Electronics & Communication Engineering

4 Yrs. B.Tech In Electronics and communication with specialization Embedded system and IOT

Effective from 2021-22

भारतीय सूचना प्रौद्योगिकी संस्थान राँची

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, RANCHI

(An Institution of National importance under act of Parliament)

(Ranchi - 834010), Jharkhand

I. Highlights of Changes in Proposed B.Tech Course Structure

Proposed course structure
• Bachelor degree is classified into B.Tech and B.Tech (Hon.). Condition for B.Tech (Hons.)= CGPA ≥ 8.0 (at the end of fourth semester)
• Total credits B.Tech = 162-170 credits B.Tech (Hons.)=174-182 credits
• Common courses for all Branches in first year.
• Two credits is allocated to all laboratory courses.

II. Format of Subject codes

1) Course code AA-XYZZ is explained as
AA - Department
X-Academic year
Y-Theory/Lab; 0 ==Theory and 1== Lab
ZZ-odd/even semester; odd number == odd semester and even number == even semester

2) For project/seminar/comprehensive viva:
AA= PR
X= 1

3) For open electives:
AA= OE

Indian Institute of Information Technology, Ranchi
Curriculum for
B. Tech (Hons.) and B.Tech

Breakup of the credits semester wise

Credit required for B Tech – 162-170;
Credit required for B Tech (Hons.) –174-182 (Only for Students with CGPA ≥ 8.0 at the end of 4th Semester)

Semester/ Projects	Credits - B.Tech Hons.	Credits - B.Tech
I	20	20
II	24	24
III	23-25	23-25
IV	21-22	21-22
V	23-24	19-20
VI	20-23	17-19
VII	23-24	18-20
VIII	20	20
Total	174-182	162-170

Semester wise courses

Semester I – Common for B Tech (Hons.) & B Tech.				
S. No.	Course Code	Course Title	L-T-P	Credits
1.	MA-1001	Mathematics-I (Calculus and Differential Equations)	3-1-0	4
2.	EC-1001	Electronic Devices & Circuits	3-0-0	3
3.	EC-1003/ PH-1001	Electrical Technology / Engineering Physics	3-0-0	3
4.	CS-1001	Computer Programming: Concepts and Practices	3-0-0	3
5.	HS-1001	Professional Communication	2-0-0	2
6.	EC-1101	Electronic Devices & Circuits lab	0-0-3	2
7.	CS-1101	Computer Programming Lab	0-0-3	2
8.	CA-1101	Co-Curricular Activity I	0-0-2	1
	Total Credits			20

Semester II - Common for B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**MA-1002**	Mathematics-II (Probability and Statistics)	3-1-0	4
2.	**EC-1002**	Digital Logic & Design	3-0-0	3
3.	**EC-1003/ PH-1001**	Electrical Technology / Engineering Physics	3-0-0	3
4.	**CS-1002**	Data Structures and Programming Languages	3-0-0	3
5.	**CS-1004**	Discrete Mathematics	3-1-0	4
6.	**HS-1002**	Ethics and Human Values	2-0-0	2
7.	**EC-1102**	Digital Logic & Design Lab	0-0-3	2
8.	**CS-1102**	Data Structures Lab	0-0-3	2
9.	**CA-1102**	Co-Curricular Activity II	0-0-2	1
	Total Credits			**24**

Semester III - Common for B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**MA-2001**	Mathematics-III (Complex variable, Real analysis & Linear Algebra)	3-1-0	4
2.	**CD-2001**	Python Programming	3-0-0	3
3.	**CD-2003**	Computer Organization and Architecture	3-0-0	3
4.	**EI-2001**	Analog & Linear Integrated Circuit	3-0-0	3
5.	**EI-2003**	Ci rcuit Analysis & Synthesis	3-0-0	3
6.	**HS-2001**	Management Concepts and Organizational Behaviour	2-0-0	2
7.	**CD-2101**	Python Programming Lab	0-0-3	2
8.	**CD-2103**	Computer Organization and Architecture Lab	0-0-3	2
9.	**EI-2101**	Analog & Linear Integrated Circuit Lab	0-0-3	2
	Total Credits			**24**

Semester IV- Common for B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**EI-2002**	Electromagnetic Theory	3-1-0	4
2.	**EI-2004**	Microprocessors and Microcontrollers	3-0-0	3
3.	**EI-2006**	Signals and Systems	3-0-0	3
4.	**EI-2008**	Analog Communication	3-0-0	3
5.	**EI-2010**	Control System	3-0-0	3
6.	**ES-2002**	Environmental Science & Green Technology	2-0-0	2
7.	**EI-2104**	Microprocessors and Microcontrollers Lab	0-0-3	2
8.	**EI-2108**	Analog Communication Lab	0-0-3	2
	Total Credits			**22**

Semester V- Common for B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**CD-3005**	Database Management Systems	3-0-0	3
2.	**EI-3001**	Digital Communication	3-0-0	3
3.	**EI-3003**	Embedded System	3-0-0	3
4.	**EI-3005**	Microwave Engineering	3-0-0	3
5.	**-----**	**Hons. Elective-I**	**3-1-0**	**4**
6.	**HS-3001**	Entrepreneurship Development	2-0-0	2
7.	**CD-3105**	Database Management Systems lab	0-0-3	2
8.	**EI-3101**	Digital Communication Lab	0-0-3	2
9.	**EI-3103**	Embedded System Lab	0-0-3	2
	Total Credits			**24 (20)**

Hons. Elective-I		
S. No.	**Course Code**	**Course Title**
1.	**HC-3001**	Computational Intelligence
2.	**HC-3003**	Optical Communication
3.	**HC-3005**	Wireless Communication 2.5G and Beyond.
4..	**HC-3007**	Semiconductor Material & Device Characterization
5.	**HC-3009**	Advanced Digital image processing.
6.	**HC-3011**	MEMS and Lab on Chip.

