PE-EC801A	Antennas and Propagation	3L:0T	3 credits

Fundamental Concepts- Physical concept of radiation, Radiation pattern, near-andfar-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Radiation from Wires and Loops- Infinitesimal dipole, finite-length dipole, linearelements near conductors, dipoles for mobile communication, small circular loop.

Aperture and Reflector Antennas-Huygens' principle, radiation from rectangularand circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.

Broadband Antennas- Log-periodic and Yagi-Uda antennas, frequencyindependent antennas, broadcast antennas.

Micro strip Antennas- Basic characteristics of micro strip antennas, feedingmethods, methods of analysis, design of rectangular and circular patch antennas.

Antenna Arrays-Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.

Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, fixedweight beam forming basics, Adaptive beam forming.

Different modes of Radio Wave propagation used in current practice.

Text/Reference Books:

1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, Antenna Engineering Handbook, McGraw ill, 1984.
5. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
6. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005
7. R.E. Crompton, Adaptive Antennas, John Wiley

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the properties and various types of antennas.
2. Analyze the properties of different types of antennas and their design.
3. Operate antenna design software tools and come up with the design of the antenna of required specifications.

PE-EC801B	Fiber Optic Communication	3L:0T	3 credits

Introduction to vector nature of light, propagation of light, propagation of light ina cylindrical dielectric rod, Ray model, wave model.

Different types of optical fibers, Modal analysis of a step index fiber.
Signaldegradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detectorresponsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.

Optical switches - coupled mode analysis of directional couplers, electro-

opticswitches. Optical amplifiers - EDFA, Raman amplifier.

WDM and DWDM systems. Principles of WDM networks.

Nonlinear effects in fiber optic links. Concept of self-phase modulation, groupvelocity dispersion and solition based communication.

Text/Reference Books

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the principles fiber-optic communication, the components and the bandwidth advantages.
2. Understand the properties of the optical fibers and optical components.
3. Understand operation of lasers, LEDs, and detectors
4. Analyze system performance of optical communication systems
5. Design optical networks and understand non-linear effects in optical fibers

PE-EC801C	Error Correcting Codes	3L:0T	3 credits

Linear block codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the McWilliams identities; Perfect codes, Introduction to finite fields and finite rings; factorization of (X^n-1) over a finite field; Cyclic Codes.

BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes. ;Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm. Convolution codes; Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.

Text/Reference Books:

1. F.J. McWilliams and N.J.A. Slone, The theory of error correcting codes, 1977.
2. R.E. Balahut, Theory and practice of error control codes, Addison Wesley, 1983.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the error sources
2. Understand error control coding applied in digital communication

PE-EC802A	Mixed Signal Design	3L:0T	3 credits

Analog and discrete-time signal processing, introduction to sampling theory;Analog continuous-time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform.

Switched-capacitor filters- Nonidealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.

Basics of data converters; Successive approximation ADCs, Dual slope ADCs,Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.

Mixed-signal layout, Interconnects and data transmission; Voltage-mode signalingand data transmission; Current-mode signaling and data transmission.

Introduction to frequency synthesizers and synchronization; Basics of PLL,Analog PLLs; Digital PLLs; DLLs.

Text/Reference Books:

1. R. Jacob Baker, CMOS mixed-signal circuit design, Wiley India, IEEE press, reprint 2008.
2. Behzad Razavi , Design of analog CMOS integrated circuits, McGraw-Hill, 2003.
3. R. Jacob Baker, CMOS circuit design, layout and simulation, Revised second edition, IEEE press, 2008.
4. Rudy V. dePlassche, CMOS Integrated ADCs and DACs, Springer, Indian edition, 2005.
5. Arthur B. Williams, Electronic Filter Design Handbook, McGraw-Hill, 1981.
6. R. Schauman, Design of analog filters by, Prentice-Hall 1990 (or newer additions).
7. M. Burns et al., An introduction to mixed-signal IC test and measurement by, Oxford university press, first Indian edition, 2008.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the practical situations where mixed signal analysis is required.
2. Analyze and handle the inter-conversions between signals.
3. Design systems involving mixed signals

PE-EC802B	Industrial Automation and Control	3L:0T	3 credits

Sensors: Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors etc
Actuators: Dc motors, Servo motors, Stepper motors, Piezo electric actuators, Pneumatic actuators etc.
Signal Conditioning: Filtering, Amplifying, Isolation, ADC, DAC, Sensor protection circuits, Signal transmission and noise suppression, Estimation of errors and calibration.

Controller tuning:
PI controller, PD controller, PID controller and tuning methods: *Ziegler-Nichols tuning method, Cohen coon tuning method,* Implementation of PID controllers (digital and analog).

