University of Mumbai

No. UG/ 84 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office circular No.UG/24 of 2013-14, dated 21st July, 2014 relating to the eligibility for M.E. degree course.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Computer Engineering at its meeting held on 09th May, 2019 have been accepted by the Academic Council at its meeting held on 10th May, 2019 vide item No. 4.29 and subsequently approved by the Management Council at its meeting held on 01st June, 2019 vide item No. 13 and that in accordance therewith, , in exercise of the powers conferred upon the Management Council that Addendum of New branch in O.5134 under Section 74(4) of the Maharashtra Public Universities Act, 2016 (Mah. Act No. VI of 2017), the amendment of O. 5134 relating to the M.E. Artificial Intelligence and introduction of New Syllabus for Master of Engineering - Artificial Intelligence (CBCGS), has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in) and to read as under:-

Amendment of O. 5134 relating to the M.E. Artificial Intelligence and introduction of New Syllabus for Master of Engineering - Artificial Intelligence (CBCGS):-

THE AMENDED ORDINANCE 5134:-

Any person who has passed an examination for the Degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering of any other University recognized as equivalent to the Bachelor of Engineering degree of this University is deemed eligible for admission to the Masters degree course in Engineering in the specific branch in which he / she has taken the degree of Bachelor of Engineering of a related branch as listed below:-

Master of Engineering	Bachelor of Engineering
1. Civil Engineering with (i) Environmental Engineering Subjects (ii) Hydraulics Engineering Subjects (iii) Water Resource Engineering subjects	a. Civil Engineering OR b. Environmental Engineering OR c. Construction Engineering OR d. Water Management

../2-

1. Civil Engineering with (iv) Structural Engineering Subjects (v) Construction Management Subjects (vi) Goo-technical Engineering Subjects (vii) Traffic and Transportation Engineering Subjects	a. Civil Engineering OR b. Construction Engineering OR c. Structural Engineering
1. Civil Engineering **Construction Engineering and Management**	a. Civil Engineering OR b. Construction Engineering
2. Mechanical Engineering with (i) Machine Design Subjects (ii) Automobile Engineering Subjects (iii) CAD/CAM & Robotics subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Aerospace / Aeronautical Engineering
2. Mechanical Engineering with (iii) Fluid Pumping Machine Subjects (iv) Internal Combustion Engineering Subjects (v) Thermal Engineering Subjects (vi) Heat Power subjects (vii) Energy Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Aerospace / Aeronautical Engineering
2. Mechanical Engineering with (viii) Manufacturing systems Engineering subjects (ix) Production Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering
2. Mechanical Engineering i) Energy System & Management ii) Product Design & Development	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Aerospace Engineering
3. Production Engineering	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering

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4. Electrical Engineering with (i) Control Systems Engineering Subjects (ii) Power Systems Engineering Subjects (iii) Power Electronics and Drives	a. Electrical Engineering OR b. Electronics Engineering OR c. Instrumentation Engineering OR d. Power Electronics OR e. Electronics and Power OR f. Industrial Electronics OR g. Electronics and Telecommunication Engineering
4. Electrical Engineering Power Plant Engineering & Energy Management	a. Electrical Engineering OR b. Electronics & Power OR c. Power Engineering OR d. Instrumentation Engineering
5. Electronics Engineering **6. Electronics & Telecommunication Engineering**	a. Electrical Engineering OR b. Electronics Engineering OR c. Electronics and Tele-Communication Engineering OR d. Instrumentation Engineering OR e. Computer Engineering OR f. Power Engineering OR g. Biomedical Engineering OR h. Information Technology
7. Instrumentation Engineering **8. Instrumentation & Control Engineering**	a. Electrical Engineering OR b. Electronics Engineering OR c. Instrumentation Engineering OR d. Power Electronics OR e. Biomedical Engineering OR f. Mechanical Engineering OR g. Chemical Engineering
9. Computer Engineering	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication Engineering OR e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
10. Information Technology **11. Information Technology in Information Security** **12. Information Technology in Information and cyber warfare** **13. Information Technology in AI and Robotics**	All branches of the Bachelor of Engineering (B.E.) degree courses

14. Biomedical Engineering	a. Biomedical Engineering OR b. Computer Engineering OR c. Instrumentation Engineering OR d. Electronics Engineering OR e. Electronics and Tele-Communication Engg. OR f. Electrical Engineering OR g. Information Technology OR h. Electronics and Power Engineering OR i. Electrical and Electronics Engineering OR j. Power Electronics
15. Chemical Engineering	a. Chemical Engineering OR b. Chemical Technology OR c. Petrochemical Engineering OR d. Petroleum Engineering OR e. Biotechnology
16. Signal Processing	a. Electrical Engineering OR b. Electronics Engineering OR c. Electronics & Telecommunication Engineering OR d. Instrumentations Engineering OR e. Computer Engineering OR f. Power Electronics OR g. Biomedical Engineering
17. Packing Technology	a .B.E. (Printing & Packing Technology) OR b. B.E. (Printing Technology) OR c. B.E. (Packing Technology) OR d. B.E. (Mechanical Engineering) OR e. B.E. (Chemical Engineering) OR f. B.E. (Plastic Engineering) OR g. B.E. (Polymers Engineering) OR h. B.E. (Food Technology) OR i. B.E. (Bio-Technology)
18. Advance Communication & Information System	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics & Telecommunication Engineering OR e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics

Addendum of New branch in for New Branch the O. 5134 regarding M.E. Artificial Intelligence

19. Artificial Intelligence	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication Engineering OR e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics

Notwithstanding what is stated above, candidate who have passed the Section A and Section B examinations conducted by the (1) The Institution of Engineers (India), Kolkota 700020 and (2) Institution of Electronics and Telecommunication Engineers (India), New Delhi, is deemed eligible for admission to the Master of Engineering degree course in the specific branch in which they have passed Section A and Section B examinations of a related branch as listed above.

MUMBAI – 400 032
28th August 2019

(Dr. Ajay Deshmukh)
REGISTRAR

To

The Principals of the affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.29/10/05/2019
M.C/13/01/06/2019

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No. UG/84 -A of 2019   MUMBAI-400 032   28th August, 2019

Copy forwarded with Compliments for information to:-
  1) The I/c Dean, Faculty of Science & Technology,
  2) The Chairman, Ad-hoc Board of Studies in Computer Engineering,
  3) The Director, Board of Examinations and Evaluation,
  4) The Director, Board of Students Development,
  5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

UNIVERSITY OF MUMBAI

Syllabus

for

Master of Engineering

Program: M.E. (Artificial Intelligence)

Under

FACULTY OF TECHNOLOGY

Computer Engineering Discipline

(As per Choice Based Credit and Grading System)

with effect from

Academic Year 2019-20

From the Dean's Desk:

The era of digitalization has changed and is changing the way we produce, communicate and even the way cities work. Artificial Intelligence (AI) is considered to be the next remarkable technological development, alike the past industrial revolutions and the current digital revolution. The scope of the AI market seems promising with opportunities in diverse sectors such as the healthcare, security, retail, agriculture, automotive, manufacturing, and finance. In fact, it is estimated that AI will transform the labour market by creating more a million new job opportunities related to this field. Also, the increasing amount of digital data and the growing consumer preference for smart devices is resulting into multi fold rise in the demand for engineers with proficiency in AI. This Masters programme in Artificial Intelligence will open the doors to gain skills for developing of a wide range of applications with efficiency, accuracy and reduced risk.

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes, Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System was implemented for First Year Master of Engineering from the academic year 2016-2017and subsequently the system has been carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Dean (I/c),
Faculty of Science & Technology,
Member - Board of Deans, Academic Council and Senate
University of Mumbai, Mumbai

Preamble:

University of Mumbai feels that it is desirable to provide specialized Masters programme in Artificial Intelligence to address the needs of the industry, which today requires more specialized resource in each field.

The objective of the programme is to give students a deeper understanding of technology and how to apply logic to create Artificial Intelligence and teach them to create and programme unique projects for the Artificial Intelligence field. Many skills may be developed during this master's program that could lead to high-paying jobs and career advancements in the future. Students may develop critical-thinking and technology skills that help them excel in their career field, and they may also learn crucial problem-solving abilities.

The M. E. in Artificial Intelligence programme is offered to students who are interested in advanced learning and research in any area of Artificial Intelligence, Machine Learning and Business Intelligence. Applicants to this programme are expected to have a background in Computer Science and Engineering / Information Technology / Electronics Engineering / Electronics and Telecommunication Engineering / Electrical Engineering / Instrumentation Engineering / Power Electronics.