Semester VI- B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**EI-3002**	Industrial IoT	3-0-0	3
2.	**EI-3004**	Advanced Embedded Processor and Microcontrollers	3-0-0	3
3.	**EI-3006**	Sensors and Actuators	3-0-0	3
4.	**---**	Open Elective-I	3-0-0	3
5.	**---**	**Hons Elective-II**	**3-1-0**	**4**
6.	**EI-3008**	VLSI and MEMS	3-0-0	3
7.	**EI-3102**	Industrial IOT Lab	0-0-3	2
8.	**EI-3106**	Sensors and actuators Lab	0-0-3	2
	Total credits			**23(19)**

Open Elective-I			Hons. Elective-II		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1.	**OE-3012**	Quantum Computing	**1.**	**HI-3002**	Wireless sensors and networks
2.	**CD-3006/OE-3016**	Design Thinking	**2.**	**HI-3004**	Information theory and coding
3.	**OE-3022**	Exploratory Data Science	**3.**	**HI-3006**	Metamaterial Sensors
4.	**OE-3014**	Advanced algorithm			

Semester VII- B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**EI-4001**	Optical Sensors	3-0-0	3
2.	**---**	Open Elective-II	3-0-0	3
3.	**---**	Open Elective-III	3-0-0	3
4.	**---**	Open Elective-IV	3-0-0	3
5.	**---**	**Hons Elective-III**	**3-1-0**	**4**
6.	**EI-4101**	Optical sensors Lab	0-0-3	2
7.	**PR-4101**	Minor Project	---	4
8.	**PR-4103**	Industrial / Internship Seminar	---	2
	Total Credits			**24(20)**

Hons. Elective-III		
S. No.	**Course Code**	**Course Title**
1.	**HI-4001**	CAD for VLSI
2.	**HI-4003**	Adaptive signal processing
3.	**HI-4005**	Robotics
4.	**HI-4007**	Communication protocol for IOT.

Open Elective-II,III,IV					
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1.	**OE-4007**	Optimization techniques	**9.**	**OE-4067**	Embedded systems in Biomedical application
2.	**OE-4033**	Cloud Computing	**10.**	**OE-4069**	Advanced digital design
3.	**OE-4043**	Data Analytics for IoT	**11.**	**OE-4071**	Embedded sensing technology
4..	**OE-4057**	Advanced Embedded control system	**12.**	**OE-4073**	Smart grid technology and IOT
5.	**OE-4059**	Real time operating system	**13.**	**OE-4075**	IOT Edge notes
6..	**OE-4061**	Intelligent visual surveillance system	**14.**	**CD-4001/OE-4077**	Deep and Reinforced learning
7.	**OE-4063**	Antenna for IOT	**15.**	**OE-4079**	Evolutionary and heuristic algorithms
8.	**OE-4065**	IOT Architecture and cloud computing	**16.**	**OE-4081**	Energy Harvesting and power Management for IoT

Industrial Training: Students to undertake summer internships during summer break (May to July)

Semester VIII - Common for B Tech (Hons.) & B Tech.				
S. No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1.	**PR-4102**	Project/Internship	----	16
2.	**PR-4104**	Comprehensive Viva	----	4
	Total Credits			**20**

Legend:

L - Number of lecture hours per week

T - Number of tutorial hours per week

P - Number of practical hours per week

C - Number of credits for the course

Note:

1. Others elective courses as decided by committee to be taken from NPTEL/MOOCs/SWAYAM/COURSERA or any other online platform. Course codes will be decided later as per the format.
2. Elective courses may be added or removed later on the recommendation of competent authority.

APPENDIX

Syllabus of B.Tech in ECE with specialization ES&IOT

Semester I

MA1001	Mathematics-I (Calculus and Differential Equations)	L-T-P-C:3-1-0-4

Course objective: In this course, students are introduced to some basic tools in Mathematics which are useful in modelling and analyzing physical phenomena involving continuous changes of variables or parameters. The differential and integral calculus of functions of one or more variables and of vector functions taught in this course have applications across all branches of engineering. This course will also help in understanding the applications of Laplace and Fourier Transformations in Communication theory.

Module-I

Series and Partial Differentiation: Sequence and Series, Rolle's Theorem, Lagrange and Cauchy Mean Value theorems, convergence, Cauchy root test, D'Alembert ratio test, Rabbe's test, Comparison test, Integral test, Lograthmic test, Leibnitz's rule. Function of Several Variables, Limit, Continuity and Differentiability, Partial Differentiation, Homogeneous function, Euler's theorem, change of variables, Jacobian, Taylor's theorem for function of several variables, Extrema of function of multi-variables, saddle points, Lagrange method for undetermined multipliers.

Module-II

Integral Calculus:Multi Integral (Double & Triple Integral), Change of order of integration, Area of bounded region, Arc length of curve, volume and surface area of solid of revolution, multiple integral by change of variables, Dirichlet integrals, Beta and Gamma Functions, Improper integrals, Beta and Gamma functions.

Module-III

Vector Calculus: Gradient and directional derivatives of scalar fields. Divergence and Curl of vector fields. Line, surface, and volume integrals. Green's, Gauss's, and Stoke's theorems and their application.

