTCOME

1. Demonstrate proficiency in data warehousing concepts.
2. Apply various data mining techniques and algorithms to extract actionable insights from large datasets.
3. Gain practical experience in designing, implementing, and managing data warehouses.

Recommended Readings

1. "Data Warehousing Fundamentals" by Paulraj Ponniah
2. "Introduction to Data Mining" by Pang-Ning Tan, Michael Steinbach, and Vipin Kumar
3. "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball and Margy Ross
4. "Principles of Data Mining" by David J. Hand, Heikki Mannila, and Padhraic Smyth

5. "Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management" by Gordon

Program Core - IV

Course Code	AIL104
Course Name	Soft Computing
Credits	3

COURSE OBJECTIVE
1. To introduce the concepts and techniques of building blocks of Artificial Intelligence and Soft Computing techniques and their difference from conventional techniques. 2. To generate an ability to design, analyze and perform experiments on real life problems using various Neural Network algorithms. 3. To conceptualize Fuzzy Logic and its implementation for various real-world applications. 4. To provide the understanding of Genetic Algorithms and its applications in developing solutions to real-world problems.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: What is computational intelligence?- Biological basis for neural networks- Biological versus Artificial neural networks- Biological basis for evolutionary computation- Behavioral motivations for fuzzy logic, Myths about computational intelligence- Computational intelligence application areas, Evolutionary computation, computational intelligence-Adoption, Types, self-organization and evolution, Historical views of computational intelligence, Computational intelligence and Soft computing versus Artificial intelligence and Hard computing.	10
Unit 2: Evolutionary Computation Concepts and Paradigms- History of evolutionary computation & overview, Genetic algorithms, Evolutionary programming &strategies, Genetic programming, Particle swarm optimization, Evolutionary computation implementations-Implementation issues, Genetic algorithm implementation, Particle swarm optimization implementation.	10
Unit 3: Neural Network Concepts and Paradigms- What Neural Networks are? Why they are useful, Neural network components and terminology- Topologies - Adaptation, Comparing neural networks and other information Processing methods- Stochastic- Kalman filters - Linear and Nonlinear regression - Correlation - Bayes classification -Vector quantization -Radial basis functions - Preprocessing - Post processing.	10
Unit 4: Fuzzy Systems Concepts and Paradigms - Fuzzy sets and Fuzzy logic - Approximate reasoning, Developing a fuzzy controller - Fuzzy rule system implementation.	5
Unit 5: Performance Metrics- General issues- Partitioning the patterns for training, testing, and Validation-Cross validation - Fitness and fitness functions - Parametric and nonparametric statistics, Evolutionary algorithm effectiveness metrics, Receiver operating characteristic curves, Computational intelligence tools for explanation facilities, Case Studies for implementation of practical applications in computational intelligence. Recent Trends in deep learning,	13

various classifiers, neural networks and genetic algorithm, Implementation of recently proposed soft computing techniques.	

COURSE OUTCOME

After completion of course, students would be able to:

1. Identify and describe soft computing techniques and their roles in building intelligent machines
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
3. Apply genetic algorithms to combinatorial optimization problems.
4. Evaluate and compare solutions by various soft computing approaches for a given problem.

Recommended Readings

1. "Soft Computing: Techniques and its Applications in Electrical Engineering" by M. N. Ahmadi.
2. "Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms" by Sivanandam, S. N., & Deepa, S. N.
3. "Soft Computing: Fundamentals and Applications" by Ajith Abraham.
4. "Soft Computing: A Fusion of Foundations, Methodologies and Applications" edited by Lotfi A. Zadeh, Janusz Kacprzyk, and Ronald R. Yager.
5. "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence" by Jang, J. S. R., Sun, C. T., & Mizutani, E.

Program Core - V

Course Code	AIL105
Course Name	Introduction to Artificial Intelligence
Credits	3

COURSE OBJECTIVE
1. To familiarize students with the fundamental concepts, theories, and applications of artificial intelligence. 2. To gain insight into the various subfields of AI, such as machine learning, natural language processing, computer vision, and robotics.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction of AI, Definition of AI, birth of AI, brief history of AI, Future of Artificial Intelligence, Turing test, Types of environment, Types of agents, Characteristics of Intelligent Agents, typical Intelligent Agents, PEAS (Performance measure, Environment, Actuators, Sensors). Applications of Artificial Intelligence in real word.	10
Unit 2: Problem Solving Approach to Typical AI problems, Problem solving Methods. Introduction to searching & Search Strategies, Uninformed, Informed, Heuristics, Hill climbing, A*, AO* Algorithms, Local Search Algorithms and Optimization Problems. Searching with Partial Observations, Constraint Satisfaction Problems, Constraint Propagation, Backtracking Search, Game Playing, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha, Beta Pruning, Stochastic Games, Evaluation functions.	10
Unit 3: Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and dempstershafer theory.	10
Unit 4: First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, Decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning.	8
Unit 5: Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems how expert systems works, problem areas addressed by expert systems, expert systems success factors, types of expert systems, expert systems and the internet interacts web, knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition, machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts reasoning in artificial intelligence, inference with rules, with frames: model based reasoning, case based reasoning, explanation & meta knowledge inference with uncertainty representing uncertainty.	10

COURSE OUTCOME
1. Understand concepts of Artificial Intelligence and different types of intelligent agents and their architecture.

2. Formulate problems as state space search problem & efficiently solve them.
3. Understand the working of various informed and uninformed searching algorithms and different heuristics
4. Understand concept of knowledge representation i.e. propositional logic, first order logic.

Recommended Readings

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.
2. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth.
3. "Pattern Recognition and Machine Learning" by Christopher M. Bishop.
4. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
5. "Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger and William A. Stubblefield.

References

1. Patrick Henry Winston, Artificial Intelligence, Third Edition, Addison-Wesley Publishing Company.
2. Nils J. Nilsson, Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg.
3. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, PHI.
4. Nils J. Nilsson, Quest for Artificial Intelligence, First Edition, Cambridge University Press.
5. N. P. Padhy – Artificial Intelligence and Intelligence Systems, OXFORD publication.
6. B. Yagna Narayana - Artificial Neural Networks, PHI

Program Core - VI

Course Code	AIL106
Course Name	Research Methodology and IPR
Credits	3

COURSE OBJECTIVE
To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Research Methodology: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics	10
Unit 2: Results And Analysis: Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	10
Unit 3: Technical Writing: Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee	9
Unit 4: Intellectual Property Rights: Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.	10
Unit 5: Patent Rights and New Developments in IPR: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.	9

COURSE OUTCOME
At the end of this course, students will be able to 1. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. 2. Understand research problem formulation & Analyze research related information and Follow research ethics 3. Correlate the results of any research article with other published results. Write a review article in the field of engineering.

References

1. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.

2. Stuart Melville and Wayne Goddard, “Research methodology: An introduction for science & engineering students’, Juta & Company, 1996.
3. Robert P. Merges, Peter S. Menell and Mark A. Lemley, “Intellectual Property in New Technological Age”, Aspen Publishers, 2016.
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5. Mayall , “Industrial Design”, McGraw Hill, 1992.
6. Niebel , “Product Design”, McGraw Hill, 1974.
7. Asimov , “Introduction to Design”, Prentice Hall, 1962.