Automation:
PLC (Programmable logic controllers): Overview, operation and architecture, PLC programming, Application examples.
DCS (Distributed control systems): Overview, Advantages, Functional requirements of Distributed control systems, Communication for distributed control, Application examples.
SCADA (supervisory control and data acquisition): Introduction to SCADA, SCADA system components, architecture and communication, SCADA applications.
Advanced control techniques: Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, internal mode control.

Text book
1. Computer-Based Industrial Control, Krishna Kant,2nd edition Prentice Hall of India Ltd.
2. Chemical Process Control – Theory and Practice, Stephanopoulous, Prentice Hall of India Ltd, 1984.
3. Fundamentals of Industrial Instrumentation and Process Control, William C. Dunn, TataMcGrawHill, 2009.

Course Outcome : At the end of the course, the students will be able to :

1. select suitable sensor to measure industrial parameters and the different types of actuators and its working. They will be able to design proper signal conditioning circuit to the transducer.
2. determine the effect of proportional gain, integral time, derivative gain constant on the system performance and will be able to tune the controller using tuning methods, implement PID using electronic , digital, pneumatic and hydraulic methods.
3. design the ladder logic to implement any process with given problem statement.
4. analyze DCS hardware and its merits/demerits in an industrial automation
5. analyze SCADA hardware and software and its merits/demerits in industrial automation.
6. design the complex control scheme to a particular process.

PE-EC802C	**VLSI Design Automation**	**3L:0T**	**3 credits**

Unit-I: Introduction to VLSI Design methodologies

Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity - Tractable and Intractable problems - general purpose methodsfor combinatorial optimization.

Unit-II: Layout Compaction, Placement & Partitioning

Layout Compaction: Design rules - problem formulation - algorithms for constraint graph compaction *–Placement & Partitioning:* Circuit representation - Placement algorithms - partitioning

Unit-III: Floorplanning & Routing

Floor planning concepts: Terminologies, floorplan representation, shape functions and floorplan sizing *Routing:* Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing.

Unit-IV: VLSI Simulation

Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis- High level Synthesis.

Unit-V: High Level Synthesis

Hardware models - Internal representation - Allocation assignment and scheduling - Simple scheduling algorithm - Assignment problem – High level transformations.

REFERENCE BOOKS

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwar Academic Publishers, 2002

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OE-EC803A	**Internet of Things(IoT)**	**3L:0T:0P**	**3 credits**

Introduction:

The Internet of Things: an Overview:

The flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things,Enchanted Objects, Who is Making the Internet of Things?

Design Principles for Connected Devices:

Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

Internet Principles:

Internet Communications: An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports, Application Layer Protocols.

Prototyping:

Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.

Prototyping Embedded Devices:

Electronics, Embedded Computing Basics, Developing on the Arduino, Raspberry Pi, Beaglebone Black, Electric Imp, Mobile Phone and Tablets, Plug Computing: Always-on Internet of Things.

Prototyping the Physical Design:

Preparation, Sketch, Iterate, and Explore, Non-digital Methods, Laser Cutting, 3D Printing, CNC Milling, Repurposing/Recycling.

Prototyping Online Components:

Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols.

Techniques for Writing Embedded Code:

Memory Management, Performance and Battery Life, Libraries, Debugging.

Prototype to Reality:

Business Models: A Short History of Business Models, The Business Model Canvas, Who Is The Business Model

For Models, Funding an Internet of Things Startup, Lean Startups.

Moving to Manufacture:

What Are You Producing?, Designing Kits, Designing Printed Circuit Boards, Manufacturing Printed Circuit Boards, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software,

Ethics:

Characterizing the Internet of Things, Privacy, Control, Environment, Solutions.

Text Book

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley publication, 1st Edition, November 2013.

Course Outcome : At the end of the course, the students will be able to :

1. understand the application areas of IOT.
2. realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
3. understand building blocks of Internet of Things and characteristics.

OE-EC803B	**Big Data Analysis**	**3L:0T:0P**	**3 credits**

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OE-EC803C	**Cyber Security**	**3L:0T:0P**	**3 credits**

Introduction:
Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution –
Productivity – Internet – E commerce – Counter Measures Challenges. Botnets.

Cyber security objectives and guidance
Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project – Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.

Cyber governance issues
Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation – Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare.

Cyber infrastructure issues
Cyber Infrastructure Issue – economics ,finance and banking – Health care – Industrial Control systems. Cyber insurance, cyber security in international relations.

Text Book
1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy
Guidebook" John Wiley & Sons 2012.