Module-IV

Ordinary Differential Equations: Existence and uniqueness of solutions of first order ODE, Exact differential equations, solution of linear differential equation, higher order linear differential equation, Solution of homogeneous and non-homogeneous ODE, variation of parameters, Undetermined coefficients, power series method, System of simultaneous ODE.

Module-V

Partial Differential Equations: Formation and classification of PDE, First order PDE: Complete, General and Particular solution, Lagrange's linear PDE, Non-linear first order PDE, Charpit's Method, Higher Order, Homogeneous linear PDE, Complementary function & Particular integrals. Non-homogeneous PDE, Application of Partial Differential Equation.

Module-VI

Laplace and Fourier Transforms: Laplace Transform and its properties, Unit-step, Impulse and Periodic functions, Error Function, Inverse Laplace Transform, Convolution Theorem, Evaluation of Integral by Laplace transform, Application of Laplace transform to solution of ODE & PDE. Fourier Series and Fourier Transform: Fourier series, Convergence of Fourier series, Half range series. Fourier Integral, Fourier Sine and Cosine Integral, Complex form of Fourier integral. Fourier Transform, Fourier Sine and Cosine Transform, Finite sine and Cosine transform, Convolution Theorem, Application of Fourier Transform to boundary value problems.

Course outcome:

- Able to identify the convergence of sequences and infinite series. And also able to identify the nature of multivariate functions.
- Able to evaluate special types of definite and improper integrals.
- Able to solve ordinary differential equations.
- Able to solve partial differential equations.
- Able to apply Laplace and Fourier transforms in engineering applications.

Text Books:

1. Simmons, G.F.: "Differential Equations", TATA McGraw-Hill Publishing Company LTD. New Delhi, (1995).
2. Das, B.C. and B.N. Mukherjee.: "Integral Calculus-Differential Equations", UN Dhur& Sons Pvt. Ltd, Kolkata (1996).
3. Raisinghania M.D.: "Advanced Differential Equations", S.Chand Publications(1995).

Reference Books:

1. Jain, Rajinder Kumar, and Satteluri RK Iyengar: "Advanced Engineering Mathematics", Alpha Science Int'l Ltd. (2007).
2. Grewal, B.S.: "Higher Engineering Mathematics", Khanna Publishers, New Delhi (2010).
3. Kreyszig, Erwin: "Advanced Engineering Mathematics", Wiley India Publications, 10th Edition (2009).

EC-1001	Electronic Devices & Circuits	L-T-P-C:3-0-0-3

Course objective:

- Use of basic electronic devices in building circuits.
- Explain the structure and working operation of basic semiconductor devices.
- Analyze the characteristics of different electronic devices such as diodes and transistors.

Module I

Physics of Semiconductor Device: Insulators, semiconductors, and metals classification using energy band diagrams, mobility and conductivity, electrons and holes in intrinsic and extrinsic semiconductors, drift and diffusion, charge densities in semiconductors, Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic semiconductors, Effect of Excess Carrier in Semiconductor Device.

Module II

Diode Characteristics and Applications: P-N junction diode and its characteristics, Mathematical analysis of built-in potential, depletion width, peak electric field and diffusion current density, Diode applications (half-wave and full-wave rectifiers, clippers, clampers), Non-ideal diode models, Zener diodes and its applications, Diode capacitance and switching times, Types of diodes (LED, Varactor diode, Schottky diode, Photodiode).

Module III

BJT: Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cutoff and saturation operations, Q point, BJT switching times, Applications of BJT.

FET: Field Effect Transistor (FET types, operation, configurations, characteristics), MOS structure, CV characteristics, Metal-Oxide Semiconductor FET, Complimentary MOSFET (CMOS).

Module IV

BJT biasing and small-signal analysis of BJT amplifiers, FET biasing and small-signal analysis of FET amplifiers, Frequency response (low-frequency and high-frequency responses of amplifiers), and Gain bandwidth product.

Course outcome:

Upon Completion of the course, the students will be able to:

- Choose and adapt the required components to construct various electronic circuit.
- Apply P-N junction diodes for different applications.
- Apply BJT, FET and MOSFET circuits for different applications.
- Demonstrate the operating principle and output characteristics of pn junction diodes, zener diode, Varactor diode, BJT.

Text Book:

1. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, 7th Edition, 2017.
2. Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 11th Edition, 2015.

Reference Book:

1. Jacob Millman, Christos C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill, 2nd Edition, 2017.
2. Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw Hill, 5th Edition, 2012.

EC-1101	Electronic Devices & Circuits lab	L-T-P-C:0-0-3-2

Familiarization with Cathode Ray Oscilloscope, Function generator and various electronic components and Experiments related to Volt-Ampere Characteristics of PN junction diode, Zener Diode and Light Emitting Diode, Zener Voltage regulator characteristics, clipping circuits, clamper circuits, Half-Wave rectifier with and without filter, Full-Wave rectifier with and without filter, Bipolar Junction Transistor, Frequency response of CE amplifier, Characteristics of n-channel/p-channel MOSFETs and CMOS inverter.

Project:

Familiarization with PCB design

EC-1003	Electrical Technology	L-T-P-C:3-0-0-3

Course objective:

- To understand the basic principles of electrical & electronic circuits.
- To realize the fundamental behavior of AC circuits and solve AC circuit problems.
- To know the basic principle of single-phase transformers and its performance.

Module I

Electrical Circuit: Circuit elements resistance, Inductance and capacitance, Kirchhoff's laws, Voltage Source (definition, characteristics of practical source, and equivalent current source). Magnetic circuit, Flux, MMF, Reluctance, Analogy with electric circuits. Simple calculations for composite magnetic circuits. Three phase system: its necessity and advantages, meaning of phase sequence, Star and Delta connections, Balanced supply and balanced load, Line and phase voltage/current relation, Three phase power measurements.