Program Core - VII

Course Code	AIL201
Course Name	Machine Learning Techniques
Credits	3

COURSE OBJECTIVE
1. To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IoT nodes. 2. To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances. 3. Explore supervised and unsupervised learning paradigms of machine learning. To explore Deep learning technique and various feature extraction strategies.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Introduction to Machine Learning: Introduction. Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance. Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.	10
Unit 2: Decision tree learning: Introduction, Decision tree representation, appropriate problems for decision tree learning, the basic decision tree algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning, Python exercise on Decision Tree. Instance based Learning: K nearest neighbor, the Curse of Dimensionality, Feature Selection: forward search, backward search, univariate, multivariate feature selection approach, Feature reduction (Principal Component Analysis) , Python exercise on kNN and PCA. Recommender System: Content based system, Collaborative filtering based.	7
Unit 3: Probability and Bayes Learning: Bayesian Learning, Naïve Bayes, Python exercise on Naïve Bayes, Logistic Regression. Support Vector Machine: Introduction, the Dual formulation, Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem.	6
Unit 4: Artificial Neural Networks: Introduction, Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, multilayer networks and the back propagation algorithm.	9
Unit 5: Ensembles: Introduction, Bagging and boosting, Random forest, Discussion on some research papers. Clustering: Introduction, K-mean clustering, agglomerative hierarchical clustering, Python exercise on k-mean clustering.	9

COURSE OUTCOME
1. After completion of course, students would be able to: 2. Extract features that can be used for a particular machine learning approach in various IoT applications. 3. To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach. 4. To mathematically analyse various machine learning approaches and paradigms.

Recommended Readings

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop.
2. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron.
3. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy.
4. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
5. "Machine Learning Yearning" by Andrew Ng.

References

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.

Program Core - VIII

Course Code	AIL202
Course Name	Deep Learning Techniques
Credits	3

COURSE OBJECTIVE
To understand the foundations of deep learning, activation functions, reinforcement learning, deep reinforcement learning, RNN including the ability to successfully implement, apply and test relevant learning algorithms.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Overview of machine learning, linear classifiers, loss functions Introduction to Tensor Flow: Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, Tensor Board, Modularity, Sharing Variables, Keras	10
Unit 2: Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Soft max Perceptron: What is a Perceptron, XOR Gate Artificial Neural Networks: Introduction, Perceptron Training Rule, Gradient Descent Rule, vanishing gradient problem and solution	12
Unit 3: Convolutional Neural Networks: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, problem and solution of under fitting and over fitting	10
Unit 4: Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, GRU, Encoder Decoder architectures	8
Unit 5: Deep Learning Applications: Image segmentation, Object detection, Attention model for computer vision tasks, Natural Language Processing, Speech Recognition, Video Analytics	8

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand the basics of deep learning and reinforcement learning paradigms. 2. Understand the importance of neural networks for deep learning. 3. Construct and train convolutional, recurrent and recursive neural networks.

Recommended Readings

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal
3. "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani
4. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
5. "Deep Reinforcement Learning Hands-On" by Maxim Lapan

References

1. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.

2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

Program Core - IX

Course Code	AIL203
Course Name	Optimization Methods
Credits	3

COURSE OBJECTIVE
1. To introduce students to the modeling of constrained decision-making problems and optimization. 2. Provide students with the basic mathematical concepts of optimization. 3. Provide students with the modelling skills necessary to describe and formulate optimization problems.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Historical Development: Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems. Classification of optimization problems, Optimization techniques –classical and advanced techniques**,** Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.	10
Unit 2: Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.	12
Unit 3: Allocation problems and Game Theory: Introduction to Transportation problems, Transportation problem –Methods of basic feasible solution -Optimal solution–MODI Method. Assignment problem-Hungarian method, Game theory: Two people-zero sum game-mixed stages -Dominance properties	10
Unit 4: Sequential optimization: Representation of multi stage decision process Types of multi stage decision problems; Concept of sub optimization and the principle of optimality. Recursive equations –Forward and backward recursions; Computational procedure in dynamic programming (DP), Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP; Problem formulation and application in Design of continuous beam and optimal geometric layout of a truss	8
Unit 5: Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines. Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount	8

COURSE OUTCOME
After completion of course, students would be able to: 1. Extract features that can be used for a particular machine learning approach in various IoT applications. 2. To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach. 3. To mathematically analyse various machine learning approaches and paradigms.

References

1. Hamdy A. Taha, Operations Research, Prentice Hall, Pearso.
2. J. S Arora, Introduction to optimum design, IInd edition, Elsevier India Pvt. Ltd.,
3. S. S Rao, Optimization: theory and application, Wiley Eastern Ltd., New Delhi.
4. Wayne L. Winston - Operations Research_ Applications and Algorithms-Duxbury Press (2003).
5. Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Network Flows: Theory, Algorithms, and Applications, Pearson.
6. J K Sharma, Operations Research Theory and Applications, MacMillan India Ltd.
7. N D Vohra, Quantitative Techniques in management, Tata McGraw Hill.
8. Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston
9. Publishing Co. Inc., Virginia.
10. Achille Messac, Optimization in practice with MATLAB, Cambridge University Press, 2015.

Program Core - X

Course Code	AIL204
Course Name	Natural Language Computing
Credits	3

COURSE OBJECTIVE
1. To explain the leading trends and systems in natural language processing. 2. To understand the concepts of morphology, syntax, semantics and pragmatics of the language. 3. To recognize the significance of pragmatics for natural language understanding

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: History of NLP; Generic NLP system; Levels of NLP; Knowledge in language processing problem; Ambiguity in natural language; Stages in NLP; Challenges of NLP; Role of machine learning; Brief history of the field; Applications of NLP: Machine translation, Question answering system, Information retrieval, Text categorization, text summarization & Sentiment analysis	8
Unit 2: Morphology analysis survey of English morphology, inflectional morphology & derivational morphology; Regular expressions; Finite automata; Finite state transducers (FST); Morphological parsing with FST; Lexicon free FST, Porter stemmer, N-Grams, N-gram language model, N-gram for spelling correction.	10
Unit 3: Part-of-Speech tagging (POS); Lexical syntax tag set for English (Penn Treebank); Rule based POS tagging; Stochastic POS tagging; Issues: Multiple tags & words, unknown words, class-based n-grams, HM Model ME, SVM, CRF; Context Free Grammar; Constituency; Context free rules & trees; Sentence level construction; Noun Phrase; Coordination; Agreement; Verb phrase & sub categorization.	10
Unit 4: Attachment for fragment of English sentences, noun phrases, verb phrases, prepositional phrases; Relations among lexemes & their senses; Homonymy, Polysemy based disambiguation & limitations, Robust WSD; Machine learning approach and dictionary-based approach.	8
Unit 5: Discourse reference resolution; Reference phenomenon; Syntactic & semantic constraints on co reference; Preferences in pronoun interpretation; Algorithm for pronoun resolution; Text coherence; Discourse structure, Implementation of applications like Machine translation, Information retrieval, Question answers system, Categorization, Summarization; Sentiment analysis; Case Studies and recent researches in Natural Language Processing	12

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand fundamentals of Natural Language Processing. 2. Model linguistic phenomena with formal grammars. 3. Design, implement and analyze Natural Language Processing algorithms. 4. Understand approaches to syntax, semantics and discourse generation in natural

language processing.
5. Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction, etc.