The programme is a 72-credit post-graduate degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Subhash K. Shinde
Chairman,
Adhoc Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE)

(With Effect from 2019-20)

University of Mumbai

Semester - I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC101	Building Blocks of Artificial Intelligence	04	-	-	04	-	-	04
MEAIC102	Machine Learning and Pattern Recognition	04	-	-	04	-	-	04
MEAIC103	Mathematical Foundations of Data Science	04	-	-	04	-	-	04
MEAIDLO-I	Department Level Optional Course – I	04	-	-	04	-	-	04
ILO-I	Institute Level Optional Course – I*	03	-	-	03	-	-	03
MEAIL101	AI Programming Lab	-	02	-	-	01	-	01
MEAIL102	Data Science Lab	-	02	-	-	01	-	01
Total		**19**	**04**	**-**	**19**	**02**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIC101	Building Blocks of Artificial Intelligence	20	20	20	80	03	-	-	100
MEAIC102	Machine Learning and Pattern Recognition	20	20	20	80	03	-	-	100
MEAIC103	Mathematical Foundations of Data Science	20	20	20	80	03	-	-	100
MEAIDLO-I	Department Level Optional Course – I	20	20	20	80	03	-	-	100
ILO-I	Institute Level Optional Course – I	20	20	20	80	03	-	-	100
MEAIL101	AI Programming Lab	-	-	-	-	-	25	25	50
MEAIL102	Data Science Lab	-	-	-	-	-	25	25	50
Total		**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE)

(With Effect from 2019-20)

University of Mumbai

Semester - I

Department Level Optional Course – I#	
Course Code	**Course Name**
MEAIDLO1011	Computer Vision
MEAIDLO1012	Natural Language Processing
MEAIDLO1013	Design and Analysis of Algorithms
MEAIDLO1014	Information Retrieval
MEAIDLO1015	Blockchain

Institute Level Optional Course – I*	
Course Code	**Course Name**
ILO1011	Product Lifecycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management & Mitigation Measures
ILO1018	Energy Audit and Management

Department Level Optional Course (DLO): Every student is required to take one Department Elective Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

* Institute Level Optional Course (ILO): Every student is required to take one Institute Elective Course for Semester I and Semester II, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE)

(With Effect from 2019-20)

University of Mumbai

Semester - II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC201	Deep and Reinforcement Learning	04	-	-	04	-	-	04
MEAIC202	Big Data Analytics	04	-	-	04	-	-	04
MEAIC203	Bio-inspired Artificial Intelligence	04	-	-	04	-	-	04
MEAIDLO-II	Department Level Optional Course – II	04	-	-	04	-	-	04
ILO-II	Institute Level Optional Course – II	03	-	-	03	-	-	03
MEAIL201	Machine Learning Lab	-	02	-		01	-	01
MEAIL202	Big Data Lab	-	02	-		01	-	01
Total		**19**	**04**	**-**	**19**	**02**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIC201	Deep and Reinforcement Learning	20	20	20	80	03	-	-	100
MEAIC202	Big Data Analytics	20	20	20	80	03	-	-	100
MEAIC203	Bio-inspired Artificial Intelligence	20	20	20	80	03	-	-	100
MEAIDLO-II	Department Level Optional Course – II	20	20	20	80	03	-	-	100
ILO-II	Institute Level Optional Course – II	20	20	20	80	03	-	-	100
MEAIL201	Machine Learning Lab	-	-	-	-	-	25	25	50
MEAIL202	Big Data Lab	-	-	-	-	-	25	25	50
Total		**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE)

(With Effect from 2019-20)

University of Mumbai

Semester - II

Department Level Optional Course – II	
Course Code	**Course Name**
MEAIDLO2021	Artificial Intelligence in Bioinformatics
MEAIDLO2022	IoT Data Analytics
MEAIDLO2023	Speech Recognition
MEAIDLO2024	Autonomous Robotics
MEAIDLO2025	Mixed Reality
MEAIDLO2026	Robotics Process Automation

Institute Level Optional Course – II	
Course Code	**Course Name**
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and CSR
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIS301	Seminar: State-of-the-art research topics	-	06	-	-	03	-	03
MEAID301	Dissertation – I	-	24	-	-	12	-	12
Total		**-**	**30**	**-**	**-**	**15**	**-**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIS301	Seminar: State-of-the-art research topics	-	-	-	-	-	50	50	100
MEAID301	Dissertation – I	-	-	-	-	-	100	-	100
Total		-	**-**	-	-	-	**150**	**50**	**200**

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAID401	Dissertation – II	-	30	-	-	15	-	15
Total		**-**	**30**	**-**	**-**	**15**	**-**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAID401	Dissertation - II	-	-	-	-	-	100	100	200
Total		-	**-**	-	-	-	**100**	**100**	**200**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC101	Building Blocks of Artificial Intelligence	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

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.
5. To introduce the need and concept of hybrid soft computing algorithms.

Course Outcomes:

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

1. Understand AI concepts used to develop solutions that mimic human like thought process on deterministic machines for real-world problems.
2. Analyze and evaluate whether a problem can be solved using AI techniques and analyze the same using basic concepts of AI.
3. Understand the fundamental concepts of Neural Networks, different neural network architectures, algorithms, applications and their limitations.
4. Apply Fuzzy Logic, the concept of fuzziness and fuzzy set theory in various systems.
5. Apply Genetic Algorithms in problems with self-learning situations that seek global optimum.
6. Create solutions to real-world problems using Neural Network, Genetic Algorithms, Fuzzy Logic or their Hybrid systems.

Prerequisites: Data Structures & Algorithms, Fundamentals of Mathematics.

Sr. No.	Module	Detailed Content	Hours
1	Foundations of Artificial Intelligence	Introduction to artificial intelligence; Application areas of artificial intelligence; State space search: Depth first search, Breadth first search; Heuristic search: Best first search, Hill Climbing, Beam Search, Tabu Search; Introduction to randomized search: Simulated annealing, Genetic algorithms, Ant colony optimization; Introduction to expert systems; Introduction to AI-related fields like game playing, speech recognition, language detection machine, computer vision, robotics.	8
2	Introduction to Soft Computing	Importance of soft computing; Soft computing versus hard computing; Supervised and unsupervised learning; Introduction	6

3	Neural Networks	Basic concepts of neural network; Overview of learning rules and parameters; Activation functions; Single layer perceptron and multilayer perceptron; Multilayer feed forward network; Backpropagation networks: Architecture, Algorithm, Variation of standard backpropagation neural network; Radial basis function network; Recurrent neural network; Introduction to Associative Memory; Recent applications.	10
		to main components of soft computing: Fuzzy logic, Neural networks, Genetic algorithms.	
4	Genetic Algorithms	Difference between traditional algorithms and Genetic Algorithm (GA); Basic concepts of GA; Working principle; Encoding methods; Fitness function; GA Operators: Reproduction, Crossover, Mutation; Convergence of GA; Detailed algorithmic steps; Adjustment of parameters; Multi-criteria optimization; Solution of typical problems using genetic algorithm; Recent applications.	8
5	Fuzzy Logic	Concepts of uncertainty and imprecision; Concepts, properties and operations on classical sets and fuzzy sets; Classical & fuzzy relations; Membership functions and its types; Fuzzification; Fuzzy rule-based systems; Defuzzification; Fuzzy propositions; Fuzzy extension principle; Fuzzy inference system; Recent applications.	8
6	Hybrid Systems	Introduction to hybrid systems: Fuzzy-neural systems, Genetic-fuzzy systems, Neuro-genetic systems; Details of any one method for each hybrid system.	8

Text Books:

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
2. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India.

Reference Books:

1. J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House.
2. D. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley
3. G. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and A: Theory and Applications, Pearson.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC102	Machine Learning and Pattern Recognition	04	-	-	04	-	-	04

		Examination Scheme					
		Theory					
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**
		Test 1	Test 2	Avg			
		20	20	20	80	03	-

Oral/ Prac	Total
-	100

Course Objectives:

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 feature extraction, feature evaluation, and data mining.
3. To understand and apply both supervised and unsupervised machine learning algorithms to detect and characterize patterns in real-world data.
4. To develop prototype pattern recognition algorithms that can be used to study algorithm behavior and performance against real-world multivariate data.
5. To understand complexity of machine learning algorithms, their limitations and open-issues.

Course Outcomes:

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.
3. Apply parametric and non-parametric methods for pattern recognition in real-world problems.
4. Create solutions to real-world problems using pattern recognition and machine intelligence algorithms.
5. Understand and apply ensemble methods for performance enhancement of machine learning algorithms.
6. Analyze the performance of machine learning algorithms, effect of parameters and tuning of parameters.

Prerequisites: Fundamentals of Data Mining, Fundamentals of Mathematics.

Sr. No.	Module	Detailed Content	Hours
1	Introduction	Basic definitions; Hypothesis space and inductive bias; Data cleaning; Data transformation; Evaluation; Model visualization; Cross-validation; Linear Regression.	6
2	Feature Extraction	Curse of dimensionality; Principal component analysis; Fisher linear discriminant, Feature extraction from multivariate data, image data; Feature evaluation.	8
3	Non-parametric Methods for Pattern	Non-numeric data or nominal data; Linear regression; Decision tree algorithms: ID3, C4.5, Classification and	10

4	Bayes Learning and Parametric Estimation Methods	Maximum-Likelihood estimation; Maximum a posteriori estimation; Naïve Bayes and Bayesian classifiers; K-nearest neighbour method; Support Vector Machines; Algorithms for clustering: K-means, Hierarchical and other methods.	10
5	Ensemble Classifiers	Need and usefulness of ensemble classifiers; Bagging; Boosting, Random forests; Decorate; Vote; Stacking.	8
6	Algorithmic Performance Evaluation	Analysis of classification, clustering, prediction, association algorithms; Approaches of parameter tuning.	6

| | Recognition | Regression Trees (CART); Overfitting and underfitting. | |

Text Books:

1. T. Mitchell, Machine Learning, McGraw Hill.
2. M. Gopal, Applied Machine Learning, McGraw Hill.

Reference Books:

1. A. Ethem, Introduction to Machine Learning, PHI Learning Pvt. Ltd.
2. M. Evangelia, Supervised and Unsupervised Pattern Recognition, CRC Press.
3. C. Bishop, Neural Networks for Pattern Recognition, Oxford University Press.
4. G. James, D. Witten, T. Hastie, R. Tibshirani, Introduction to Statistical Learning, Springer.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC103	**Mathematical Foundations of Data Science**	04	-	-	04	-	-	04
		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

This course will introduce students to the fundamental mathematical concepts required for applying data science.

Course Outcomes:

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

1. Understand the importance of linear algebra, statistics and probability from data science perspective.
2. Understand the elements of structured data and data distribution for binary as well as categorical data.
3. Apply the knowledge of sampling and distribution algorithms to evaluate the real distribution of sampling data.
4. Apply the knowledge of significance testing, use of null value hypothesis to outline the conditions for a particular test.
5. Evaluate and analyze the results of confusion matrix.
6. Apply optimization techniques for improvising performance.