Module II

Parameters of AC Circuits: Periodic function, Average & R.M.S. values, Steady state behavior with sinusoidal excitation, Phasor representation, Reactance & Impedance, Series & parallel circuit, Power factor, Principle of generation of single phase & three phase voltages, Power in balanced three phase AC system.

Module III

Transformers: Necessity of transformer, Principle of operation, Types and construction of transformers. EMF equation, Losses, Variation of losses with respect to load, Efficiency, Condition for maximum efficiency. Domestic wiring: service mains, meter board and distribution board. Brief

discussion on concealed conduit wiring. Two-way and three-way control. Elementary discussion on circuit protective devices: Fuse and Miniature circuit breaker (MCB), Electric shock, Precautions against shock. Earthing: pipe and plate earthing.

Course Outcome:

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

- Design electrical & electronic systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline.
- Analysis the single-phase AC circuits, representation of alternating quantities and determining the power in these circuits for opto-electronics & energy storage device application.
- Learn the use of transformers in voltage regulators, voltage stabilizers, power supplies, rectifier etc.

Text Book:

1. B.L. Theraja, A.K. Theraja, Electrical Technology, S Chand; 24th revised edition, 2005.
2. D.P. Kothari and I.J. Nagrath, Basic Electrical Engineering, McGraw-Hill; Forth edition, 2019.
3. V. Del. Toto, Electrical Engineering Fundamentals, Pearson Education India; 2nd edition, 2015.
4. J. Hiley, K. Brown and I.M. Smith, Electrical and Electronic Technology, Pearson Publishers; 10th Edition, 2018
5. V. Mittle, A. Mittle, Basic Electrical Engineering, McGraw Hill Education; 2nd edition, 2017.

Reference Book:

1. E. Fitzgerald, A. Grabel, D.E. Higginbotham, Basic Electrical Engineering, McGraw-Hill Education; 5th edition, 1981.
2. R. Boylestad, L. Mashlsky, Electronics Devices and Circuit theory, Pearson Education India; 2nd edition, 2017.
3. J.N. Swamy, N.V. Sinha, Elements of Electrical Engineering, Mahajan Publishing House, Ahmedabad, 2016.
4. D.C. Kulshresta, Basic Electrical Engineering, McGraw Hill Education; 1st edition, 2017.
5. R. Saravanakumar, V. Jegathesan, K.V. Kumar, Basic Electrical and Electronics Engineering, Wiley, 2011.

CS-1001	Computer Programming: Concepts and Practices	L-T-P-C:3-0-0-3

Course objective:

- To understand the basic concept of writing a program.
- To understand role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language

- To apply the use of conditional expressions and looping statements to solve problems associated with conditions, repetitions and function.
- To analyze the concept of array and pointers dealing with memory management.
- To Evaluate the File handling concepts for permanent storage of data or record.
  To create dynamic data structure applications as self-referential structure.

Module I

Computer fundamentals, Evolution of programming languages, Syntax and semantics, Concurrency, Number systems, Functional Programming and Logic programming languages, Computational complexity

Module II

Programming in C, Pseudo-code, Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators, expressions and statements, conditional and looping statements.

Module III

Data types, Type Checking and Scopes, Storage Classes, Arrays, Sequential and Linked linear lists, Trees, Trees representations, binary tree traversals, Graphs, Graphs representations.

Module IV

Functions, Structures, Union, Storage Classes, Pointers, Dynamic memory allocations, file handling in C, Pre-processor directives and macros, I/O handling, Header files.

Module V

Sorting and searching algorithms, String algorithms, Pattern search and text editing, Hashing.

Course outcome:

- Understand fundamental principles of problem solving.
- Familiarize the design and analysis of algorithms.
- Understand and practice the C programming language for solving mathematical and scientific problems.

Text Book:

1. K. L.P. Mishra and N. Chandrasekaran; Theory of Computer Science (Automata, Languages and Computation), 2nd Edition, Prentice-Hall Punb.India, 2016.
2. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.

Reference Books:

1. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015.
2. Robert Sedgewick; Algorithms in C, Addition-Wesley, 2010.

CS-1101	**Computer Programming Lab**	**L-T-P-C:0-0-3-2**
Familiarization of a computer and the environment for execution of sample programs involving expression evaluation, Conditionals and branching, Iteration, Functions. Applications of Arrays, Sequential and Linked linear lists, structure, pointer and dynamic memory allocation, String manipulation. Sorting and Searching algorithms and File- handling.		

PH-1001	**Engineering Physics**	**L-T-P-C:3-0-0-3**

Course objective:

- To apply basic principles of physics to engineering applications.
- To introduce advances in technology for engineering applications.
- To apply the concepts of special theory of relativity in various field of engineering.
- Explain Quantum Mechanics to understand wave particle dualism
- Explain the principles of laser and optical fibers.

Module I

Mathematical Preliminaries: Physical meaning of Gradient, Divergence and Curl. The fundamental theorem of divergences (Gauss's divergence theorem) and curls (Stokes' curl theorem). Curvilinear Coordinates: Polar coordinates, Spherical polar coordinates and Cylindrical polar coordinates. Gradient, divergence and curl in curvilinear coordinates.

Module II

Electrodynamics: Maxwell's equations: differential and integral forms, significance of Maxwell's equations, displacement current and correction in Ampere's law, Electromagnetic waves, EM wave equation, plane electromagnetic waves, Polarization of EM waves, Poynting's theorem.