References

1. James Allen. Natural Language Understanding. The Benajmins/Cummings Publishing Company Inc. 1994. ISBN 0-8053-0334-0.
2. Tom Mitchell. Machine Learning. McGraw Hill, 1997. ISBN 0070428077.
3. Cover, T. M. and J. A. Thomas: Elements of Information Theory. Wiley. 1991. ISBN 0-471-06259-6.
4. Charniak, E.: Statistical Language Learning. The MIT Press. 1996. ISBN 0-262-53141-0.

Program Core - XI

Course Code	AIL205
Course Name	Problem Solving Methods in Artificial Intelligence
Credits	3

COURSE OBJECTIVE
1. To introduce the concepts and techniques in problems solving methodology in Artificial Intelligence 2. Learn about constraint satisfaction problems and heuristics

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Problem solving and artificial intelligence; Puzzles and games; What is a solution? Problem states and operators; Reducing problems into sub problems; Problem representation; The use of logic in problem solving; Representation and search problems.	8
Unit 2: State descriptions; Operators; Goal states; Graph notation; Problem reduction; Problem Solving as Search; Uninformed or blind search; Informed search; Graph searching process: Breadth-first methods, Depth first methods, Optimal search algorithms, A* search - admissibility, optimality; heuristics	12
Unit 3: Constraint Satisfaction Problems (CSPs); Constraints as relations; Constraint modelling and solving; Map-Coloring Problem; Constraint Graph; Methods to solve CSPs - backtracking, Forward checking, Look ahead, Arc consistency algorithms; Implementation issues of CSP algorithms.	10
Unit 4: Combinatorial Optimization Problems; Discrete optimization techniques: exact algorithms (linear programming), approximation algorithms heuristic algorithms. Identifying various instances of problems such as Resource allocation, Knapsack, travelling salesman etc	8
Unit 5: Local search and met heuristics; Single-solution based algorithms vs population based algorithms; Simulated Annealing; Tabu search; Genetic Algorithms; Scatter Search; Ant Colony Optimization; Adaptive Memory Procedures; Variable Neighborhood Search; Evolutionary Algorithms; Memetic Algorithms; Particle Swarm, The Harmony Method etc.	10

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand and solve gaming problems in AI 2. Various Searching algorithms and CSP algorithms 3. Analyzing and optimizing different heuristic techniques

References

1. Problem Solving Methods in Artificial Intelligence - Nils Nilson (McGraw-Hill).
2. How to solve it by computer - R. G. Dromey.
3. Artificial Intelligence for Humans Volume-1, 2, 3 - Jeff Heaton.

Program Core - XII

Course Code	AIL301
Course Name	Artificial Intelligence and Knowledge Representation
Credits	3

COURSE OBJECTIVE
1. To introduce the concept and functionality of various AI problem sets. 2. In-depth knowledge of various searching techniques and knowledge representation techniques 3. Various concepts involved in different Learning techniques

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.	6
Unit 2: Searching: Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.	10
Unit 3: Knowledge Representation: Using Predicate logic, representing facts in logic, functions and predicates, Conversion to clause form, Resolution in propositional logic, Resolution in predicate logic, Unification. Representing Knowledge Using Rules: Procedural Versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning	12
Unit 4: Learning: What is learning, Rote learning, Learning by Taking Advice, Learning in Problem-solving, Learning from example: induction, Explanation-based learning. Connectionist Models: Hopfield Networks, Learning in Neural Networks, Applications of Neural Networks, Recurrent Networks. Connectionist AI and Symbolic AI.	12
Unit 5: Expert System: Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition-examples.	8

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand AI concepts and its ecosystems of application 2. Analyze and evaluate the problem domain and AI techniques used to solve them

References

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.
2. Artificial Intelligence, Kevin Knight, Elaine Rich, B. Shivashankar Nair, 3rd Edition,2008
3. Artificial Neural Networks B. Yagna Narayana, PHI.
4. Artificial Intelligence, 2nd Edition, E.Rich and K.Knight (TMH)
5. Artificial Intelligence and Expert Systems – Patterson PHI.

6. Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.
7. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
8. Neural Networks Simon Haykin PHI.
9. Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition.

Program Core - XIII

Course Code	AIL401
Course Name	Video Analytics using AI
Credits	3

COURSE OBJECTIVE
1. To learn computer video fundamentals knowledge 2. To know about video types and its analysis 3. To know video coding standards 4. To learn AI based video analytics examples.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Video Formation, Perception, and Representation, Color Perception and Specification. Video Capture and Display. Analog Video Raster. Analog Color Television Systems. Digital Video. Video Sampling- Basics of the Lattice Theory. Sampling over Lattices. Sampling of Video Signals. Filtering Operations in Cameras and Display Devices	8
Unit 2: Video Analytics, Analog Video signal, Analog video standards, Analog video equipment, Digital Video Signal, Digital video Standards, digital Video Processing. Video Compression: Basic Concepts and Techniques of Video Coding and the H.264 Standard, MPEG1and MPEG-2Video Standards. Vector Quantization, Subband Coding, Structure of vector quantizer, VC Codebook Design, Practical VQ Examples, Fractal Compression, Subband Coding: sub band decomposition, coding of subbands	12
Unit 3: AI Based Application of Video Analytics, Object Tracking , object detection, Loitering detection, People counting, Automatic number plate detection, motion detection, Automatic number plate recognition , crowd detection, Facial detection and recognition, optical character recognition	8
Unit 4: Object Detection and Recognition in Video, Texture models Image and Video classification models- Object tracking in Video. Applications and Case studies- Industrial- Retail-Transportation& Travel Remote sensing. Video Analytics for business Intelligence using AI.	10
Unit 5: Intelligent Video Surveillance Systems, Basics of Video Processing and Motion Analysis, Background Modeling. Object Classification and Detection. Human Activity Recognition. Object Tracking. Camera Networks for Surveillance. Surveillance Systems and Applications. Emerging Techniques in Visual Surveillance System	10

COURSE OUTCOME
After learning the course, the students should be able to: 1. Discuss video formation and representation 2. Interpret the video coding standards and compression techniques

3. Explain concepts of vector quantization 4. Apply video analytics for AI application
4. Apply video analytics for object detection and recognition in video.