Prerequisites: Fundamentals of Probability and Statistics.

Sr. No.	Module	Detailed Content	Hours
1	Basics of Data Science	Introduction; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems; Probability, Statistics and Random Processes: Probability theory and axioms; Random variables.	8
2	Linear Algebra	Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures.	8
3	Exploratory Data Analysis	Elements of structured data; Estimates of location; Estimates of variability; Expectations and moments; Exploring the data distribution; Exploring binary and categorical data; Covariance and correlation; Exploring two or more variables.	8
4	Data and Sampling Distributions	Random sampling and sample bias; Selection bias; Central limit theorem; Standard error; Bootstrap;	8

		Confidence intervals; Normal distribution; Long-tailed distributions; Student's t-distribution; Binomial distribution; Poisson distributions; Exponential distribution; Weibull distribution; Fitting a model.	
5	Statistics and Significance Testing	Hypothesis tests; A/B testing; Chi-square test; confidence intervals; p-values; ANOVA; t-test; Confidence (statistical) intervals; Degrees of freedom; White-noise process.	8
6	Evaluation and Optimization	Mathematics in algorithmic performance evaluation: Confusion matrix; Precision; Recall; Specificity; ROC Curve; AUC; Lift; Optimization: Global and local optima; Unconstrained and constrained optimization; Introduction to least squares optimization.	8

Text Books:

1. P. Bruce and A. Bruce, Practical Statistics for Data Scientists: 50 Essential Concepts, O'Reilly.
2. C. O'Neil and R. Schutt, Doing Data Science, O'Reilly.

Reference Books:

1. G. Strang, Introduction to Linear Algebra, 5th edition, Wellesley-Cambridge Press, USA.
2. W. Hines, D. Montgomery, D. Goldman, C. Borror, Probability and Statistics in Engineering, Wiley India Pvt. Ltd.
3. A. Agresti, C. Franklin, B. Klingenberg, Statistics: The Art and Science of Learning from Data, Global Edition, Pearson.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO1011	**Computer Vision**	04	-	-	04	-	-	04

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To review image processing techniques for computer vision.
2. To understand shape and region analysis.
3. To understand Hough Transform and its applications to detect lines, circles, ellipses.
4. To understand three-dimensional image analysis techniques.
5. To understand motion analysis.
6. To implement computer vision algorithms for real-world problems.

Course Outcomes:

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

1. Understand and apply fundamental image processing techniques required for computer vision.
2. Analyze shapes and regions.
3. Apply Hough Transform for line, circle, and ellipse detections.
4. Understand and analyze 3D vision techniques.
5. Understand motion analysis.
6. Develop applications using computer vision techniques.

Prerequisites: Fundamentals of Image Processing.

Sr. No.	Module	Detailed Content	Hours
1	Image Processing Foundations	Review of image processing techniques; classical filtering operations; thresholding techniques; edge detection techniques; corner and interest point detection; mathematical morphology; texture.	9
2	Shapes And Regions	Binary shape analysis; connectedness; object labelling and counting; size filtering; distance functions; skeletons and thinning; deformable shape analysis; boundary tracking procedures; active contours; shape models and shape recognition; centroidal profiles; handling occlusion; boundary length measures; boundary descriptors; chain codes; Fourier descriptors; region descriptors; moments.	9
3	Hough Transform	Line detection; Hough Transform (HT) for line detection; foot-of-normal method; line localization; line fitting; RANSAC for straight line detection; HT based circular object detection; accurate centre location; speed problem; ellipse detection; Case	9

			study: Human Iris location; hole detection; generalized Hough Transform (GHT); spatial matched filtering; GHT for ellipse detection; object location; GHT for feature collation.	
4	3D Vision		Methods for 3D vision; projection schemes; shape from shading; photometric stereo; shape from texture; shape from focus; active range finding; surface representations; point-based representation; volumetric representations; 3D object recognition; 3D reconstruction.	9
5	Introduction To Motion		Triangulation; bundle adjustment; translational alignment; parametric motion; spline-based motion; optical flow; layered motion	6
6	Applications and Case Studies		Implementation of application like face detection, face recognition, eigen faces, surveillance, foreground-background separation, particle filters, Chamfer matching, tracking, and occlusion; combining views from multiple cameras; human gait analysis; locating roadway; road markings; identifying road signs; locating pedestrians, etc.; Case Studies and recent researches in Computer Vision.	6

Text Books:

1. D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education.
2. J. Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images, O'Reilly.

Reference Books:

1. M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, 3rd Edition, Academic Press.
2. R. Jain, R. Kasturi, B. Schunck, Machine Vision, Indo American Books.
3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer.
4. S. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO1012	**Natural Language Processing**	04	-	-	04	-	-	04

		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

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.
4. To enable students to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes:

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.
6. Implement proper experimental methodology for training and evaluating empirical NLP systems.

Prerequisites: Fundamentals of Mathematics and Computer Programming skills.

Sr. No.	Module	Detailed Content	Hours
1	Introduction	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
2	Words & Word Forms	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
3	Syntax Passing	Part-of-Speech tagging (POS); Lexical syntax tag set for English (Penn Treebank); Rule based POS tagging; Stochastic POS tagging; Issues: Multiple tags & words,	8

		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.	
4	Semantic Analysis	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
5	Discourse	Discourse reference resolution; Reference phenomenon; Syntactic & semantic constraints on co reference; Preferences in pronoun interpretation; Algorithm for pronoun resolution; Text coherence; Discourse structure.	8
6	Applications and Case Studies	Implementation of applications like Machine translation, Information retrieval, Question answers system, Categorization, Summarization; Sentiment analysis; Case Studies and recent researches in Natural Language Processing	6

Text Books:

1. A. Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly.
2. T. Siddiqui, Natural Language Processing and Information Retrieval, Oxford University Press.
3. S. Bird, Natural Language Processing with Python, 1st edition, O'Reilly.

Reference Books:

1. D. Rao and B. McMahan, Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning, O'Reilly.
2. D. Jurafsky and J. Martin, Speech and Language Processing, 2nd edition, Prentice Hall.
3. A. Kao, Natural Language Processing and Text Mining, Elsevier.
4. A. James, Natural Language Understanding, 2nd edition, Pearson

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO1013	Design and Analysis of Algorithms	04	-	-	04	-	-	04

		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

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.
5. To study about NP Completeness of problems.
6. To analyze the running time and space complexity of algorithms.

Course Outcomes:

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.
4. Design algorithms using greedy, dynamic and string-matching algorithms to solve real-life problems.
5. Implement parallel algorithms for suitable applications.
6. Understand concepts of NP-completeness and evaluate algorithms accordingly.

Prerequisites: Data Structures, Programming skills.

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Analysis of Algorithms	Design and analysis fundamentals; Performance analysis: space and time complexity; Growth of a function: Asymptotic notation; Mathematical background for algorithm analysis, Recurrences: Substitution method, Recursion-tree method, Master method; Randomized algorithms.	8
2	Advanced Data Structures	B trees; B+ trees; 2-3 tree operations; Tries; Heap operations; AVL tree; Huffman code; Heap operations; Topological sort; Analysis of all problems.	8
3	Greedy and Dynamic Algorithms	Characteristics of greedy algorithms; Problem solving using greedy algorithms: Job scheduling problem, Graph travelling and colouring problem, Knapsack problem, Matrix Chain Multiplication problem; The principle of optimality for dynamic programming; Problem solving using dynamic	10

		algorithms: Making change problem, Assembly line scheduling, Knapsack problem, Matrix chain multiplication problem; Analysis of all problems.	
4	Parallel Algorithms	Sequential vs. Parallel Algorithms; Models: Data parallel model, Task graph model, Work pool model, Master slave model, Producer consumer or pipeline model; Hybrid model; Speedup and efficiency; Examples of parallel algorithms: Parallel sorting, Parallel matrix chain multiplication; Analysis of all problems.	8
5	Applied Algorithms	String matching algorithms: The naive string-matching algorithm, The Rabin-Karp algorithm, String Matching with finite automata, The Knuth-Morris-Pratt algorithm, Longest Common Subsequence; Randomized Algorithms: Monte Carlo and Las Vegas algorithms; Analysis of artificial intelligence algorithms: Decision tree classifier, Neural networks.	8
6	NP-Completeness and Approximation Algorithms	Introduction to NP-Completeness: The class P and NP, NP-Complete, NP-Hard, NP-Completeness and reducibility; Approximation algorithms: Vertex-cover problem, Traveling-salesman problem.	6

Text Books:

1. T. Cormen, C. Leiserson, R Rivest and C. Stein, Introduction to Algorithms, 3rd edition, Prentice Hall.
2. G. Brassard, P. Bratley, Fundamental of Algorithms, PHI.

Reference Books:

1. A. Levitin, Introduction to Design and Analysis of Algorithms, Pearson.
2. S. Basu, Design Methods and Analysis of Algorithm, PHI.
3. A. Bhargava, Grokking Algorithms: An illustrated guide for programmers and other curious people, Manning Publications.
4. A. Basheer, M. Zaghlool, FPGA-Based High Performance Parallel Computing, Scholars' Press.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO1014	**Information Retrieval**	04	-	-	04	-	-	04
		Examination Scheme						
		Theory						
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Prac**	**Total**
		Test 1	**Test 2**	**Avg**					
		20	20	20	80	03	-	-	100

Course Objectives:

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.
4. To understand the concepts of digital libraries and image retrieval.

Course Outcomes:

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.
5. Apply image retrieval techniques while developing solutions to real-world problems.
6. Create an information retrieval system using the available tools.