Module III

Special Relativity: Basics of Special Relativity, Galilean and Lorentz transformations, Michelson- Morley experiment. Postulates of Einstein's special theory of relativity. Time dilation and length contraction, relativistic kinematics and mass-energy equivalence.

Module IV

Quantum Physics: Dual nature of matter, de-Broglie Hypothesis, Heisenberg uncertainty principle and its applications, postulates of quantum mechanics, wave function & its physical significance, probability density, Schrodinger's wave equation, Eigen values & Eigen functions, Application of Schrodinger equation.

Module V

Laser and Fiber Optics: Principles of lasers, Einstein Coefficients and their relations, Types of Lasers and their applications. Concept of optical fibers and types of optical fibers, modes of propagation, fiber optic communication, optical fiber sensors, connector and couplers.

Course outcome: Student will be able to:

- Determine gradient, divergence and curl of scalar and vector fields.
- To formulate and solve the engineering problems on electromagnetism.
- To explain special theory of relativity and apply its concepts in various fields of engineering.
- To explain fundamentals of quantum mechanics and apply it to problems on bound states.
- Describe the basics of laser physics and working of optical fibers.

Text Book:

1. Panofsky & Phillips, Classical Electricity & Magnetism, 2nd ed., Dover Publications, 2005. (Text Book).
2. Optical Fiber communication- G Keiser (McGraw Hill) (Text Book)
3. Neeraj Mehta, Applied Physics for Engineers, PHI Learning Pvt. Ltd., 2011. (Text Book)
4. Perspectives of Modern Physics, A. Beiser (Text Book).

Reference Book:

1. 1.Antennas and Wave Propagation, G.S.N. Raju, Pearson Education (Ref)
2. David J Griffith, Introduction to Electrodynamics, 4th ed. , PHI, 2014. (Ref.).
3. Paul Dirac, Principles of Quantum Mechanics, 4th ed., Oxford Uni. Press, 2004. (Ref.)

HS-1001	Professional Communication	L-T-P-C:2-0-0-2

Course objective: The course aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

Module I

Communication Fundamentals: Introduction to Verbal and Nonverbal Communication, received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

Module II

Interviewing Principles and Skills: Fundamental principles of interviewing, Interview etiquette: dress code, body language, attending job interviews, telephone/skype interview, one to one interview &panel interview, Success in an interview, Types of Interviews, Improving self-expression Important Non-verbal aspects.

Module III

Group Discussions: Methodology of GD, Improving Group performance, Developing persuasive speaking skills, Listener oriented speaking, Group discussion practice

Module IV

Professional Writing: Kinds of business letters, Job Applications and Resume Writing, Report Writing, Proposal layout and design, E-mail etiquette, Notices, Agenda and Minutes, Technical writing, business writing.

Module V

Delivering Professional Presentations: Elements of effective English, Effective paragraphs, The power of reading, Punctuation and Capitalization

Course outcome:

At the end of the course Learners will be able to

- Make effective verbal and nonverbal communication.
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Text Book:

1. Barun K. Mitra, Effective Technical Communication, Oxford University Press, Delhi.2006.

Reference Book:

1. Business Correspondence and Report Writing - R. C. Sharma
2. Business Communication - M. Balasubramanyam
3. Essentials of Business Communication - R. Pal and Kolahalli
4. Business Communication and Report Writing - Sharma, Mohan
5. Lesikar's Basic Business Communication – Lesikar

Semester II

MA1002	Mathematics II (Probability and Statistics)	L-T-P-C:3-1-0-4
Course objective:		

The main objective of this course is to provide basic principles of statistical inference students. The foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, prediction, computer networks, communication engineering etc.

Module I

Theory of Probability: Sample spaces, random experiments, conditional probability, and Bayes' theorem. Random variables and distribution functions: Binomial, Poisson, Normal, Exponential distributions, Mathematical Expectation and generating functions, Joint, marginal and conditional distributions.

Module II

Multivariate distribution: χ^2, t and F distributions. Multinomial, uniform distribution on bounded subsets of R^p, multivariate normal and Dirichlet distributions, Cauchy distributions.

Module III

Chebyshev's Inequality, Convergence in probability, Convergence almost surely, weak law of large numbers, Central and De-Moivre Laplace limit theorems.

Module IV

Sampling distribution: χ^2, t and F distributions. Estimation: Method of moments, maximum likelihood estimation, unbiasedness, consistency, comparing two estimators, confidence interval estimation for mean, difference of means, variance, proportions, sample size problems. Test of Hypothesis: Neyman-Pearson Lemma, composite hypothesis, comparison of normal populations, large-sample test, test on multinomial distributions, goodness of fit.

Module V

Curve fitting and Correlation: Principle of least squares and curve fitting, correlation and regression, scatter diagram, regression lines, bivariate frequency distribution. Theory of errors: Gauss Postulate of arithmetic mean, normal law, error function.

Course outcome:

- Acquiring a basic knowledge of Probability Theory, useful for modeling uncertain phenomena, and required for understanding the logic of Statistical Methods and Machine Learning.
- Use available resources to learn about and use other distributions as they arise.
- Understand the law of large numbers and the central limit theorem.
- Understand the difference between probability and likelihood functions, and find the maximum likelihood estimate for a model parameter.

- Present the analysis of derived statistics to all audiences

Text Book:

1. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor. 12th Edition, 2020. Sultan Chand and Sons.
2. Applied Statistics and Probability for Engineers by Douglas C. Montgomery & George C. Runger. 7th Edition, 2018. Willey.