References

1. R.G.Gupta, Audio and Video Systems, McGraw Hill l Education (India), 2nd Edition,2010.
2. Kelthjack, Video Demystified: A Handbook for the Digital Engineer,5th Edition, Newnes, 2007.
3. Intelligent Video Surveillance Systems Jean-Yves Dufour
4. Akramullah, S. (2014). Video Coding Standards. In: Digital Video Concepts, Methods, and Metrics. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4302-6713-3_3
5. Maheshkumar H Kolekar , Intelligent Video Surveillance Systems An Algorithmic Approach , Chapmanand Hall/CRC208 Pages 94 B/W Illustrations, ISBN 9781498767118, 2018
6. Video Processing and Communications, Yao Wang, J. Osternann and QinZhang, Pearson Education
7. A.M. Dhake, Television and video Engineering, TMH Publication, 2nd Edition
8. A.M. Tekalp, Digital Video, PrenticeHall, 1995

Elective Courses

Course Code	AEL201
Course Name	Design Thinking
Credits	3

COURSE OBJECTIVE
1. To acquaint with Entrepreneurial qualities. 2. To apply entrepreneurship in Engineering Courses. 3. To imbibe Entrepreneurial capabilities in engineering students

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Entrepreneurship and its importance	6
Unit 2: Achievement Motivation. Case Studies of Indian Entrepreneurs	8
Unit 3: Product Identification, Market Survey	8
Unit 4: Whom to contact for what? Financial Management	8
Unit 5: Business Planning	8
Unit 6: Project Report preparation	10

COURSE OUTCOME
After learning the course, the students should be able to: 1. Motivate students to think about Entrepreneurship alternative to employment. 2. Registering students for Startup / Udyam registration of MSME.

References

1. Entrepreneurial Development by Vasant Desai, Himalaya publication
2. Entrepreneurship Development and Small Business Enterprise. Poornima M. Charantimath. Pearson Education India, 2005
3. Dynamics of entrepreneurial development and management: Entrepreneurship, project management, finances, programmes, and problems. by Vasant Desai.
4. Course Material by EDII, Ahmadabad

Course Code	AEL202
Course Name	Advanced Algorithms and Analysis
Credits	3

COURSE OBJECTIVE
1. To understand the usage of algorithms in computing. 2. To learn and use hierarchical data structures and its operations. 3. To learn the usage of parallel algorithms and its applications. 4. To select and design data structures and algorithms that is appropriate for problems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Defining Key Terms: Algorithm complexity, Greedy method, Dynamic Programming, Backtracking, Branch-and-bound Techniques; Examples for understanding above techniques; Memory model, linked lists and basic programming skills.	8
Unit 2: Overview - Class P - Class NP - NP Hardness - NP Completeness - Cook Levine Theorem - Important NP Complete Problems. Heuristic and Randomized algorithms.	8
Unit 3: Use of probabilistic inequalities in analysis, Amortized Analysis - Aggregate Method - Accounting Method - Potential Method, competitive analysis, applications using examples.	10
Unit 4: Point location, Convex hulls and Voronoi diagrams, Arrangements, graph connectivity, Network Flow and Matching: Flow Algorithms - Maximum Flow – Cuts - Maximum Bipartite Matching - Graph partitioning via multi-commodity flow, Karger'r Min Cut Algorithm, String matching and document processing algorithms.	12
Unit 5: Approximation algorithms for known NP hard problems - Analysis of Approximation Algorithms Use of Linear programming and primal dual; local search heuristics; Parallel algorithms: Basic techniques for sorting, searching, merging, list ranking in PRAMs and Interconnection.	10

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand fundamentals of designing and analyzing algorithms. 2. Design advanced data structures and algorithms to solve computing problems. 3. Analyze the running time and space complexity of algorithms.

References

1. Allan Borodin and Ran El-Yaniv: Online Computation and Competitive Analysis, Cambridge University Press, 2005.
2. Michael T Goodric and Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples”, John Wiley and Sons, 2002.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Third Edition, The MIT Press, 2009.
4. Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, “Algorithms”, Tata McGraw-Hill, 2009.

5. RK Ahuja, TL Magnanti and JB Orlin, “Network flows: Theory, Algorithms, and Applications”, Prentice Hall Englewood Cliffs, NJ 1993.
6. Joseph JáJá: Introduction to Parallel Algorithms 1992.
7. Rajeev Motwani, Prabhakar Raghavan: Randomized Algorithms, Cambridge University Press, 1955.
8. Jiri Matousek and Bernd Gärtner: Understanding and Using Linear Programming, 2006.

Course Code	AEL203
Course Name	Data Warehousing and Pattern Mining
Credits	3

COURSE OBJECTIVE
1. To understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms. 2. To understand and apply the basic methods of classification and prediction, web mining.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Data warehouse concepts, Data warehouse modeling, Data Cube and OLAP, schemas for multidimensional data models, concept hierarchy, measures, and indexing techniques. Data warehouse– design and usage, implementation, architectural components, Role of Metadata, Dimensional Modeling, Data Extraction, Transformation and Loading, Data Quality.	10
Unit 2: Classification and Prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns. Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, and Similarity search in Time-series analysis.	15
Unit 3: Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams.	8
Unit 4: Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.	8
Unit 5: Recent trends in Distributed Warehousing and Pattern Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis.	7

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand the fundamentals of data warehousing and pattern mining. 2. Understand the issue of related to mining data streams and pattern matching in streams 3. Mining webpages and classify them.

References

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier Publication, 2011.

2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. G Dong and J Pei, Sequence Data Mining, Springer, 2007.

Course Code	AEL204
Course Name	Big Data Analytics
Credits	3

COURSE OBJECTIVE
1. Understand big data for business intelligence. Learn business case studies for big data analytics. 2. Understand NoSQL big data management. Perform map-reduce analytics using Hadoop and related tools

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.	9
Unit 2: Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.	9
Unit 3: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment.	10
Unit 4: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM Info Sphere Big Insights and Streams.	10
Unit 5: Simple linear Regression-Multiple linear regression-Interpretation of regression coefficients; Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications. Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.	10

COURSE OUTCOME
1. After completion of course, students would be: 2. Describe big data and use cases from selected business domains Explain NoSQL big data management 3. Install, configure, and run Hadoop and HDFS Perform map-reduce analytics using Hadoop

4. Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

References

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
6. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007.
7. Pete Warden, "Big Data Glossary", O'Reilly, 2011.
8. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", 2nd Edition, Elsevier, Reprinted 2008.
9. Da Ruan, Guoquing Chen, Etienne E.Kerre, Geert Wets, "Intelligent Data Mining", Springer, 2007.
10. Paul Zikopoulos, DirkdeRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles , David Corrigan, "Harness the Power of Big Data The IBM Big Data Platform", Tata McGraw Hill Publications, 2012.
11. Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A Hands On Approach", VPT, 2016
12. Bart Baesens "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)", John Wiley & Sons,2014.