Prerequisites: Database Management Systems

Sr. No.	Module	Detailed Content	Hours
1	Introduction	Basic concepts; Practical issues; Retrieval process; Architecture; Boolean retrieval; Retrieval evaluation; Open source retrieval systems; History of web search; Web characteristics; Impact of the web on information retrieval; Information retrieval versus web search; Components of a search engine.	6
2	Retrieval Models	Taxonomy and characterization of information retrieval models: Boolean model, Vector model; Term weighting; Scoring and ranking; Language models; Set theoretic models; Probabilistic models; Algebraic models; Structured text retrieval models; Models for browsing.	8
3	Indexing	Static and dynamic inverted indices; Index construction and index compression; Searching; Sequential searching and pattern matching; Query operations; Query	10

		languages; Query processing; Relevance feedback and query expansion; Automatic local and global analysis; Measuring effectiveness and efficiency.	
4	Classification and Clustering	Text classification and Naïve Bayes; Vector space classification; Support vector machines and Machine learning on documents; Flat clustering; Hierarchical clustering; Matrix decompositions and latent semantic indexing; Fusion and meta learning.	8
5	Searching the Web	Searching the web; Structure of the web; IR and web search; Static and dynamic Ranking; Web crawling and indexing; Link analysis; XML retrieval; Multimedia IR: Models and languages; Indexing and searching; Parallel and distributed IR; Digital libraries.	8
6	Image Retrieval	Introduction to content-based image retrieval; Challenges in image retrieval; Image representation; Indexing and retrieving images; Relevance feedback.	8

Text Books:

1. C. Manning, P. Raghavan, H. Schutze, Introduction to Information Retrieval, First South Asian Edition, Cambridge University Press.
2. R. B. Yates, B. R. Neto, Modern Information Retrieval: The concepts and Technology behind Search, 2nd edition, ACM Press Books.

Reference Books:

1. S. Büttcher, C. Clarke and G. Cormack, Information Retrieval - Implementing and Evaluating Search Engines, MIT Press
2. R. Korfhage, Information Storage and Retrieval, Wiley.
3. P. Paliwal, S. Balakrishnan, Principles of Information Retrieval, Anmol Publications Pvt. Ltd.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO1015	**Blockchain**	04	-	-	04	-	-	04

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

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.

Course Outcomes:

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, Hyperledger or Azure.

Prerequisites: Cryptography.

Sr. No.	Module	Detailed Content	Hours
1	Basics	Identifying the problems with current infrastructure; Understanding Centralised Practises, Policies & Business; Businesses with Decentralised 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.	6
2	Cryptography	Block Ciphers; Encryptions; Secret Keys; Elliptic Curve Cryptography; Hash cryptography; Encryption vs hashing; Digital Signature; Memory Hard Algorithm, Zero Knowledge Proof.	6
3	Blockchain Concepts	Introduction: Transactions, blocks, hashes, consensus, verify and confirm blocks, peer to peer networks, blocks of data in a chain, decentralisation of networks, processes & workflows, cryptocurrencies, nodes, assets, consensus, dapps; types of blockchain; chain policy; working of blockchain; life of blockchain application; privacy,	10

4	Blockchain Implementation	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
		anonymity and security of blockchain.	
5	Smart Contracts	History; Distributed ledger; Smart contracts; Cryptocurrency; Bitcoin protocols; Mining strategy and rewards; Ethereum – construction; DAO; GHOST; Vulnerability; Attacks; Sidechain; Namecoin.	8
6	Use Cases	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.	8

Text Books:

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.

Reference Books:

1. M. Swan, Blockchain: Blueprint for a New Economy, O'Reilly.
2. R. Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing.
3. R. Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing.
4. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1011	**Product Life Cycle Management**	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:
1. To familiarize the students with the need, benefits and components of PLM.
2. To acquaint students with Product Data Management & PLM strategies.
3. To give insights into new product development program and guidelines for designing and developing a product.
4. To familiarize the students with Virtual Product Development.

Course Outcomes:

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

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.

Sr. No.	Detailed Content	Hours
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM.	10
2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and their use in the Design Process.	9

3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM. system, financial justification of PDM, barriers to PDM implementation.	5
4	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies.	5
5	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	5
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	5

References:

1. J. Stark, Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN: 1852338105.
2. F. Giudice, G. Rosa, Antonino Risitano, Product Design for the environment - A life cycle approach, Taylor & Francis 2006, ISBN: 0849327229.
3. S. Antti, I. Anselmie, Product Life Cycle Management, Springer, Dreamtech, ISBN: 3540257314.
4. M. Grieve, Product Lifecycle Management: Driving the next generation of lean thinking, Tata McGraw Hill, 2006, ISBN: 0070636265.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1012	**Reliability Engineering**	03	-	-	03	-	-	03

		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure.

Course Outcomes:

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

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis.

Sr. No.	Detailed Content	Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Bayes Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	8
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	8
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	5
4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	8
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics,	5

	Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	5

References:

1. L. Srinath, Reliability Engineering, Affiliated East-West Press (P) Ltd., 1985.
2. C. Ebeling, Reliability and Maintainability Engineering, Tata McGraw Hill.
3. B. Dhillion, C. Singh, Engineering Reliability, John Wiley & Sons, 1980.
4. P.D.T. Conor, Practical Reliability Engineering, John Wiley & Sons, 1985.
5. K. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons.
6. M. Spiegel, Probability and Statistics, Tata McGraw-Hill Publishing Co. Ltd.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1013	**Management Information System**	03	-	-	03	-	-	03
		Examination Scheme						
		Theory						
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Prac**
		Test 1	**Test 2**	**Avg**				
		20	20	20	80	03	-	-

Note: The last table structure includes a final "Total" of 100.

Course Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built.
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage.
4. Identify the basic steps in systems development.

Course Outcomes:

Upon completion of the course, the learners will be able to:
1. Explain how information systems Transform Business.
2. Identify the impact information systems have on an organization.
3. Describe IT infrastructure and its components and its current trends.
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making.
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.

Sr. No.	Detailed Content	Hours
1	Introduction to Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
2	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
3	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
4	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
5	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
6	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

References:

1. K. Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1014	**Design of Experiments**	03	-	-	03	-	-	03

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand the issues and principles of Design of Experiments (DOE).
2. To list the guidelines for designing experiments.
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization.

Course Outcomes:

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

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
2. Apply the methods taught to real life situations.
3. Plan, analyze, and interpret the results of experiments.

Sr. No.	Detailed Content	Hours
1	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	6
2	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	8
3	**Two-Level Factorial Designs:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.	7
4	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	7
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	7
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	4

References:

1. R. Mayers, D. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. G. Box, J. Hunter, W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W. Diamond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. A. Dean, and D. Voss, Design and Analysis of Experiments (Springer text in Statistics), Springer
6. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill.
7. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1015	**Operations Research**	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO1015	**Operations Research**	20	20	20	80	03	-	-	100

Course Objectives:

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

Course Outcomes:

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

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

Sr. No.	Detailed Content	Hours
1	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research. **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis. **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem. **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique.	14

	Introduction to Decomposition algorithms.	
2	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	5
3	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	5
4	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	5
5	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	5
6	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model.	5

References:

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

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1016	**Cyber Security and Laws**	03	-	-	03	-	-	03

ILO1016	**Cyber Security and Laws**	Examination Scheme							

	Examination Scheme							
	Theory					TW	Oral/ Prac	Total
	Internal			End Sem. Exam	Exam Duration (in Hrs)			
	Test 1	Test 2	Avg					
	20	20	20	80	03	-	-	100

Course Objectives:

1. To understand and identify different types cybercrime and cyber law.
2. To recognized Indian IT Act 2008 and its latest amendments.
3. To learn various types of security standards compliances.

Course Outcomes:

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

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development.

Sr. No.	Detailed Content	Hours
1	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
2	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	9
3	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft).	6
4	**The Concept of Cyberspace:** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law.	8
5	**Indian IT Act:** Cyber Crime and Criminal Justice: Penalties, Adjudication and	6

| 6 | **Information Security Standard compliances:** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI. | 6 |

Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments.

References:

1. N. Godbole, S. Belapure, Cyber Security, Wiley India, New Delhi.
2. S. Vishwanathan, The Indian Cyber Law; Bharat Law House New Delhi.
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. P. Mali, Cyber Law & Cyber Crimes; Snow White Publications, Mumbai.
5. K. Knapp, Cyber Security & Global Information Assurance, Information Science Publishing.
6. W. Stallings, Cryptography and Network Security, Pearson Publication
7. Websites for more information: The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
8. Website for more information: A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1017	**Disaster Management and Mitigation Measures**	03	-	-	03	-	-	03

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand physics and various types of disaster occurring around the world.
2. To identify extent and damaging capacity of a disaster.
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster.
5. To understand application of GIS in the field of disaster management.
6. To understand the emergency government response structures before, during and after disaster.

Course Outcomes:

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

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Content	Hours
1	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	3
2	Natural Disaster and Manmade disasters: 3.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 3.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	9
3	Disaster Management, Policy and Administration: 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	6

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	6
5	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	9
6	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	6

References:

1. H. Gupta Disaster Management, Universities Press Publications.
2. O. Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for land warfare studies, New Delhi, 2011.
3. D. Copolla, B. Heinemann, Introduction to International Disaster Management, Elsevier Publications.
4. J. Pinkowski, Disaster Management Handbook, CRC Press, Taylor and Francis group.
5. R. Dasgupta, Disaster management & rehabilitation, Mittal Publications, New Delhi.
6. R. Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.
7. C. Albert, K. Yonng, Concepts and Techniques of GIS, Prentice Hall (India) Publications.
(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Internal Assessment:
Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO1018	**Energy Audit and Management**	03	-	-	03	-	-	03

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes:

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

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures.