Reference Book:

1 Fundamentals of Statistics by Goon A.M., Gupta M.K. and Dasgupta B. 2013. World Press

2. Statistical inference by H C Saxena and P U Surendran. Sultan Chand and Sons
3. Applied Probability and Statistics by Mario Lefebvre. 2006. Springer
4. Probability and Statistics by Morris H. DeGroot and Mark J. Schervish. 4th Edition. 2010. Pearson.

EC-1002	Digital Logic & Design	L-T-P-C:3-0-0-3

Course objective:

- To prepare students to understand the basic ideas and principles of digital logic levels.
- To prepare students to perform the analysis and designing of various digital electronic circuits.
- Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
- To understand and examine the structure of various number systems and its application in digital design.

Module I

Number System, Binary Codes and Boolean Algebra: Conversion of bases, Representation of negative numbers, 1's complement, 2's complement, arithmetic using 2's complement, Hexadecimal code, weighted codes - BCD, Excess-3 code, Gray Code. Logic gates, Boolean Algebra, Standard and canonical representation and minimization of Boolean expressions using Karnaugh map.

Module II

Combinational Logic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, BDC Adder. Carry Look ahead, Multipliers. Multiplexer/de- multiplexers, Encoders and Decoders, Application of universal logic gates.

Module III

Sequential Logic Circuits: Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK. Excitation tables, conversion of Flip Flops. State Diagrams.

Module IV

Counters and Registers: Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter Decoding, Counter applications. Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

Module V

Converters, Logic Families and Wave shaping using IC-555: Design of various Analog to Digital & Digital to Analog Converters. Parameters of Logic Families. Introduction to logic Families: DTL, RTL, TTL, CMOS.555 Timer, astable and monostable multivibrator and bistable multivibrator.

Course outcome:

After studying this course, the students would gain enough knowledge

- The ability to understand, analyze and design various combinational and sequential circuits.
- Ability to identify basic requirements for a design application and propose a cost effective solution.
- The ability to identify and prevent various hazards and timing problems in a digital design.
- To develop skill to build and troubleshoot digital circuits.
- Analyze various logic families.

Text Book:

1. Digital Design 5e, Mano / Ciletti, Pearson
2. Digital Circuits and Design 5e, Salivahanan, Oxford
3. Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6e, Mano, Pearson.
4. A. Anand Kumar, "Fundamental of Digital Circuits," PHI 4th edition, 2018

Reference Book:

1. Digital Electronics: Principles and Integrated Circuits, Maini, Wiley
2. Digital Electronics, Kharate, Oxford
3. Digital Design: Principles and Practices, 4e, Wakerly, Pearson
4. Subrata Ghosal, "Digital Electronics," Cengage publication, 2nd edition, 2018

EC-1102	Digital Logic & Design Lab	L-T-P-C:0-0-3-2

Digital Logic and Design Lab includes both software and hardware portion for designing, realization, analysis and implementation of various Digital Logic circuits, such as Half adder, Half subtractor, Full adder, Full subtractor, Code-converter, Universal Gates based circuit implementation, Digital-Comparator, Multiplexer, De-Multiplexer, Encoder, Decoder, +ve edge triggered Master slave JK-FF, -ve edge triggered Master slave JK-FF, Shift-register - SISO (serial in serial out) - SIPO (serial in parallel out) - PISO (parallel in serial out) - PIPO (parallel in parallel

out), ripple UP-counter, ripple DOWN-counter, and various synchronous as well as asynchronous counters.

CS-1002	Data Structure and Programming Languages	L-T-P-C:3-0-0-3

Course objective:

- Understand and remember algorithms and its analysis procedure.
- Introduce the concept of data structures through ADT including List, Stack, and Queues.
- To design and implement various data structure algorithms.
- To introduce various techniques for representation of the data in the real world.
- To develop application using data structure algorithms.
- Compute the complexity of various algorithms.

Module I

Data structures fundamentals, Abstract data types, Arrays, Sequential and linked structures, Stacks, Queues, Dynamic memory allocation, Compaction and Garbage collector, Python fundamentals, Data types, Variables, Boolean values, Operators, Functions, Tuples.

Module II

I/O Operations, Conditional execution, Loops, Logical and bit wise operations, Lists and list processing, Dictionaries and Data processing, Modules, Packages.

Module III

String and List methods, Exceptions, Trees, binary trees, binary tree traversals, Threaded trees, Applications of trees.

Module IV

Graphs, Graphs representations, Depth first and Breadth first search algorithms, minimum spanning trees, Shortest path algorithms, Application of Graphs.

Module V

Sorting and Searching, Merge-sort, Quick-sort, Heap-sort, Binary search, External search, Hashing, String algorithms.

Course outcome:

- Select appropriate data structures as applied to specified problem definition.
- Implement operations like searching, insertion, and deletion, traversing mechanism etc. On various data structures.
- Students will be able to implement linear and Non-Linear data structures.
- Implement appropriate sorting/searching technique for given problem.
- Design advance data structure using Non-linear data structure.
- Determine and analyse the complexity of given Algorithms.

Text Book:

1. Jon Kleinberg and Eva Tardos; Algorithm Design, Pearson education Inc. 2006.
2. John Jelly; Python Programming : An Introduction to Computer Science , 3rd Edition , 2016

Reference Books:

1. G. Shanker Rao; Mathematical Foundations of Computer Science, I.K. International Publishing House Private Limited, 2006.
2. A.M. Tenenbaum, Y. langsum and M.J. Augenstein; Data Structures using C, Prentice Hall of India private. Limited, 2015.
   Robert Sedgewick; Algorithms in C, Addition-Wesley, 1998.