Course Code	AEL205
Course Name	Information Retrieval
Credits	3

COURSE OBJECTIVE
1. To understand the basics of information retrieval with pertinence to modeling, query operations and indexing. 2. To get an understanding of machine learning techniques for text classification and clustering. 3. To understand the various applications of information retrieval, giving emphasis to multimedia, and web search.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Overview of Information Retrieval, Architecture of a Search Engine, Acquiring Data: Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection and Removal. Processing Text: Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, More detail on Page Rank, Feature Extraction and Named Entity Recognition, Internationalization.	10
Unit 2: Ranking with Indexes Abstract Model of Ranking, Inverted indexes, Map Reduce, Query Processing: Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching**.** Queries and Interfaces: Information Needs and Queries, Query Transformation and Refinement: Stopping and Stemming Revisited, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization. Displaying the Results: Result Pages and Snippets, Advertising and Search, Clustering the Results; Translation; User Behavior Analysis.	12
Unit 3: Retrieval Models: Overview of Retrieval Models; Boolean Retrieval, The Vector Space Model. Probabilistic Models: Information Retrieval as Classification, The BM25 Ranking Algorithm. Ranking based on Language Models: Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback. Complex Queries and Combining Evidence: The Inference Network Model, The Galago Query Language. Models for Web search, Machine Learning and Information Retrieval: Learning to Rank (Le ToR), Topic Models	10
Unit 4: Evaluating Search Engines: Test collections, Query logs, Effectiveness Metrics: Recall and Precision, Averaging and interpolation, focusing on the top documents. Training, Testing, and Statistics: Significance tests, setting parameter values Classification and Clustering	8

Unit 5: Data Structure using Python Networks of People and Search Engines: User tagging, searching within Communities, Filtering and recommending, Meta search. Beyond Bag of Words: Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of Words, etc., XML Retrieval, Dimensionality Reduction and LSI	8

COURSE OUTCOME
Upon completion of the course, the learners will be able to: 1. Understand the need and importance of information retrieval. 2. Understand the standard methods for information indexing and retrieval and implement different information retrieval models. 3. Apply Artificial Intelligence techniques to text classification and clustering for efficient information retrieval. 4. Design an efficient search engine and analyze the web content structure.

References

1. Search Engines: Information Retrieval in Practice. Bruce Croft, Donald Metzler, and Trevor Strohman, Pearson Education, 2009.
2. Modern Information Retrieval. Baeza-Yates Ricardo and Berthier Ribeiro-Neto. 2nd edition, Addison-Wesley, 2011.

Course Code	AEL206
Course Name	Pattern Recognition
Credits	3

COURSE OBJECTIVE

1. To understand the concept of a pattern and the basic approach to the development of pattern recognition algorithms.
2. To understand and apply the basic methods of feature extraction, feature evaluation, and data mining.
3. To develop prototype pattern recognition algorithms that can be used to study algorithm behavior and performance against real-world multivariate data.
4. To understand complexity of machine learning algorithms, their limitations and open-issues

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Overview of Pattern recognition – Basics of Probability and Statistics, Linear Algebra, Linear Transformations, Components of Pattern Recognition System, Learning and adaptation Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.	10
Unit 2: Clustering for unsupervised learning and classification– Clustering concept – C Means algorithm – Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.	8
Unit 3: Feature Extraction and Feature Selection: Feature extraction – discrete cosine and sine transform, Discrete Fourier transform, Principal Component analysis, Kernel Principal Component Analysis. Feature selection – class separability measures, Feature Selection Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms. Principle component analysis, Independent component analysis, Linear discriminant analysis, Feature selection through functional approximation – Elements of formal grammars, Syntactic description – Stochastic grammars – Structural Representation.	14
Unit 4: State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.	8
Unit 5: Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception	8

COURSE OUTCOME

Upon completion of the course, the learners will be able to:

1. Understand the fundamentals of pattern recognition and machine learning.
2. Understand the issue of dimensionality and apply suitable feature extraction

methods considering the characteristics of a given problem.

References

1. Andrew Webb, “Statistical Pattern Recognition”, Arnold publishers, London,1999.
2. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
3. M. Narasimha Murthy and V. Susheela Devi, “Pattern Recognition”, Springer 2011.
4. Menahem Friedman, Abraham Kandel, “Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches”, World Scientific publishing Co. Ltd, 2000.
5. Robert J.Schalkoff, “Pattern Recognition Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 1992.
6. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John Wiley, 2001.
7. S.Theodoridis and K.Koutroumbas, “Pattern Recognition”, 4th Ed., Academic Press. 2009.

Course Code	AEL207
Course Name	Introduction to High Performance Computing
Credits	3

COURSE OBJECTIVE
1. The objective of this course is to introduce structure of high performance computing for students. 2. Details about multiprocessing and thread level parallelism is included. 3. Introduction to inter connection networks and clusters is also detailed in the course.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to pipelining – Types of pipelining – Hazards in pipelining - Introduction to instruction level parallelism (ILP) – Challenges in ILP - Basic Compiler Techniques for exposing ILP - Reducing Branch costs with prediction - Overcoming Data hazards with Dynamic scheduling - Hardware-based speculation - Exploiting ILP using multiple issue and static scheduling - Exploiting ILP using dynamic scheduling, multiple issue and speculation - Tomasulo's approach, VLIW approach for multi-issue	12
Unit 2: Introduction to multi processors and thread level parallelism - Characteristics of application domain - Systematic shared memory architecture - Distributed shared – memory architecture – Synchronization– Multithreading - Multithreading-fined grained and coarse grained, superscalar and super pipelining, hyper threading. Vector architectures; organizations and performance tuning; GPU architecture and internal organization, Elementary concepts in CUDA programming	10
Unit 3: Introduction to cache performance - Cache Optimizations - Virtual memory - Advanced optimizations of Cache performance - Memory technology and optimizations - Protection: Virtual memory and virtual machines - multi-banked caches, critical word first, early restart approaches, hardware pre-fetching, write buffer merging.	10
Unit 4: Introduction to parallel computing platforms; (Open MP, MPI, Open CL, Open ACC) with performance improvement analysis done using real-life AI and ML applications	8
Unit 5: Introduction to inter connection networks and clusters - interconnection network media - practical issues in interconnecting networks- examples - clusters - designing a cluster – System on Chip (SoC) Interconnects – Network on Chip (NOC).	8

COURSE OUTCOME

Upon completion of the course, the learners will be able to:

1. Understand the concept of pipelining and parallelism
2. Optimization and memory management
3. Analyze the concept of threading involved in achieving parallelism.

References

1. Wang, Endong, Qing Zhang, Bo Shen, Guangyong Zhang, Xiaowei Lu, Qing Wu, and Yajuan Wang. "High-performance computing on the Intel Xeon Phi." Springer 5, 2014.
2. Sanders, Jason, and Edward Kandrot. “CUDA by example: an introduction to general-purpose GPU programming”, Addison-Wesley Professional, 2010.
3. Chandra, Rohit, Leo Dagum, David Kohr, Ramesh Menon, Dror Maydan, and Jeff McDonald. Parallel programming in Open MP. Morgan kaufmann, 2001.
4. Kaeli, David R., Perhaad Mistry, Dana Schaa, and Dong Ping Zhang. Heterogeneous computing with Open CL 2.0. Morgan Kaufmann, 2015.
5. Farber, Rob. Parallel programming with Open ACC. Newnes, 2016.

