

Course Name: Computational Electromagnetic

Course Code: ECM-301

**Course Type: PE
(Semester III)**

Course Broad Category: (Major)

1. Course Prerequisite

Electromagnetic Waves and Transmission Lines

2. Course Learning Objectives:

- i. Understand the mathematical foundations of computational electromagnetics, including vector calculus, numerical linear algebra, and differential equation formulation of Maxwell's equations.
- ii. Derive and implement numerical techniques such as the Finite Difference Time Domain (FDTD), Finite Element Method (FEM), Method of Moments (MoM), and related algorithms used to solve EM field problems.
- iii. Model and simulate electromagnetic structures (antennas, waveguides, microwave circuits, scattering problems, etc.) using computational tools and custom-developed codes.
- iv. Analyze numerical stability, dispersion, and accuracy of various CEM methods and select appropriate techniques for different classes of EM problems.
- v. Apply boundary conditions and material models accurately within computational frameworks for realistic EM designs.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

4. Course Content:

Course Name: Computational Electromagnetic

Course Code: ECM-301

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	36L
1.	Introduction to CEM: Role and applications of computational electromagnetic, Review of Maxwell's equations, Wave equation formulation, Boundary conditions and material models, Numerical modeling challenges (accuracy, stability, convergence)	12L

Module	Topics	36L
2.	<p>Numerical Methods for Electromagnetics:</p> <p>2.1 Finite Difference Methods, Finite Difference Time Domain (FDTD), Yee algorithm, Leapfrog time stepping, Courant stability condition, Perfectly Matched Layers (PML), Source modeling, Finite Difference Frequency Domain (FDFD)</p> <p>2.2 Finite Element Method (FEM), Weak formulation of Maxwell's equations, Basis functions (edge elements), Mesh generation and refinement, Solving linear systems Eigenvalue problems (waveguides & resonators)</p> <p>2.3 Method of Moments (MoM), Integral equation formulation, Green's functions Surface integral equations (EFIE/MFIE/CFIE), Applications to antennas and scattering</p>	12 L
3.	<p>Special Techniques in CEM:</p> <p>Transmission Line Matrix (TLM) method, Beam propagation method (BPM) for photonics, Spectral domain techniques, Fast Multipole Method (FMM), Domain decomposition</p>	12L

5. References:

Text Books:

- Computational Electrodynamics: The FDTD Method – Taflove & Hagness
- The Finite Element Method in Electromagnetics – Jin

Reference Books:

- Field and Wave Electromagnetics – D. K. Cheng
- Antenna Theory: Analysis and Design – C. A. Balanis

***** End of Syllabus*****

Course Name: Pattern Recognition and Machine Learning

Course Code: ECM-302

Course Type: PE

(Semester – III)

Course Broad Category: (Major)

1. Course Prerequisite:

The course assumes familiarity with probability and statistics, including random variables, probability distributions, expectation, and variance. Students should be comfortable with basic linear algebra (vectors, matrices, and eigenvalues) and calculus (differentiation, partial derivatives, and optimization basics). Prior exposure to signals and systems or introductory data analysis, as well as programming experience in MATLAB or Python, will be beneficial for implementing pattern recognition and machine learning algorithms.

2. Course Learning Objectives:

- i. To introduce the fundamental concepts, terminology, and models of pattern recognition and machine learning.
- ii. To develop the ability to formulate classification and regression problems using probabilistic and linear models.
- iii. To enable students to design, train, and evaluate neural networks and support vector machines for classification.
- iv. To provide understanding of algorithm-independent aspects of learning, such as bias–variance tradeoff and ensemble methods.
- v. To develop the capability to apply unsupervised learning and clustering methods for structure discovery in data.
- vi. To prepare students to select and combine appropriate supervised and unsupervised techniques for real-world pattern recognition tasks.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

4. Course Content:

Course Name: Pattern Recognition and Machine Learning

Course Code: ECM-302

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Contents	39L
1.	Pattern recognition problems and representative applications; general pattern recognition system design cycle; learning and adaptation concepts. Probability distributions and parametric learning frameworks for pattern recognition. Maximum likelihood estimation; Bayesian decision theory; Bayes rule, discriminant functions, decision boundaries, loss functions and risk; Bayesian error analysis and performance limits in classification.	7L
2.	Linear models for regression and classification; formulation of regression problems, parameter estimation. Linear regression: least-squares solution, assumptions, model interpretation. Logistic regression for binary classification: logistic function, decision boundaries, maximum likelihood training, gradient-based optimization, regularization perspective.	6L