Sr. No.	Detailed Content	Hours
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance.	4
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR).	8

3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	4
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	3

References:

1. G. Stokes, Handbook of Electrical Installation Practice, Blackwell Science.
2. A. Valia, Designing with light: Lighting Handbook, Lighting System.
3. W. Turner, Energy Management Handbook, John Wiley and Sons.
4. A. K. Tyagi, Handbook on Energy Audits and Management, Tata Energy Research Institute (TERI).
5. C. Smith, Energy Management Principles, Pergamon Press.
6. D. Patrick, S. Ray and E. Richardson, Energy Conservation Guidebook, Fairmont Press
7. A. Thumann, W. Younger, T. Niehus, Handbook of Energy Audits, CRC Press.
8. Website: www.energymanagertraining.com; www.bee-india.nic.in.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIL101	**AI Programming Lab**	-	02	-	-	01	-	01
		Examination Scheme						
		Theory						
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Prac**	**Total**
		Test 1	**Test 2**	**Avg**				
		-	-	-	-	-	25	25	50

Practical sessions based on the courses MEAIC101 and MEAIC102 will be conducted in this laboratory. Implementation of AI and Soft Computing techniques to understand, analyse, compare and visualize the performance of the induced models will be done using Python with Pytorch, Numpy, NLTK, Scikit-learn, etc. packages and MATLAB.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIL102	**Data Science Lab**	-	02	-	-	01	-	01
		Examination Scheme						
		Theory						
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Prac**	**Total**
		Test 1	**Test 2**	**Avg**				
		-	-	-	-	-	25	25	50

Practical sessions based on the courses MEAIC102 and MEAIC103 will be conducted in this laboratory. Implementation of Exploratory data analysis, Statistical techniques, Evaluation methods, Machine Learning and Data Science techniques will be done using R, MATLAB, Python, Weka.

End Semester Examination:
Practical/Oral examination for both laboratories is to be conducted by a pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC201	Deep and Reinforcement Learning	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

To understand the foundations of deep learning, reinforcement learning, and deep reinforcement learning including the ability to successfully implement, apply and test relevant learning algorithms in TensorFlow.

Course Outcomes:

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. Apply optimization and regularization techniques to train deep neural networks.
4. Construct and train convolutional, recurrent and recursive neural networks.
5. Implement and apply reinforcement learning algorithms.
6. Analyze real-world problems for solutions using deep and reinforcement learning.

Prerequisites: Fundamentals of Neural Networks and Mathematics.

Sr. No.	Module	Detailed Content	Hours
1	Foundations of Deep learning	Introduction to Neural Networks; Shallow Neural Networks; Deep Neural Networks; Recurrent Neural Networks; Reinforcement Learning; Successful application examples; Fundamental principles and techniques to Deep Learning and Reinforcement Learning.	6
2	Neural Networks in Deep learning	Deep Feedforward Networks: Example of Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms; Regularization techniques for deep learning; Optimization for Training Deep Models.	8
3	Convolutional neural networks, Recurrent and recursive neural networks	Convolutional neural networks (CNN): Fundamentals, Properties of CNN representations, Need, Architecture, Building CNN; Sequence Modelling: Recurrent and Recursive Nets, Unfolding Computational Graphs, Deep Recurrent Networks, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-	10

		to-Sequence Architectures, Recursive Neural Networks, Echo State Networks.	
4	Reinforcement Learning	Fundamentals of Reinforcement Learning; Agent environment framework; Successes of reinforcement learning; Bandit problems and online learning; Markov decision processes; Returns and value functions	8
5	Algorithms for Reinforcement Learning	Dynamic programming algorithms for reinforcement learning; Monte Carlo methods for reinforcement learning; Temporal-Difference Learning	8
6	Deep Reinforcement Learning and Case Studies	Fundamentals and applications of Deep Reinforcement Learning; Case studies of deep learning applications; Case studies of reinforcement learning applications; Active research topics in deep and reinforcement learning	8

Text Books:

1. I. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press.
2. R. Sutton and A. Barto Reinforcement Learning: An Introduction, MIT Press.

Reference Books:

1. S. Ravichandiran, Hands-on Reinforcement Learning with Python, Packt Publishing.
2. N. Buduma, N. Locascio, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly.
3. G. Ciaburro, Keras Reinforcement Learning Projects, Packt Publishing.
4. C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC202	Big Data Analytics	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To implement methods for big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, MapReduce, etc.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.
5. To understand the issues in privacy-preservation and handling data streams.

Course Outcomes:

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

1. Analyze the key issues in data science and its associated applications in intelligent business and scientific computing.
2. Understand and apply the methods of big data analytics.
3. Investigate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
4. Implement big data analytics using Hadoop, Map Reduce, NOSQL, etc.
5. Understand the fundamentals of privacy-preservation in data analytics.
6. Implement the concepts of data stream mining using MOA.

Prerequisites: Database Management Systems, Fundamentals of Data Mining.

Sr. No.	Module	Detailed Content	Hours
1	Introduction	Business Intelligence vs Data Science vs Big Data Analytics; Data warehouse; Data mining: Introduction, Knowledge discovery from data, Data pre-processing, Classification, Clustering, Prediction, Association, Recent applications of data mining methods; Decision support system (DSS) and its components; Business intelligence.	6
2	Big Data Analytics	Introduction; Distributed file system; Big data and its importance; Four Vs; Drivers for Big data; Hadoop; Big data analytics; Big data applications like recommender systems, social media applications, etc.; Recent research in big data analytics.	8
3	Hadoop for Data	Apache Hadoop & Hadoop ecosystem; Hadoop	10

		distributed file system (HDFS); Architecture of HDFS; Architectural assumptions and goals; Moving data in and out of Hadoop.	
	Analytics		
4	Big Data Processing	Use of MapReduce; Architecture of the MapReduce framework; Phases of a MapReduce job; MapReduce design patterns; YARN architecture; Algorithms using map reduce; Exploration of Pig, Hive and Oozie, NOSQL.	8
5	Privacy and Data Science	Significance of Privacy and Ethics in Application of Data Science; Reidentification of Anonymous People with Big Data, Privacy-preserving data mining algorithms, Data Partitioning and Privacy; Recent research in privacy-preserving data mining.	8
6	Data Streams	Static data, incremental data and data streams; Storage and Processing of Data Streams; Algorithms for Data Stream Mining: Hoeffding tree, Windowing, MOA for data stream mining; Recent research in data stream mining.	8

Text Books:

1. A. Maheshwari, Big Data, McGraw Hill.
2. T. White, Hadoop: The Definitive Guide, 3rd edition, O'reily Media.

Reference Books:

1. A. Bifet, R. Gavaldà, G. Holmes, B. Pfahringer, F. Bach, Machine Learning for Data Streams – with Practical Examples in MOA, MIT Press.
2. S. Acharya and S. Chellappan, Big Data Analytics, Wiley.
3. C. Aggarwal and P. Yu, Privacy-Preserving Data Mining - Models and Algorithms, Springer.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIC203	Bio-inspired Artificial Intelligence	04	-	-	04	-	-	04

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

To course will provide a motivation to learn bio-inspired algorithms and will impart knowledge of various bio-inspired AI algorithms.

Course Outcomes:

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

1. Understand the principles of bio-inspired algorithms.
2. Apply evolutionary algorithms to optimize solutions for real-world problems.
3. Develop optimized solutions using algorithms like ACO.
4. Understand the applications of immune systems and apply it in suitable situations.
5. Apply swarm intelligence to develop solutions for real-world problems.
6. Investigate about cutting edge research that uses bio-inspired algorithms.

Prerequisites: Fundamentals of Artificial Intelligence

Sr. No.	Module	Detailed Content	Hours
1	Introduction	From nature to nature-inspired computing; Bio-inspired computing; Multi-objective optimization; Artificial life; Constraint handling; Artificial neural networks.	6
2	Evolutionary Computing	Foundation of evolutionary theory; Evolutionary strategies; Evolutionary algorithms: Genetic algorithm and Genetic programming; Representations; Initial population; Fitness function; Selection and reproduction; Genetic operators (Selection, Crossover, Mutation); Elitism; Parallel implementations; Adaptive genetic algorithm.	8
3	Collective Systems	Ant colony optimization: Ant foraging behaviour; Theoretical considerations; Convergence proofs; ACO algorithm; ACO and model-based search; Variations of ACO; Artificial bee colony (ABC) Optimization: Behaviour of real bees, ABC algorithm, Variations of ABC.	10
4	Immune Systems	Introduction; Artificial immune systems: Biological motivation, Design principles; Main types of algorithms: Bone marrow, Negative selection, Clonal selection; Continuous immune network models; Discrete immune network models; Scope of artificial immune systems.	8
5	Swarm	Particle swarm optimization: Principles of bird flocking and	8

6	Case Studies	Case Studies and recent research in bio-inspired artificial intelligence.	8

Table continues with Module 5 content at top:

Intelligence and Other Algorithms | fish schooling; Evolution of PSO; Operating principles, PSO algorithm, Neighbourhood topologies, Convergence criteria, Variations of PSO; Overview of other bio-inspired algorithms: Harmony Search, Honey-Bee Optimization, Memetic Algorithms, Co-evolution.

Text Books:

1. D. Floreano and C. Mattiussi, Bio-inspired Artificial Intelligence, MIT Press.
2. S. Olariu and A. Zomaya, Handbook of Bioinspired Algorithms and Applications, Chapman and Hall/CRC.

Reference Books:

1. K. Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley.
2. D. Marco, S. Thomas, Ant Colony Optimization, Prentice Hall India Learning Pvt. Ltd.
3. R. Chiong, Nature-Inspired Algorithms for Optimization, Springer.
4. N. Arana-Daniel, C. Lopez-Franco A. Alanis, Bio-inspired Algorithms for Engineering, Elsevier.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2021	Artificial Intelligence in Bioinformatics	04	-	-	04	-	-	04

		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg				
		20	20	20	80	03	-	-	100

Course Objectives:

This course introduces the concepts and state-of-the-art research in bioinformatics, data mining and AI especially for medical application.