Reference Book
1. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
2. B.G Raggad, " Information Security Management", CRC Press, Taylor Francis, 2015

Course Outcome : At the end of the course, the students will be able to :
1. understand the concept of cyber security

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OE-EC804A	**Artificial Intelligence**	**3L:0T:0P**	**3 credits**

Introduction:
Overview; Foundation; History; The State of Art.
Intelligent Agents:
Agents and environment; Rationality; The nature of environment; The structure of agents.
Solving Problems by Searching:
Problem-solving agents; Well defined problems & solutions; Formulating problems; Searching for solution; Uninformed search strategies: (BFS, DFS, DLS, IDDFS, Bidirectional Search)
Informed Search and Exploration:
Informed search strategies; Heuristic functions; On-line search agents and unknown environment.
Constraint Satisfaction Problems:
Constraint satisfaction problems; Backtracking search for CSPs; Local search for CSPs.
Adversial search:
Games; Optimal decisions in games; Alpha-Beta pruning.
Logical Agents:
Knowledge-based agents; The wumpus world as an example world; Logic: Propositional logic Reasoning patterns in propositional logic.
First-order Logic:
Syntax and semantics of first-order logic; Use of first-order logic.

Text Book
1. Artificial Intelligence: A Modern Approach – Stuart Russel, Peter Norvig, 3rd Edition, Pearson Education,
Reference Book
1. Artificial Intelligence - Elaine Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, Tata McGraw
Hill, 2008.
2. Artificial Intelligence: A new Synthesis – Nils J. Nilsson, 1st Edition, Elsevier, 1997.
3. Introduction to Artificial Intelligence and Expert Systems- Dan W. Patterson 2nd Edition, PHI, 2009.

Course Outcome: At the end of the course, the students will be able to:
1. understand the modern view of AI as the study of agents that receive percepts from the environment and
perform actions.
2. demonstrate awareness of the major challenges facing AI and the complex of typical problems within the field.

3. exhibit strong familiarity with a number of important AI techniques, including in particular search, knowledge representation, planning and constraint management.
4. asses critically the techniques presented and to apply them to real world problems.

OE-EC804B	**Microwave Integrated Circuits**	**3L:0T:0P**	**3 credits**

Introduction: Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC.

Planar Transmission Lines-I: Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip.

Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW).

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider.

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S- parameters, noise measurement.

Text Book

1. Microstrip Lines and Slot Lines - K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, 2nd Ed., 1996.
2. Foundation for Microstrip Circuit Design-T. C. Edwards, John Wiley & Sons Ltd, 2nd Ed., 1992.

Reference Book

1. Stripline-like Transmission lines for Microwave Integrated Circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd, 1st Ed., 1989.
2. Microwave Integrated Circuits, K.C. Gupta and A. Singh, Wiley Eastern Limited, 1st Ed., 1975.

Course Outcome: At the end of the course, the students will be able to :

1. analyze the fabrication techniques of MIC and MMIC , use of active devices with MIC and MMIC, differentiate between MIC and MMIC.
2. analyze and design strip lines and micro strip lines, and model the discontinuities in those lines.
3. analyze and design slot lines, fin lines, coplanar lines and coplanar wave-guides
4. design parallel coupled lines for couplers and power divider circuits.
5. differentiate between various measurement techniques associated with planar transmission lines.

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OE-EC804C	**Organizational Behavior**	**3L:0T:0P**	**3 credits**

UNIT-1-Introduction to Organization and OrganizationalBehaviour :
Meaning and definition of organization, features and principles of organization, Organizational structures and nature of organizational behavior.

UNIT-2-Personality :
Meaning of Personality, Personality Development, Determinants of personality, Application of personality in the organizational level. Motivation-concept of motivation, motivation and behavior, Theories of motivation, Need theory, Hygiene theory, Theory X and Theory Y,Elements of sound motivational system, Motivation in Indian organization.

UNIT-3-Leadership :
Meaning,Theory of leadership, Trait theory,Behavioural theory, Leadership styles, Leadership in Indian Organisation. Group Dynamics-Concept of Group Dynamic, Types of Group, Group Behaviour, Group Decisions, Techniques to improve group decision, merits and de-merits of group decision.

UNIT-4- Organizational Change :
Meaning and Nature of organizational chage,Factors of organizational change, Resistance to change, Factors in resistance, Overcoming resistance to change, Organizational Development-Concept, Objectives and process of organization development.

Text Book
1. ORGB, An innovative Approach to Learning and Teaching ,Organizational Behaviour, Nelson, Quick, Khandelwal, Cengage Learning, 2012.

Reference Book
1. Organizational Behaviour Dr S.S.Khanka, S.Chand, 2014.
2. Organisational Behaviour. Arun Kumar and N.Meenaskshi .Vikas Publishing House, 2009.
3. Managing Organisational Behaviour, Moorhead & Griffin. CENGAGE Learning, 2014.
4. Human Behaviour at Work. Keith Davies, 2002.

Course Outcome : At the end of the course the students will be able to:
1. know about organisational structure, organisational behaviour and personality development.
2. learn about motivational techniques and skill required to work in a group and the process of group decision making.
3. know various leadership styles and the role of leader in achievement of organisational objective.
4. learn about the reasons organizational change and its development.

EC881	**Project Stage II**	**L:0T:15P**	**7.5 credits**

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under EC P1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under EC P1;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.