	Comparison of linear regression vs logistic regression in classification settings.	
3.	Perceptron model, decision regions, perceptron learning rule and convergence issues. Multi-layer perceptron (MLP) architectures: hidden layers, activation functions. Error surfaces and local minima. Back propagation algorithm: forward pass, backward pass, gradient computation, learning rate and convergence behaviour. Practical techniques for improving back propagation: normalization, weight initialization, regularization, early stopping, momentum, mini-batch training. Additional network structures and training methods. Introduction to ensemble methods, Adaboost; brief overview of deep learning concepts and their relevance to pattern recognition.	8L
4.	Linear discriminant functions and decision surfaces for two-category classification; geometric interpretation. Extension to multi-category classification problems. Minimum squared error procedures; relation to linear regression. Ho–Kashyap procedure for linear discriminant design. Linear programming approaches for discriminant function design. Introduction to Support Vector Machines (SVM): margin, separating hyper plane, primal and dual forms, kernel functions (conceptual), soft margin SVM.	7L
5.	Concept of no inherent superiority of any classifier; relation to the “no free lunch” idea. Bias and variance: decomposition of error, under fitting and over fitting. Re-sampling methods for classifier design and performance estimation: hold-out, cross-validation, bootstrap (conceptual). Combining classifiers: voting, averaging, bagging, boosting (concept-level). Model selection and performance estimation issues in practical systems.	5L
6.	Role of unsupervised learning in pattern recognition; clustering objectives. K-means clustering: objective function, iterative algorithm, convergence aspects, limitations. Fuzzy k-means clustering: membership functions, fuzzy partitioning, algorithmic steps. Hierarchical clustering: agglomerative and divisive strategies, linkage criteria, dendrogram interpretation. Qualitative comparison of clustering methods and issues of cluster validity.	6L

5. References:

Text Books

- Max A Richard O. Duda, Peter E. Hart, David G. Stork – Pattern Classification (2nd Edition)
- Christopher M. Bishop – Pattern Recognition and Machine Learning.

Reference Book

- Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical learning (2nd Edition).Yong Liang Guan – Deep Learning for Wireless Communications.

*** End of Syllabus***

Course Name: VLSI for Secure Communication

Course Code: ECM-303

**Course Type: PE
(Semester –III)**

Course Broad Category: (Major)

1. Course Prerequisite:

Digital Logic and Digital System Design
VLSI / CMOS Fundamentals
Computer Architecture
Signals and Communication Basics
Cryptography / Network Security fundamentals.

2. Course Learning Objectives:

- i. To introduce fundamentals of VLSI design with emphasis on secure hardware.
- ii. To understand cryptographic algorithms and their hardware realization.
- iii. To explore hardware threats (side-channel attacks, Trojans, reverse engineering) and countermeasures.
- iv. To study secure VLSI architectures for communication systems.
- v. To provide hands-on experience with FPGA/ASIC tools for secure hardware design.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

4. Course Content:

Course Name: VLSI for Secure Communication

Course Code: ECM-303

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	34L
1.	Fundamentals of VLSI for Secure Systems: Review of MOS transistor basics, CMOS logic design, VLSI design flow (RTL, synthesis, P&R, verification), Power, performance, and area trade-offs in secure hardware. Introduction to secure hardware design challenges.	6L

Module	Topics	34L
2.	Cryptography and Secure Communication Basics: Overview of secure communication systems, Symmetric key algorithms: AES, DES, lightweight ciphers, public key algorithms: RSA, ECC, post-quantum cryptography, Hash functions and digital signatures, Hardware vs software implementations – efficiency and security.	8L
3.	Hardware Security Threats and Countermeasures: Side-channel attacks (power analysis, EM analysis, fault injection), Hardware Trojans and detection techniques, Secure key storage and Physically Unclonable Functions (PUFs). Countermeasures: masking, hiding, error detection codes.	8L
4.	VLSI Implementation of Cryptographic Primitives: Hardware architectures for block ciphers and stream ciphers, Modular arithmetic (GF arithmetic, Montgomery multiplication), FPGA and ASIC implementations of AES, RSA, ECC. Pipelining and parallelism for high-speed secure designs. Lightweight cryptography for IoT and embedded systems. Integration of security into SoC/FPGA-based communication systems.	12L

6. References:

Text Books

- W. Wolf, Modern VLSI Design: System-on-Chip Design, Pearson.
- B. Sklar, Digital Communications: Fundamentals and Applications, Pearson.
- W. Stallings, Cryptography and Network Security, Pearson.
- R. Karri et al., Introduction to Hardware Security and Trust, Springer.

Reference Books

- K. Gaj et al., Cryptographic Engineering, Springer.
- Mukhopadhyay & R. Roychowdhury, Hardware Security: Design, Threats, and Safeguards, CRC Press.
- Recent IEEE/ACM papers on VLSI security and secure communication hardware.