Course Outcomes:

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

1. Understand the concepts of molecular biology, DNA analysis with respect to data processing.
2. Analyze biological sequences and score matrices with respect to data processing.
3. Implement data mining algorithms on microarray, gene expression, feature selection for proteomic and genomic data.
4. Understand ethics in using bioinformatics.
5. Apply AI in medical field for development of contributive solutions.
6. Investigate state-of-the-art research and developments in bioinformatics.

Prerequisites: Fundamentals of Artificial Intelligence

Sr. No.	Module	Detailed Content	Hours
1	Introduction	Introduction to Bioinformatics and Data Mining; Molecular Biology background: Analysing DNA; Bioinformatics perspective of how individuals of a species differ and how different species differ; Bioinformatics challenges and opportunities.	6
2	Biological Sequence Analysis	DNA sequence analysis; DNA databases; Protein structure and function; Protein sequence databases; Sequence alignment; Sequence comparison, Sequence similarity search; Longest common subsequence problem; Scoring matrices for similarity search PAM, BLOSUM, etc.	8
3	Mining Biological Data	Protein structural classification; Protein structural prediction; Modeling text retrieval in biomedicine; Mining from microarray and gene expressions; Feature selection for proteomic and genomic data mining.	10
4	Ethics in Bioinformatics	Ethical and social challenges of electronic health information; Public access to anatomic images; Evidence-based medicine; Outcome measures and practice guidelines for using data mining in medicine; Computer assisted medical and patient education.	8

5	AI in Medical Informatics	Infectious disease informatics and outbreak detection; Identification of biological Relationships from text documents; Medical expert systems; Telemedicine and tele surgery; Internet grateful med (IGM).	8
6	Case Studies	Case Studies and recent research in application of artificial intelligence in bioinformatics.	8

Text Books:

1. S. Rastogi, N. Mendiratta and P. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, PHI.
2. Z. Ghosh, B. Mallick, Bioinformatics: Principles and Applications, Oxford University Press.

Reference Books:

1. J. Chen and S. Lonardi, Biological Data Mining, Chapman and Hall/CRC.
2. V. Buffalo, Bioinformatics Data Skills, O′Reilly Publishing.
3. H. Zengyou, Data Mining for Bioinformatics Applications, Woodhead Publishing.
4. L. Low, Bioinformatics: A Practical Handbook of Next Generation Sequencing and its Applications, World Scientific Publishing.
5. M. Model, Bioinformatics Programming Using Python, O′Reilly Publishing.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2022	IoT Data Analytics	04	-	-	04	-	-	04

Examination Scheme							
Theory					TW	Oral/ Prac	Total
Internal			End Sem. Exam	Exam Duration (in Hrs)			
Test 1	Test 2	Avg					
20	20	20	80	03	-	-	100

Course Objectives:

1. To understand the significance of the Internet of Things Data Analytics.
2. To discuss the architecture, operation, and business benefits of an IoT solution.
3. To explore the relationship between IoT, cloud computing, and big data.

Course Outcomes:

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

1. Understand the fundamentals of IoT and IoT Data Analytics.
2. Apply the design protocols of IoT in addition to protecting the privacy and trust of a network.
3. Analyze and evaluate the use of IoT Analytics in several dominating application areas.
4. Create solutions for Smart Homes, Smart Environmental Care and Smart Travelling using IoT Data Analytics.
5. Develop solutions for Smart Agriculture using IoT Data Analytics.
6. Design solutions for Smart Healthcare using IoT Data Analytics.

Prerequisites: Fundamentals of Internet of Things and Data Analytics.

Sr. No.	Module	Detailed Content	Hours
1	Data Science and IoT	Fundamentals of data analytics, Android programming, Web programming, Internet of Things (IoT); Characteristics of IoT, IoT vision, Application areas of IoT; IoT Technology: Architectural overview, Components of IoT, Devices and Gateways, Local and wide area networking, IoT data collection, storage, processing and analytics, data management in IoT, IoT analytics; AI and IoT ecosystem; Cloud-based IoT analytics; IoT and big data; Challenges in IoT data analytics applications.	10
2	Design Principles of IoT	Design principles for connected devices; IoT system layers and design standardization; networking technology in IoT; protocols in IoT; security, privacy and Trust in IoT.	6
3	IoT Data Analytics in Smart Homes	Introduction; IoT Data Analytics techniques for: Security and Surveillance, Energy Conservation; Recent research in IoT data analytics for smart homes.	6
4	IoT Data Analytics in Smart Agriculture	Introduction; IoT Data Analytics techniques for: Weather prediction, Demand pricing, Disease prediction, Crop yield prediction; Recent research in IoT data analytics for smart travelling.	8

| 5 | IoT Data Analytics in Smart Healthcare | Introduction; IoT Data Analytics techniques for: Remote health monitoring, Remote medical assistance, Data assortment, transfer and analysis, Tracking and alerts; Recent research in IoT data analytics for smart healthcare. | 8 |
| 6 | IoT Data Analytics in Smart Environmental Care and Smart Travelling | Introduction and need of environmental care, IoT Data Analytics techniques for: Fire detection, Air pollution prediction, Earthquake early detection; Recent research in IoT data analytics for smart environmental care. Introduction and need of smart travelling: IoT Data Analytics techniques for: Self-driving cars, Travel route optimization, Smart traffic management; Recent research in IoT data analytics for smart travelling. | 10 |

Text Books:

1. H. David, S. Gonzalo, G. Patrick, B. Rob, H. Jerome, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Pearson.
2. A. Minteer, Analytics for the Internet of Things (IoT) - Intelligent analytics for your intelligent devices, Packt Publishing Ltd.

Reference Books:

1. N. Wilkins, Internet of Things: What You Need to Know about Iot, Big Data, Predictive Analytics, Artificial Intelligence, Machine Learning, Cybersecurity, Business Intelligence, Augmented Reality and our Future, IP.
2. J. Soldatos, Building Blocks for IoT Analytics, River Publishers.
3. H. Geng, Internet of Things and Data Analytics Handbook, Wiley.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2023	**Speech Recognition**	04	-	-	04	-	-	04

Examination Scheme							
Theory					TW	Oral/ Prac	Total
Internal			End Sem. Exam	Exam Duration (in Hrs)			
Test 1	Test 2	Avg					
20	20	20	80	03	-	-	100

Course Objectives:

1. To introduce speech production and related parameters of speech.
2. To show the computation and use of techniques such as short time Fourier transform, linear predictive coefficients and other coefficients in the analysis of speech.
3. To understand different speech modeling procedures such as Markov and their implementation issues.

Course Outcomes:

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

1. Understand the basic concepts of speech and fundamental signal processing approaches to speech spectral analysis.
2. Analyze various features of speech and understand the techniques of extracting the features and pattern comparison techniques.
3. Apply statistical modeling techniques.
4. Understand the architecture and various models of continuous speech recognition system.
5. Apply methods of text to speech synthesis for different applications.
6. Investigate recent developments in speech recognition.

Prerequisites: Fundamentals of Artificial Intelligence and Signal Processing.

Sr. No.	Module	Detailed Content	Hours
1	Basic Concepts	Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics, Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.	10
2	Speech Analysis	Features; Feature Extraction and Pattern Comparison Techniques; Speech distortion measures– mathematical and perceptual, Log, Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering; Likelihood Distortions; Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients; Time Alignment and Normalization; Dynamic Time Warping, Multiple Time, Alignment Paths.	6
3	Speech Modelling	Hidden Markov Models: Markov Processes, HMMs, Evaluation, Optimal State Sequence, Viterbi Search,	6

		Baum-Welch Parameter Re-estimation; Implementation issues.	
4	Speech Recognition	Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system, acoustics and language models, n-grams, context dependent sub-word units; Applications and present status.	8
5	Speech Synthesis	Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness; role of prosody; applications and current status.	8
6	Case Studies	Case Studies and recent research in speech processing	10

Text Books:

1. L. Rabiner and B. Juang, Fundamentals of Speech Recognition, Pearson Education.
2. D. Jurafsky and J. Martin, Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson Education.

Reference Books:

1. S. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, California Technical Publishing.
2. T. Quatieri, Discrete-Time Speech Signal Processing – Principles and Practice, Pearson Education.
3. C. Becchetti and L. Ricotti, Speech Recognition, John Wiley and Sons.
4. B. Gold and N. Morgan, Speech and Audio Signal Processing, Processing and Perception of Speech and Music, Wiley- India Edition.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2024	Autonomous Robotics	04	-	-	04	-	-	04

		Examination Scheme						
		Theory						
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

To introduce the concepts of autonomous robotics and familiarize learners with methods of modelling/analysis/control that have been proven efficient through research.

Course Outcomes:

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

1. Understand the fundamentals of robotics.
2. Understand and apply spatial descriptions, transformations and kinematics.
3. Construct trajectory and check collision.
4. Analyze and plan motion and path of motion.
5. Apply manipulation algorithms.
6. Develop applications using sensors and actuators.

Prerequisites: Fundamentals of Mathematics and Physics.