Course Code	AEL208
Course Name	Computer Vision
Credits	3

COURSE OBJECTIVE
1. Be familiar with both the theoretical and practical aspects of computing with images. 2. Have described the foundation of image formation, measurement, and analysis. 3. Understand the geometric relationships between 2D images and the 3D world. 4. Grasp the principles of state-of-the-art deep neural networks.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, introduction to computer vision	8
Unit 2: Feature Extraction: Shape, histogram, color, spectral, texture, Feature analysis, feature vectors, distance /similarity measures, data preprocessing, Edges - Canny, LOG, DOG; Scale-Space Analysis-Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram, SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.	9
Unit 3: Depth estimation and Multi-camera views: Perspective, Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Binocular Stereopsis: Camera and Epipolar Geometry; Auto-calibration. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.	9
Unit 4: Motion Analysis: Optical Flow, KLT, Spatio-Temporal Analysis, Background Subtraction and Modeling, Dynamic Stereo; Motion parameter estimation.	9
Unit 5: Shape from X**:** Light at Surfaces; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges Albedo estimation; Photometric Stereo; Phong Model; Reflectance Map	9

COURSE OUTCOME
After completion of course, students would be able to: 1. Developed the practical skills necessary to build computer vision applications. 2. To have gained exposure to object and scene recognition and categorization from images.

References

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
5. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

Course Code	AEL209
Course Name	Social Media Analytics
Credits	3

COURSE OBJECTIVE
1. To demonstrate foundations of Social Media Analytics. 2. To analyze data mining aspects in social networks. 3. To solve mining problems by different algorithms. 4. To describe network measures for social data.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics.	8
Unit 2: Introduction, A Taxonomy of Visualization, The convergence of Visualization, Interaction and Analytics. Data mining in Social Media: Introduction, Motivations for Data mining in Social Media, Data mining methods for Social Media, Related Efforts	8
Unit 3: Introduction, Keyword search, Classification Algorithms, Clustering Algorithms Greedy Clustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.	10
Unit 4: Centrality: Degree Centrality , Eigenvector Centrality, Katz Centrality , Page Rank, Betweenness Centrality, Closeness Centrality ,Group Centrality, Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence	10
Unit 5: Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction, Case Study: Mining Twitter: Overview, Exploring Twitter's API, Analyzing 140 Characters Mining Facebook: Overview, Exploring Facebook's Social Graph API's, Analyzing Social Graph Connections.	12

COURSE OUTCOME
After learning the course, the students should be able to: 1. Discuss the basics of Social Media Analytics. 2. Describe the significance of Data mining in Social media. 3. Interpret the algorithms used for text mining. 4. Apply network measures for social media data.

References

1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press,ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.
3. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
4. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
5. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860- 901-6.
6. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN: 978-3-642-19459-7.

Course Code	AEL210
Course Name	Blockchain
Credits	3

COURSE OBJECTIVE
This course explores the fundamentals of blockchain, the workings and applications of this technology and its potential impact on Supply Chain, Manufacturing, Real Estate, Customer Loyalty, Agriculture, Financial Services, Government, Banking, Contracting and Identity Management.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Identifying the problems with current infrastructure; Understanding Centralized Practices, Policies & Business; Businesses with Decentralized Infrastructure; Overview of blockchain technology; Advantage over conventional distributed database; History of blockchain: how and when blockchain/bitcoin started, milestones on the development of bitcoin, criticism, ridicule and promise of bitcoin, sharing economy, internet of value; how economics benefits from blockchain.	10
Unit 2: Block Ciphers; Encryptions; Secret Keys; Elliptic Curve Cryptography; Hash cryptography; Encryption vs hashing; Digital Signature; Memory Hard Algorithm, Zero Knowledge Proof.	6
Unit 3: Introduction: Transactions, blocks, hashes, consensus, verify and confirm blocks, peer to peer networks, blocks of data in a chain, decentralization of networks, processes & workflows, cryptocurrencies, nodes, assets, consensus, dapps; types of blockchain; chain policy; working of blockchain; life of blockchain application; privacy, anonymity and security of blockchain.	10
Unit 4: Hyperledger: Introduction, where can Hyperledger be used, Hyperledger architecture, Hyperledger Fabric, features of Hyperledger; Open source blockchain platform technology; Tools & services; Cloud options in blockchains AWS; Azure workbench; Hyperledger console; Consensus: Proof of work, proof of stake, delegated proof of stake, proof of burn, BlocBox Protocol.	10
Unit 5: History; Distributed ledger; Smart contracts; Cryptocurrency; Bitcoin protocols; Mining strategy and rewards; Ethereum – construction; DAO; GHOST; Vulnerability; Attacks; Sidechain; Namecoin, Trade finance; Supply chain; Manufacturing; Security; Real Estate, Customer Loyalty, Agriculture, Financial Services, Government, Banking, Contracting and Identity Management; Internet of Things; Medical record management system; Domain name service, etc.; future of blockchain.	12

COURSE OUTCOME
Upon completion of the course, the learners will be able to:

1. Understand the concept of blockchain and its need.
2. Analyze methods of cryptography for application with blockchain.
3. Evaluate the working of blockchain.
4. Understand the underlying technology of transactions, blocks, proof-of-work, and consensus building.
5. Identify real world problems that blockchain can solve and analyze a use case.
6. Develop applications on blockchain using platforms such as Ethereum.

References

1. D. Tapscott, A. Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, Portfolio Publishers.
2. A. Antonopoulos, Mastering Bitcoin: Programming the Open Blockchain, O'Reilly.
3. P. Champagne, The Book of Satoshi: The Collected Writings of Bitcoin Creator Satoshi Nakamoto, e53 Publishing, LLC.
4. M. Swan, Blockchain: Blueprint for a New Economy, O'Reilly.
5. R. Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing.
6. R. Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing.
7. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press.

Course Code	AEL211
Course Name	Healthcare Data Analytics
Credits	3

COURSE OBJECTIVE
1. To learn the data analytics for biomedical images 2. To learn different clinical Prediction models and real time applications in the healthcare sector.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Healthcare Data Analytics- Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting HER, Challenges- Phenotyping Algorithms. Biomedical Image Analysis, Biomedical image modalities, Object detection, image segmentation, image registration, feature extraction, Genomic Data Analysis for Personalized Medicine, Genomic data generation, methods for data analysis, types of computational genomics studies towards personalized medicine	12
Unit 2: Data Analysis using Natural language Processing for healthcare, Natural Language Processing, Mining information from Clinical Text, challenges of processing clinical reports, applications, Social Media Analytics for healthcare.	8
Unit 3: Clinical Prediction Models and Data Mining for Healthcare data, Basic Statistical Prediction Models, Alternative Clinical Prediction Models, Survival Models. Association Analysis, Temporal Pattern Mining: Sequential Pattern Mining, Time-Interval Pattern Mining	10
Unit 4: Visual Analytics and Integrating data for Healthcare, Medical data visualization, visual analytics for public health and population research, clinical workflow, clinicians, patients. Predictive Models for Integrating Clinical and Genomic Data	8
Unit 5: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems, Analysis of Data from Online Doctor and Patient Communities.	10

COURSE OUTCOME
At the end of the course, students should be able to 1. Describe the basics of healthcare data analytics. 2. Use biomedical image features and perform data analytics. 3. Apply natural language processing for data analytics 4. Use prediction models for healthcare data analytics.