CS-1102	Data Structures Lab	L-T-P-C:0-0-3-2

Demonstration of simple programs execution on Computer in Python. Python application in solving problems on System of n algebraic equations, Matrix manipulations, Prime numbers, Fibonacci sequences, N-Queens problems, Tower of Hanoi, Sudoku puzzles, Magic squares, Sorting and Searching, Sequential and random access files manipulations, Lists, trees and graphs.

CS-1004	Discrete Mathematics	L-T-P-C: 3-1-0-4

Course objective:

- To develop logical thinking and its applications to computer. The subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument.
- To develop the ideas to identify the several algebraic structures.
- To develop the idea to solve network problems.
- To learn the idea behind development of automaton and finite state machine.s
- To understand about limit of computability.

Module I

Logics and Predicate Calculus: Mathematical Logic: Statements and Connectives, Elementary operations of logic, Well-formed statement formulas, Equivalence of formulas, Principle of duality, Tautologies and Implications, Functional completeness of sets of connectives, Exclusive OR: NAND and NOR, Disjunctive and Conjunctive Normal forms, Propositional Logic; Inference theory, Predicates, Variables and Quantifiers, Predicate formulas, Free and Bound Variables, Universe of Discourse, Valid formulas and Equivalences, Theory of Inference for Predicate Calculus

Module II

Relations and Functions: Sets: Concept of Infinity. Cardinals and Ordinals. Countable and Uncountable Numbers. Cantor's Theorems; Relations, Properties of Relations, Equivalence relations and Partitions, Relation matrices, Counting: Principle of Inclusion and Exclusion, Functions: Characteristic Functions, Permutation Functions, Cycle decomposition of permutations, Even and Odd permutations, Growth of Functions.

Module III

Partial ordered Set and Lattices: Lattices and Boolean Algebra: Partially Ordered sets, Lattices properties of Lattices, Finite Boolean Algebras.

Module IV

Abstract Algebra Algebraic Structures, Set with one operation: Semi-group, Monoid, Group, Permutation Group; Set with two operations: Ring and Fields. Isomorphism, Automorphism and Homomorphism. Polynomial Rings and Cyclic Codes.

Module V

Graph Theory: Definition and Representation of graphs; Directed Graphs: Matrix representation of Digraphs, Path and Reachability, Transitive Closures and Warshall's Algorithm. Eulerian and Hamiltonian paths and cycles, Graph Traversal algorithms. Trees: Rooted Trees, Undirected Trees, Spanning Trees of Graphs, Algorithms for Minimal Spanning Trees.

Module VI

Modelling of Computations: Language and Grammar. Finite State Machine and Monoid. Russel's Paradox and In computability. Tractable and Intractable problems.

Course outcome:

- Expressing a logic sentence in terms of predicates, quantifiers, and logical connectives.
- Distinguishing between different infinite sets and limit of computation.
- Understanding the set of different algebraic structures.
- Solving problems using tree and graph algorithms.
- Evaluating Boolean functions and simplify expressions using the properties of Boolean algebra.

Text Book:

1. C Liu, D. Mohapatra: "Elements of Discrete Mathematics, a Computer Oriented Approach", 2nd edition.
2. Narsingh Deo: "Graph Theory with Applications to Engineering and Computer Science", Dover publications, INC. Mineola, New York (2016).
3. S. Chakrborty and B.K. Sarkar: "Discrete Mathematic",Oxford University Press, First Edi.(2013).

Reference Book:

1. Tremblay and Manoher: "Discrete Mathematical Structures with Applications to Computer Science" (Tata McGraw Hill).
2. Kolman, Busby, and Ross: "Discrete Mathematical Structures" (Prentice Hall of India).
3. Mott, Kandeland Baker: "Discrete Mathematics for Computer Scientists and Mathematicians" (Prentice Hall of India).
4. Kenneth H Rosen: "Discrete Mathematics and Its Applications", TMH Publishing.

HS-1002	Ethics & Human Values	L-T-P-C:2-0-0-2

Course objective:

- To develop a critical ability to distinguish between essence and form, or between what is of value and what is superficial, to life.

- To move from discrimination to commitment. It is to create an ability to act on any discrimination in a given situation.
- It encourages students to discover what they consider valuable. After learning the course, they should be able to discriminate between valuable and the superficial in real situations in their life.

Course content:

Module I

Human Values: Morals, Values and Ethics Integrity- Work ethic- Service learning – Civic virtue – Respect for others - Living peacefully- Caring- Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy- Self-confidence- Character- Spirituality – Introduction to Yoga and meditation for professional excellence and Stress management.

Module II

Engineering Ethics: Senses of Engineering ethics – Variety of moral issues, types of inquiry- Moral dilemmas- Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories of right action – Self-interest – Customs and Religion – Uses of Ethical theories.

Module III

Engineering as Social Experimentation: Engineering as Experimentation – Engineers as responsible experimenters – Code of ethics – A Balanced Outlook on Law

Module IV

Safety, Responsibilities And Ethics: Safety and Risk – Assessment of Safety and risk, Risk Benefit Analysis and Reducing Risk – Respect for authority – Collective Bargaining – Confidentiality – Conflict of interest –Occupational crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

Module V

Global Issues: Multinational Corporations – Environmental Ethics – Computer ethics – Weapons Development – Engineers as managers – Consulting engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of conduct – Corporate Social Responsibility

Course outcome:

- It ensures students sustained happiness through identifying the essentials of human values and skills.
- It facilitates a correct understanding between profession and happiness.
- It helps students understand practically the importance of trust, mutually satisfying human behavior and enriching interaction with nature.
- Ability to develop appropriate technologies and management patterns to create harmony in professional and personal life.