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Robots	Mobile robots; Robotic arms (manipulators); Mobile manipulators; Humanoid robots, drones, UGV, AGV, etc.; Basic terminologies to characterize robot: Degrees of Freedom, Joint Space, Cartesian Space, Cartesian-Time space.	4
2	Spatial Descriptions, Transformations, Kinematics and Inverse Kinematics	Positions, orientations, frames, Transformation between frames, Transformation arithmetic; Link description of robot arm, Link connection description, convention for affixing frames to links; Using DH parameters to compute forward kinematics; Using arithmetic or geometric approach for inverse kinematics; Tool Frame; Using toolkit like python KDL Orocos to find forward kinematics and inverse kinematics.	8
3	Trajectory Generation and Collision Checking	Joint space schemes, Cartesian space schemes, Singularities, Repeatability, Accuracy; Overview of Industrial robots like ABB or FANUC programming language; Collision checking using AABB, OBB, mesh-mesh intersection, Separation axis theorem; Collision checking in unknown environments using occupancy grid,	10

			OCT-tree, etc.	
4	Path Planning and Motion Planning Algorithms	Standard planning algorithms like visibility graph, C-Obstacles, PRM, etc. used for static environments; For dynamic environments, RRT and some of its variants, Real-time Adaptive Motion Planning (RAMP), etc.; Information spaces and information mappings, sensing uncertainty, POMDPs, Kalman filtering, particle filtering.	10
5	Manipulation Algorithms	Grasping: Analytical and Data Driven Models; Data Driven Models Configuration Spaces, etc.	6
6	Sensors and Actuators	Discrete and continuous sensors, reading from point cloud data using stereo-vision sensor or laser range finder, using sensor data for further collision checking; Obstacle detection using any computer vision algorithm, Understanding different type of actuators (joints), such as, DC Motors, Stepper motors, Servo motors, linear actuators, spherical joints, etc.	10

Text Books:

1. J. Craig, Introduction to Robotics: Mechanics and Control, Pearson.
2. S. LaValle, Planning Algorithms, Packt Publishing.

Reference Books:

1. G. Blokdyk, Robotics and Autonomous Vehicles, 3rd Edition, 5starcooks.
2. F. Lewis, S. Ge, Autonomous Mobile Robots: Sensing, Control, Decision Making and Applications, CRC Press.
3. M. Gilbert, Artificial Intelligence for Autonomous Networks, Chapman and Hall/CRC.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2025	**Mixed Reality**	04	-	-	04	-	-	04

		Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

To introduce the concepts of virtual reality, augmented reality & mixed reality and familiarize learners with the architecture and techniques for mixed reality.

Course Outcomes:

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

1. Understand the fundamentals of virtual, augmented and mixed reality.
2. Understand the architecture of mixed reality systems.
3. Analyze the vital techniques required to turn a vision into reality.
4. Apply mixed reality development tools for implementing various techniques of mixed reality.
5. Design MR interfaces.
6. Develop mixed reality systems for real-world applications.

Prerequisites: Computer Graphics, Fundamentals of Virtual Reality and Augmented Reality.

Sr. No.	Module	Detailed Content	Hours
1	Introduction	The Reality–Virtuality continuum; Virtual, augmented and mixed reality, an historical perspective; Industrial applicability of virtual, augmented and mixed reality; How do we perceive reality?; Fundamental concept and components of virtual augmented and mixed reality.	8
2	Architecture and Designing of MR systems	VR-AR-MR system architecture: Tracking system, Visual, aural, and haptic display; Design principles: From traditional UI design to mixed reality UI design; Usability guidelines: Space, scale and ergonomics of immersive environments, comfort and distress, gaze direction and comfort range test, motion sickness, simulator sickness, cyber sickness.	10
3	Techniques for Mixed Reality environments	Common interaction techniques for mixed reality environments: selection, manipulation, isomorphic vs. non- isomorphic, exocentric vs egocentric interaction; Common navigation techniques: physical locomotion techniques, target based techniques, steering.	8
4	MR Development Tools and Frameworks	Development Tools like X3D Standard / Vega / MultiGen / Virtools / WebVR / React360 / Vuforia / PTC / others.	6

5	MR Interface Designing	Common interface for MR: Menu design directions, haptic control panel, the interaction design process: advanced user interaction and manipulation, distant vs direct interaction, physical controls vs virtual controls; Performance of an interaction techniques: speed, accuracy and more.	10
6	Case Studies	Case studies, researches on application of MR for Medical, Education, Art and Entertainment, Military, Manufacturing, etc. fields.	6

Text Books:

1. S. Benford, Performing Mixed Reality, The MIT Press.
2. Y. Ohta, H. Tamura, Mixed Reality: Merging Real and Virtual Worlds, Springer.

Reference Books:

1. K. Varnum, Beyond Reality: Augmented, Virtual, and Mixed Reality in the Library, Amer Library Assn Editions.
2. J. Gwinner, Getting Started with React VR, Packt Publishing.
3. E. Pangilinan, S. Lukas, V. Mohan, Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing, O'Reilly Media.
4. R. Virk, The Simulation Hypothesis: An MIT Computer Scientist Shows Why AI, Quantum Physics and Eastern Mystics All Agree We Are in a Video Game, Bayview Books.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIDLO2026	**Robotics Process Automation**	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

This course aims at providing knowledge of basic concepts of Robotic Process Automation to students. It further builds on these concepts and introduces key RPA Design and Development strategies and methodologies specifically in context of UiPath products. The student undergoing the course shall develop the competence to design and develop a robot for a defined process.

Course Outcomes:

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

1. Understand basic programming concepts and its operation from RPA perspective.
2. Understand the basic concepts of Robotic Process Automation and its applications.
3. Develop familiarity and deep understanding of UiPath tools.
4. Apply automation to image, text, data tables, citrix, pdf, email, etc., execute exception handling and apply various functionalities of orchestrator.
5. Analyze opportunities of research in Artificial Intelligence with respect to RPA.
6. Design and create robots for business processes.

Prerequisites: Basic Programming skills

Sr. No.	Module	Detailed Content	Hours
1	Programming Fundamentals	Understanding the application; Basic Web Concepts; Protocols; Email Clients; Data Structures; Data Tables; Algorithms; Software Processes; Software Design; SDLC; Scripting; Net Framework; .Net Fundamentals; XML; Control structures and functions; XML; HTML; CSS; Variables & Arguments.	6
2	RPA Concepts	Fundamentals: History of Automation, Introduction to RPA, RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, Processes and workloads that can be Automated, Types of Bots; Advanced concepts: Standardization of processes, RPA Development methodologies, Difference from SDLC, Robotic control flow architecture, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem.	6
3	UiPath Introduction &	Introduction: Installing UiPath Studio community edition,	12

		The User Interface, Keyboard Shortcuts About Updating, About Automation Projects, Introduction to Automation Debugging, Managing Activation Packages, Reusing Automations Library, Installing the Chrome Extension; Variables; Control Flow; Data Manipulation; Recording and Advanced UI Interaction; Selectors.	
	Exploration		
4	UiPath Advanced Automation	Image, Text & Advanced Citrix Automation; Excel Data Tables & PDF; Email Automation; Debugging and Exception Handling; Project Organization; Orchestrator: Tenants, Authentication, Users, Roles, Robots, Environments, Queues & Transactions, Schedules.	10
5	Artificial Intelligence and RPA	Research on application of RPA for Machine Learning, Agent awareness, Natural Language Processing, Computer Vision, etc.	4
6	Case Studies and Projects	Case studies and projects on applying RPA for designing and developing robots for real-world problems.	10

Text Books:

1. A. Tripathi, Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots with the leading RPA tool – UiPath, Packt Publishing.
2. K. Wibbenmeyer, The Simple Implementation Guide to Robotic Process Automation (RPA): How to Best Implement RPA in an Organization, iUniverse.

Reference Books:

1. S. Merianda, Robotic Process Automation Tools, Process Automation and Their Benefits: Understanding RPA and Intelligent Automation, Createspace.
2. M. Lacity, L. Willcocks, Robotic Process and Cognitive Automation: The Next Phase, Steve Brookes Publishing.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2021	**Project Management**	03	-	-	03	-	-	03
		Examination Scheme						
		Theory						
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**	**TW**	**Oral/ Prac**	**Total**
		Test 1	**Test 2**	**Avg**					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes:

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

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

Sr. No.	Detailed Content	Hours
1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
2	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
3	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8

4	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
5	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
6	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

References:

1. Ja. Meredith & S. Mantel, Project Management: A managerial approach, Wiley India, 7ᵗʰEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5ᵗʰ Ed, Project Management Institute, PA, USA.
3. G. Clements, Project Management, Cengage Learning.
4. M. Gopalan, Project Management, Wiley India.
5. D. Lock, Project Management, Gower Publishing England, 9ᵗʰ Edition.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2022	**Finance Management**	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy.

Course Outcomes:

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

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Sr. No.	Detailed Content	Hours
1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	6
2	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	6
3	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	9

4	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	5
6	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	3

References:

1. E. Brigham and J. Houston, Fundamentals of Financial Management, 13th Edition, Cengage Publications, New Delhi, 2015.
2. R. Higgins, Analysis for Financial Management, 10th Edition, McGraw Hill Education, New Delhi, 2013.
3. M. Y. Khan, Indian Financial System, 9th Edition, McGraw Hill Education, New Delhi, 2015.
4. I. Pandey, Financial Management, 11th Edition, S. Chand (G/L) & Company Limited, New Delhi. 2015.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2023	Enterpreneurship Development and Management	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME.

Course Outcomes:

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

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs.

Sr. No.	Detailed Content	Hours
1	**Overview of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership, Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	4
2	**Business Plans and Importance of Capital to Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	9
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	5
4	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises, etc.	8

5	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing.	8
6	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business.	5

References:

1. P. Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson Education
2. R. Hisrich, M. Peters and A. Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. T. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. C. N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. V. Desai, Entrepreneurial development and management, Himalaya Publishing House
6. M. Lall and S. Sahai, Entrepreneurship, Excel Books
7. R. Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2024	**Human Resource Management**	03	-	-	03	-	-	03

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Course Outcomes:

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

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

Sr. No.	Detailed Content	Hours
1	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
2	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral	7

	Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
3	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
5	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
6	**HR & MIS** • Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** • Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** • Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

References:

1. S. Robbins, Organizational Behavior, 16th Ed, 2013.
2. V. Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing.
3. K. Aswathapa, Human resource management: Text & cases, 6th edition, 2011.
4. C. Mamoria and S. Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015.
5. P. Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing.
6. L. Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2025	**Professional Ethics and Corporate Social Responsibility**	03	-	-	03	-	-	03

		Examination Scheme							
		Theory							
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand professional ethics in business.
2. To recognized corporate social responsibility.