References

1. Chandan K. Reddy and Charu C Aggarwal, “Healthcare data analytics”, Taylor & Francis, 2015
2. Hui Yang and Eva K. Lee, “Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.
3. Tinglong Dai, Sridhar Tayur , “Handbook of Healthcare Analytics”, Wiley, 2018.
4. Anand J Kulkarni, Patrick Siarry, “Big Data Analytics in healthcare”, Springer, Studies in Big Data

Course Code	AEL212
Course Name	Cognitive Systems
Credits	3

COURSE OBJECTIVE

1. Provide a comprehensive understanding of cognitive systems.
2. Introduce students to the interdisciplinary nature of cognitive science and its applications.
3. Develop critical thinking and problem-solving skills in analyzing and designing cognitive systems.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Introduction to Cognitive Systems Overview of cognitive systems, Historical development, Interdisciplinary nature, Basic concepts in cognitive science, Cognitive architectures, Applications of cognitive systems, Cognitive system modeling approaches, Cognitive development across the lifespan, Neural correlates of cognition, Ethical considerations in cognitive systems, Future trends in cognitive science.	8
Unit 2: Cognitive Psychology Fundamentals Human cognition and perception, Memory systems, Attention and consciousness, Language processing, Problem-solving and decision-making, Learning and adaptation, Emotion and cognition, Social cognition, Cognitive biases and heuristics, Cognitive development theories, Cognitive neuroscience methods.	12
Unit 3: Computational Intelligence Introduction to computational intelligence, Artificial neural networks, Fuzzy logic systems, Evolutionary algorithms, Swarm intelligence, Hybrid intelligent systems, Machine learning algorithms for cognitive systems, Deep learning architectures, Neuroevolutionary algorithms, Bio-inspired computing models, Applications of computational intelligence in cognitive science.	8
Unit 4: Cognitive Robotics Cognitive robotics fundamentals, Embodied cognition, Sensorimotor integration, Spatial cognition, Navigation and mapping, Human-robot interaction, Cognitive architectures for robots, Developmental robotics, Robot learning and adaptation, Multi-robot systems, Ethical considerations in cognitive robotics.	10
Unit 5: Applications and Advanced Topics Cognitive computing applications, Autonomous systems, Cognitive modeling and simulation, Brain-computer interfaces, Ethical considerations in cognitive systems, Future trends and challenges in cognitive science, Cognitive augmentation technologies, Cognitive rehabilitation techniques, Computational psychiatry, Neuromorphic computing, Human-centered AI design principles.	10

COURSE OUTCOME

After learning the course, the students should be able to:

1. Demonstrate a thorough understanding of cognitive systems principles.
2. Apply knowledge of cognitive science concepts to analyze and solve complex problems.
3. Design and implement computational models of cognitive processes.
4. Develop cognitive robotics systems capable of sensorimotor integration, spatial cognition, and human-robot interaction.

References

1. Boden, M. A. (Ed.). (2006). "Handbook of Cognitive Science: An Embodied Approach." Elsevier.
2. Russel, S., & Norvig, P. (2020). "Artificial Intelligence: A Modern Approach." Pearson.
3. Thrun, S., Burgard, W., & Fox, D. (2005). "Probabilistic Robotics." MIT Press.
4. Luger, G. F., & Stubblefield, W. A. (2017). "Artificial Intelligence: Structures and Strategies for Complex Problem Solving." Pearson.
5. Hutto, D. D., & Myin, E. (2017). "Evolutionary Robotics and the Reach of Embodiment." Frontiers in Psychology, 7, 1-14.

Audit Courses

ACL201: English for Research Paper Writing

COURSE OBJECTIVE
1. Understand that how to improve your writing skills and level of readability 2. Learn about what to write in each section 3. Understand the skills needed when writing a Title 4. Ensure the good quality of paper at very first-time submission

Units	Contents	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

COURSE OUTCOME
After completion of course, students would be able to: 1. Improved proficiency in academic English language skills, including reading, writing, listening, and speaking. 2. Ability to comprehend and analyze academic texts, research articles, and scholarly literature effectively. 3. Mastery of the conventions of academic writing, including structure, organization, coherence, and citation styles.

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.

ACL202: Disaster Management

COURSE OBJECTIVE
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

Units	Contents	Hours
1	**Introduction to Disaster:** Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	4
3	**Disaster Prone Areas in India;** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics	4
4	**Disaster Preparedness and Management;** Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.	4
5	**Risk Assessment;** Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation;** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	4

COURSE OUTCOME
After completion of course, students would be able to: 1. Understanding of the principles, concepts, and terminology related to disaster management. 2. Ability to identify different types of disasters, their causes, and their impacts on communities and infrastructure. 3. Proficiency in assessing risks and vulnerabilities associated with natural and

human-made disasters.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal Book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies, Deep & Deep Publication Pvt. Ltd., New Delhi.

ACL203: Sanskrit for Technical Knowledge

COURSE OBJECTIVE
1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world. 2. Learning of Sanskrit to improve brain functioning. 3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.

Unit	Content	Hours
1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences	8
2	Order; Introduction of roots, Technical information about Sanskrit Literature	8
3	Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

COURSE OUTCOME
After completion of course, students would be able to: 1. Understanding basic Sanskrit language 2. Ancient Sanskrit literature about science & technology can be understood 3. Being a logical language will help to develop logic in students

Suggested Reading

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

ACL204: Value Education

COURSE OBJECTIVE
1. Understand value of education and self-development 2. Imbibe good values in students 3. Know about the importance of character

Units	Contents	Hours
1	Values and self-development – Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgments.	6
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.	6
3	Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	6
4	Character and Competence – Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively	6

COURSE OUTCOME
1. Knowledge of self-development 2. Learn the importance of Human values 3. Developing the overall personality

Suggested Reading

Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

ACL205: Constitution of India

COURSE OBJECTIVE
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Units	Content	Hours
1	**History of Making of the Indian Constitution:** • History • Drafting Committee, (Composition & Working)	4
2	**Philosophy of the Indian Constitution:** • Preamble • Salient Features	4
3	**Contours of Constitutional Rights & Duties:** • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties.	4
4	**Organs of Governance:** • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	4

5	**Local Administration:** • District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation. • Panchayati raj: Introduction, PRI: Zila Panchayat. • Elected officials and their roles, CEO Zila Panchayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy	4
6	**Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.	4

COURSE OUTCOME
1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956.

Suggested Reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

ACL206: Pedagogy Studies

COURSE OBJECTIVE
Students will be able to: 1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. 2. Identify critical evidence gaps to guide the development.