*** End of Syllabus***

Course Name: Business Analytics

Course Code: ECM-305

Course Type: OE

(Semester –III)

Course Broad Category: (Major)

1. Course Prerequisite:

Good knowledge of statistics, mathematics, computer science.

2. Course Learning Objective:

- i. Students will demonstrate knowledge of data analytics.
- ii. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
- iii. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.

3. Evaluation System –

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

3. Course Content:

Course Name: Business Analytics

Course Code: ECM-305

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	35L
1.	Business analytics: Overview of Business analytics, Scope of Business analytics, Business. Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	8L
2.	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology	6L
3.	Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	8L

Module	Topics	35L
4.	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	5L
5.	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	4L
6.	Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4L

4. References:

Text Books:

- Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

Reference Books:

- Business Analytics by James Evans, persons Education.

***** End of Syllabus*****

Course Name: Operation Research

Course Code: ECM-306

Course Type: OE

(Semester –III)

Course Broad Category: (Major)

1. Course Prerequisite:

A strong background in mathematics, such as calculus and linear algebra, and a foundational understanding of computer programming and statistics

2. Course Learning Objective:

- i. Explain the fundamental concepts, principles, and methodology of Operations Research, including model formulation and optimization techniques.
- ii. Formulate linear, nonlinear, and integer programming models for real-world decision-making problems in engineering and management. Graph, Theory & Simulation.
- iii. Analyze constraints, sensitivity, decision variables, and resource allocation outcomes to evaluate the performance of OR-based solutions.
- iv. Evaluate alternative solutions to complex problems and recommend optimal decisions based on quantitative modeling and sensitivity analysis.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

Course Content:

Course Name: Operation Research

Course Code: ECM-306

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	33L
1.	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.	8L
2.	Formulation of a LPP - Graphical solution revised simplex method - duality theory – dual simplex method - sensitivity analysis - parametric programming.	6L
3.	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	8L
4.	inventory models - Probabilistic inventory control models - Geometric Programming.	6L
5.	Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.	5L

4. References:

Text Books:

- H.A. Taha, Operations Research, An Introduction, PHI, 2008.
- H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
- J.C. Pant, Introduction to Optimization-Operations Research, Jain Brothers, Delhi, 2008.

Reference Books:

- Hitler Libermann Operations Research: McGraw Hill Pub. 2009.
- Pannerselvam, Operations Research: Prentice Hall of India 2010
- Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

***** End of Syllabus*****

Course Name: Cost Management of Engineering Projects

Course Code: ECM-307

Course Type: OE

(Semester – III)

Course Broad Category: (Major)

1. Course Prerequisite:

A foundational understanding of project management, basic economic principles, and cost estimation concepts.

2. Course Learning Objectives:

- i. Explain the fundamental principles of Operations Research, project economics, cost estimation methods, and financial evaluation techniques. Detailed Engineering activities
- ii. Formulate mathematical models for engineering decision-making problems involving optimization, resource allocation, scheduling, and cost management.
- iii. Analyze project costs, perform break-even analysis, assess financial indicators (NPV, IRR, Payback), and evaluate alternative engineering project options.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

4. Course Content:

Course Name: Cost Management of Engineering Projects

Course Code: ECM-307

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	34L
1.	Introduction and Overview of the Strategic Cost Management Process.	4L
2.	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	6L
3.	Project meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.	8L

Module	Topics	34L
4.	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	10L
5.	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	6L

5. References

Text Books:

- Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi.
- Charles T. Horngren and George Foster, Advanced Management Accounting.
- Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.

Reference Books:

- Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

*** End of Syllabus***

Course Name: Industrial Safety

Course Code: ECM-308

Course Type: OE

(Semester – III)

Course Broad Category: (Major)

1. Course Prerequisite:

Prerequisites for studying industrial safety vary depending on the course level

2. Course Learning Objectives:

- i. Understand the fundamental principles of industrial safety including hazard identification, risk assessment, and accident causation theories.
- ii. Apply safety standards, codes, and regulations (national and international) to ensure compliance in industrial environments.
- iii. Demonstrate knowledge of safety management systems (SMS) including safety culture, safety audits, documentation, and training processes.
- iv. Develop effective emergency preparedness and disaster management plans for industrial facilities.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies.

Evaluation System –

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

4. Course Content:

Course Name: Industrial Safety

Course Code: ECM-308

Hours per Week: 3L: 0T: 0P

Credits: 3

Module	Topics	33L
1.	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	8L
2.	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	4L
3.	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii.	8L

Module	Topics	33L
	Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
4.	Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	4L
5.	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use,	5L
6.	Application of Information Theory: Group , Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements ,Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.	4L

5. References:

Text Books:

- Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services
- Maintenance Engineering, H. P. Garg, S. Chand and Company.

Reference Books:

- Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
- Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.
- Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.

*** End of Syllabus***