Course Outcomes:

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

1. Understand rights and duties of business.
2. Distinguish different aspects of corporate social responsibility.
3. Demonstrate professional ethics.
4. Understand legal aspects of corporate social responsibility.

Sr. No.	Detailed Content	Hours
1	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	4
2	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	8
3	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	6
4	**Introduction to Corporate Social Responsibility:** Potential Business Benefits— Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns - Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	5
5	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship, Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	8
6	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility— Companies Act, 2013.	8

References:

1. A. Gupta, Business Ethics: Texts and Cases from the Indian Perspective, Springer, 2013.
2. A. Crane, D. Matten, L. Spence, Corporate Social Responsibility: Readings and Cases in a Global Context, Routledge, 2007.
3. M. Velasquez, Business Ethics: Concepts and Cases, 7th Edition, Pearson, New Delhi, 2011.
4. B. Chakrabarty, Corporate Social Responsibility in India, New Delhi, 2015.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2026	**Research Methodology**	03	-	-	03	-	-	03

			Examination Scheme					
			Theory					
		Internal			End Sem. Exam	Exam Duration (in Hrs)	TW	Oral/ Prac	Total
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation.

Course Outcomes:

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

1. Prepare a preliminary research design for projects in their subject matter areas.
2. Accurately collect, analyze and report data.
3. Present complex data or situations clearly.
4. Review and analyze research findings.

Sr. No.	Detailed Content	Hours
1	**Introduction and Basic Research Concepts** 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	9
2	**Types of Research** 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	7
3	**Research Design and Sample Design** 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	7
4	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem	8

	b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
5	**Formulating Research Problem** 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	4
6	**Outcome of Research** 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	4

References:

1. C. Dawson, Practical Research Methods, New Delhi, UBS Publishers Distributors, 2002.
2. C. Kothari, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited, 1985.
3. R. Kumar, Research Methodology-A Step-by-Step Guide for Beginners, 2nd edition, Singapore, Pearson Education, 2005.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2027	**IPR and Patenting**	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications.

Course Outcomes:

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

1. Understand Intellectual Property assets.
2. Assist individuals and organizations in capacity building.
3. Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting.

Sr. No.	Detailed Content	Hours
1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	5
2	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	7
3	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	5
4	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc.), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	7
5	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia	8

		scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	
6	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	7

References:

1. R. Adukia, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India, 2007.
2. B. Keayla, Patent system and related issues at a glance, Published by National Working Group on Patent Laws.
3. T. Sengupta, Intellectual Property Law in India, Kluwer Law International, 2011.
4. T. Wong and G. Dutfield, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press, 2010.
5. W. Cornish, and D. Llewelyn, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell, 2010.
6. H. Lous, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO, 2012.
7. P. Ganguli, Intellectual Property Rights, 1st Edition, TMH, 2012.
8. R. Radha Krishnan & S. Balasubramanian, Intellectual Property Rights, 1st Edition, Excel Books, 2012.
9. M. Ashok Kumar and M. Iqbal Ali, Intellectual Property Rights, 2nd Edition, Serial Publications
10. K. Bansal and Pr. Bansal, Fundamentals of IPR for Engineers, 1st Edition, BS Publications, 2012.
11. Entrepreneurship Development and IPR Unit, BITS Pilani, A Manual on Intellectual Property Rights, 2007.
12. M. Maa, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company, 2009.
13. N. Rathore, S. Mathur, P. Mathur, A. Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency.
14. V. Irish, Intellectual Property Rights for Engineers, IET. 2005.
15. H. Rockman, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press, 2005.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2028	**Digital Business Management**	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. To familiarize with digital business concept.
2. To acquaint with E-commerce.
3. To give insights into E-business and its strategies.

Course Outcomes:

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

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan.

Sr. No.	Detailed Content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy. **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services), Opportunities and Challenges in Digital Business.	9
2	**Overview of E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals. Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing. EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.	6
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system. **Application Development:** Building Digital business Applications and Infrastructure.	6
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e-business -Security Overview,	6

	Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications.	
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation).	4
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	8

References:

1. A. Mishra, W. Sarwade, A Textbook on E-commerce, Neha Publishers & Distributors, 2011.
2. E. Awad, E-commerce from vision to fulfilment, PHI-Restricted, 2002.
3. D. Chaffey Digital Business and E-Commerce Management, 6th Ed, Pearson, August 2014.
4. C. Combe, Introduction to E-Business-Management and Strategy, Elsevier, 2006
5. E. Coupey, Digital Business Concepts and Strategy, 2nd Edition, Pearson
6. V. Morabito, Trend and Challenges in Digital Business Innovation, Springer
7. E. Darics, Digital Business Discourse, Palgrave Macmillan, April 2015.
8. E-Governance-Challenges and Opportunities, Proceedings in 2nd International Conference theory and practice of Electronic Governance Perspectives
9. The Digital Enterprise - A framework for transformation, TCS consulting journal, vol. 5
10. Measuring Digital Economy - A new perspective -DOI: 10.1787/9789264221796-en, OECD Publishing

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
ILO2029	**Environmental Management**	03	-	-	03	-	-	03
		Examination Scheme						

Course Code	Course Name	Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
		20	20	20	80	03	-	-	100

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns.
2. Learn concepts of ecology.
3. Familiarize environment related legislations.

Course Outcomes:

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

1. Understand the concept of environmental management.
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations.

Sr. No.	Detailed Content	Hours
1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
2	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	6
3	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	5
4	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
5	Total Quality Environmental Management, ISO-14000, EMS certification.	5
6	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	3

References:

1. C. Barrow, Environmental Management: Principles and Practice, Routledge Publishers London, 1999.
2. J. Lovett and D. Ockwell, A Handbook of Environmental Management, Edward Elgar Publishing.
3. T. Ramachandra and V. Kulkarni, Environmental Management, TERI Press.

4. Indian Standard Environmental Management Systems — Requirements with Guidance For Use, Bureau Of Indian Standards, February 2005
5. S. Chary and V. Vyasulu, Environmental Management: An Indian Perspective, Macmillan Publishing, India, 2000.
6. M. Theodore and L. Theodore, Introduction to Environmental Management, CRC Press
7. M. Hussain, Environment and Ecology, 3rd Edition, Access Publishing, 2015.

Internal Assessment:

Assessment consists of two tests out of which one should be compulsorily class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related project.

Theory Examination:

1. Question paper will comprise of total 6 questions.
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Subject Code	Subject Name	Credits
MEAIL201	**Machine Learning Lab**	**04**

Practical sessions based on the courses MEAIC201 and MEAIC203 will be conducted in this laboratory. Implementation of bio-inspired algorithms, deep learning, reinforcement learning, and deep reinforcement learning will be done in Caffe, Python, TensorFlow and MATLAB.

Subject Code	Subject Name	Credits
MEAIL202	**Big Data Lab**	**04**

Practical sessions based on the course MEAIC202 will be conducted in this laboratory. Implementation of techniques for big data analytics, data streams and privacy-preserving data mining will be done using Hadoop, MapReduce, Pig/Hive, NoSQL, MOA, Weka and Python.

End Semester Examination:

Practical/Oral examination for both laboratories is to be conducted by a pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAIS301	Seminar: State-of-the-art research topics	-	06	-	-	03	-	03
MEAID301	Dissertation – I	-	24	-	-	12	-	12
Total		**-**	**30**	**-**	**-**	**15**	**-**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIS301	Seminar: State-of-the-art research topics	-	-	-	-	-	50	50	100
MEAID301	Dissertation – I	-	-	-	-	-	100	-	100
Total		-	**-**	-	-	-	**150**	**50**	**200**

Guidelines for Seminar:

- Seminar should be based on thrust areas in Artificial Intelligence.
- Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
- Students should use multiple literatures from at least 10 papers from refereed Journals (Scopus Indexed & with good Thomson Reuters Impact Factor) / renowned Conferences to understand the topic and research gap.
- Implementation of one paper from refereed journal as a case study is required.
- The report should be compiled in standard format and present to the panel of examiners. (Pair of Internal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputed International / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation - I:

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures from refereed Journals (Scopus Indexed & with good Thomson Reuters Impact Factor) / renowned Conferences to understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation - I:

Dissertation - I should be assessed based on following points:

- Quality of Literature Survey and Novelty in the Problem
- Clarity of Problem Definition and Feasibility of Problem Solution
- Relevance to the Specialization
- Clarity of Objective and Scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and External examiner appointed by the Head of the Department/Institute of respective program.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Prac	Tut	Theory	Prac	Tut	Total
MEAID401	Dissertation – II	-	30	-	-	15	-	15
Total		**-**	**30**	**-**	**-**	**15**	**-**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAID401	Dissertation - II	-	-	-	-	-	100	100	200
Total		**-**	**-**	**-**	**-**	**-**	**100**	**100**	**200**

Guidelines for Assessment of Dissertation – II:

Dissertation - II should be assessed based on following points:

- Quality of Literature Survey and Novelty in the Problem
- Clarity of Problem Definition and Feasibility of Problem Solution
- Relevance to the Specialization
- Clarity of Objective and Scope
- Quality of Work Attempted or Learner Contribution
- Validation of Results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/International conference/Journal of repute. Dissertation II should be assessed by Internal and External Examiners appointed by the University of Mumbai.