Units	Content	Hours
1	Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.	4
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	4
3	Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes, beliefs, and Pedagogic strategies.	4
4	Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment ,Barriers to learning: limited resources and large class sizes	4
5	Research gaps and future directions, Research design, Contexts	4
6	Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	4

COURSE OUTCOME
Students will be able to understand: 1. What pedagogical practices teachers in formal and informal classrooms in developing countries are using? 2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? 3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

ACL207: Stress Management by Yoga

COURSE OBJECTIVE
1. To achieve overall health of body and mind 2. To overcome stress

Unit	Content	Hours
1	Definitions of Eight parts of yoga (Ashtanga)	8
2	Yam and Niyam. Do's and Don'ts in life. • Ahinsa, satya, astheya, bramhacharya and aparigraha • Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	Asana and Pranayama • Various yoga poses and their benefits for mind & body • Regularization of breathing techniques and its effects - Types of pranayama	8

COURSE OUTCOME
Students will be able to: 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency

Suggested Reading

1. 'Yogic Asanas for Group Training-Part-I' by Janardan Swami Yogabhyasi Mandal, Nagpur
2. 'Rajayoga or conquering the Internal Nature' by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

ACL208: Personality Development Through Life Enlightenment Skills

COURSE OBJECTIVE
1. To learn to achieve the highest goal happily 2. To become a person with stable mind, pleasing personality and determination 3. To awaken wisdom in students

Unit	Content	Hours
1	Neetisatakam - Holistic development of personality • Verses- 19, 20, 21, 22 (wisdom) • Verses- 29, 31, 32 (pride & heroism) • Verses- 26, 28, 63, 65 (virtue) • Verses- 52, 53, 59 (don'ts) • Verses- 71, 73, 75, 78 (do's)	8
2	Approach to day-to-day work and duties. • Shrimad Bhagwad Geeta: Chapter 2. Verses 41, 47, 48 • Chapter 3. Verses 13, 21, 27, 35, Chapter 6. Verses 5, 13, 17, 23, 35 • Chapter 18. Verses 45, 46, 48	8
3	Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter 2. Verses 56, 62, 68 • Chapter 12. Verses 13, 14, 15, 16, 17, 18 • Personality of role model. • Shrimad Bhagwad Geeta: Chapter 2. Verses 17, Chapter 3. Verses 36, 37, 42 • Chapter 4. Verses 18, 38, 39 • Chapter 18. Verses 37, 38, 63	8

COURSE OUTCOME
Students will be able to 1. Study of Shrimad Bhagwad Geeta will help the student in developing his personality and achieve the highest goal in life 2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

Suggested Reading

1. "Shrimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,

Open Elective Subject

Course Code	OEL201
Course Name	Business Analytics
Credits	3

COURSE OBJECTIVE
1. Understand the role of business analytics within an organization. 2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. 3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision-making. 4. To become familiar with processes needed to develop, report, and analyze business data.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	9
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression, Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9
Unit 4: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models, Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10

Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	12

COURSE OUTCOME
1. Students will demonstrate knowledge of data analytics. 2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics. 3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making. 4. Students will demonstrate the ability to translate data into clear, actionable insights.

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Code	OEL202
Course Name	Industrial Safety
Credits	3

COURSE OBJECTIVE
1. Understand industrial safety principles and importance. 2. Identify workplace hazards and risks. 3. Learn safety regulations and compliance. 4. Develop hazard assessment and mitigation skills.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	9
Unit 2: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	9
Unit 3: Wear, Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	10
Unit 4: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	10
Unit 5: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating	10

(DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	

COURSE OUTCOME
1. Enhanced awareness and understanding of industrial safety principles and practices. 2. Ability to identify and assess workplace hazards and risks effectively. 3. Compliance with relevant safety regulations and standards in industrial settings. 4. Improved skills in implementing safety measures to mitigate workplace hazards.

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Code	OEL203
Course Name	Operations Research
Credits	3

COURSE OBJECTIVE
1. Understanding the fundamental concepts and principles of operations research. 2. Learning various optimization techniques used to solve complex decision-making problems. 3. Developing analytical skills to model real-world problems mathematically. 4. Exploring different types of optimization problems, such as linear programming, integer programming, and nonlinear programming. 5. Studying methods for analyzing and interpreting optimization results.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	9
Unit 2: Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	9
Unit 3: Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT	10
Unit 4: Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	10
Unit 5: Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	10

COURSE OUTCOME
At the end of the course, the student should be able to 1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. 2. Students should able to apply the concept of non-linear programming 3. Students should able to carry out sensitivity analysis.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Course Code	OEL204
Course Name	Cost Management of Engineering Projects
Credits	3

COURSE OBJECTIVE
1. Understanding the principles and concepts of cost management specific to engineering projects. 2. Learning techniques for estimating project costs accurately, including cost breakdown structure development. 3. Familiarizing with cost control methods to monitor and manage project expenditures effectively. 4. Exploring strategies for budgeting and forecasting project costs throughout the project lifecycle.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	9
Unit 2: Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	10
Unit 3: Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.	10
Unit 4: Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	10
Unit 5: Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	9

COURSE OUTCOME
1. Enhanced understanding of cost management principles and techniques applicable to engineering projects. 2. Ability to develop accurate project cost estimates and breakdown structures. 3. Proficiency in implementing cost control measures to ensure projects stay within budget constraints. 4. Improved skills in budgeting and forecasting project costs throughout the project lifecycle. 5. Capability to identify and mitigate cost-related risks effectively.

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Code	OEL205
Course Name	Composite Materials
Credits	3

COURSE OBJECTIVE
1. Understanding the basic concepts and properties of composite materials. 2. Learning about the constituents and manufacturing processes of composite materials. 3. Exploring the different types of reinforcement materials and matrix materials used in composites. 4. Studying the mechanical, thermal, and electrical properties of composite materials. 5. Understanding the principles of composite material selection and design.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.	10
Unit 2: Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	10
Unit 3: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	10
Unit 4: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	9
Unit 5: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	9

COURSE OUTCOME

1. Comprehensive understanding of the fundamental principles and properties of composite materials.
2. Proficiency in identifying and selecting appropriate reinforcement and matrix materials for specific applications.
3. Ability to analyze and predict the mechanical, thermal, and electrical behavior of composite materials.

References:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Course Code	OEL206
Course Name	Waste to Energy
Credits	3

COURSE OBJECTIVE

1. Understanding the principles and concepts of waste-to-energy (WtE) technologies.
2. Learning about different types of waste streams and their potential for energy recovery.
3. Exploring various conversion technologies used in waste-to-energy processes, such as incineration, pyrolysis, gasification, and anaerobic digestion.
4. Studying the environmental, economic, and social implications of waste-to-energy systems.

Total Number of Lectures: 48

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	8
Unit 2: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	8
Unit 3: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	10
Unit 4: Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	10
Unit 5: Biogas: Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system, Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, Types of biogas Plants, Applications, Alcohol production from biomass, Bio diesel production, Urban waste to energy conversion, Biomass energy programme in India.	12

COURSE OUTCOME

1. Comprehensive understanding of waste-to-energy (WtE) technologies and their applications.
2. Ability to identify and assess different types of waste streams for energy recovery potential.

References:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.