Text Book:

1. Mike W Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003
2. Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004

Reference Book:

1. Charles B Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics-Concepts and Cases", Cengage learning, 2009.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for scientists and engineers", Oxford university press, 2001
5. Laura P Hartman and Joe Desjardins, "Business Ethics: Decision making for personal integrity and social responsibility", McGraw Hill education, India Pvt, New Delhi, 2013

Semester III

MA-2001	Mathematics-III (Complex and Real Analysis, Linear Algebra)	L-T-P-C:3-1-0-4

Course objective:

- To understand the basic theory of functions of a complex variables and complex integrations.
- To understand the real valued integrations in Riemann sense.
- To understand the function and real valued integrations in measure sense.
- To equip the students with methods of solving a general system of linear equations.
- To develop the concepts of Eigen values and diagonalization of a matrix which have many applications in engineering.

Module I

Complex Variables: Algebra of complex numbers, elementary analytic functions, complex integration, series representations for analytic functions, residue theory and conformal mapping and its applications.

Module II

Linear Algebra: Matrices over a field. Matrix, characteristic and minimal polynomials, eigen values and eigen vectors. Caylay-Hamilton Theorem. Linear transformation (L.T), rank and nullity, dual space and basis, representation of L.T by matrices. Change of basis. Normal form of matrices. Invariant factors and elementary divisors. Unitary similarity, unitary and normal operators on inner product spaces. Triangular, Jordan and rational form of matrices.

Module III

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field. Archimedean property, supremum, infimum. Riemann-Stieltjes integral, properties,

integration and differentiation, fundamental theorem of calculus. Sequence and Series, convergence, limsup, liminf.

Module IV

Bolzano-Weierstrass Theorem. Heine-Borel Theorem. Sequence and Series of Function, point wise and uniform convergence, Cauchy Criterion for uniform convergence. Weierstrass's M-Test, Abel's and Dirichlet's Test for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation Theorem. Power Series, uniqueness theorem.

Module V

Abel's and Tauber's Theorem. Function of Several Variables. Directional derivative, derivative as a linear transformation. Taylor's Theorem, Inverse function and implicit function theorem, Jacobians, extremum problems with constraints. Monotone functions, types of discontinuity, functions of bounded variation, Lebesgue measure and Lebesgue integral.

Course outcome:

- Identify analytic functions, Harmonic functions, and conformal mappings.
- Solve any given system of linear equations.
- Find the Eigen values of a matrix and how to diagonalize a matrix.
- Evaluate real definite integrals as application of Residue Theorem.
- Find regions that are mapped under certain transformations.
- Identify the behavior of function several variables.

Text Book:

1. S.Ponnuswamy and H Silverman: "Complex Variables with applications", Birkhauser Pub (2006).
2. S.C. Malik and S Arora: "Mathematical Analysis", New Age Int. Pub, 2nd Edition (1992).
3. SH Friedberg, AJ Insel, and LE Spence:"Linear Algebra", Pearson Pub 5th Edition (2021).

Reference Book:

1. J.W.Brown and R.V.Churchill: "Complex Variables and Applications",McGraw Hill
2. Publication (2013).
3. K Hoffman and R. Kunje: "Linear Algebra" Prentice-Hall Inc (1971).
4. H.L. Royden: "Real Analysis" Pearson Pub., 4th edition (2010).

CD-2001	Python Programming	L-T-P-C:3-0-0-3

Course content:

Module I

Introduction, Data Types and Operators: Installation and working with Python, Variables and data types in python, Perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations.

Module II

Python Decision making and Loops: Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, Continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.

Module III

Python Functions and Modules: Defining custom functions, Organizing Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with dictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages

Module IV

Python File Operations: An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises.

Module V

MicroPython: Introduction, main difference between MicroPython and Python, Installation of MicroPython on Hardware, MicroPython libraries, GPIO programming on MicroPython Hardware, Sensor Programming using MicroPython.

Course outcome:

The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

Text Book:

1. Introduction to Computation and Programming Using Python, John V Guttag, PHI.
2. Fundamentals of Python – First Programs, Kenneth A. Lambert.

Reference Book:

1. Python Programming Fundamentals- A Beginner's Handbook, Nischay kumar Hegde.

CD-2101	Python Programming Lab	L-T-P-C:0-0-3-2

Control structures, list and tuples, conditional statements and loops, functions, Import a module, plot data, MicroPython and NodeMCU. Configure NodeMCU for MicroPython. MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board. Connect Digital/Analog I/O module with NodeMCU, Display temperature in MicroPython, Connect NodeMCU with with WiFi Access Point and transmit data

from NodeMCU to Cloud. Connect Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service).

CD-2003	Computer Organization and Architecture	L-T-P-C:3-0-0-3

Objectives:

- To understand the structure, function and characteristics of computer systems.
- To understand the design of the various functional units and components of computers.
- To identify the elements of modern instructions sets and their impact on processor design.
- To explain the function of each element of a memory hierarchy,
- □ To identify and compare different methods for computer I/O.

Module I

Introduction: Organization and Architecture, Block diagram of digital computer, Structure and function, Register Transfer language, Register transfer Bus and Memory transfer.

Module II

Computer Arithmetic: Arithmetic micro operations, Logic micro operations, Shift micro operations and Arithmetic logic shift unit, Addition and Subtraction, Multiplication Algorithms and Division Algorithms, Floating Point representation and its Operations

Module III

Computer Organization and Design: Instruction codes, Computer Registers, Computer instructions, Instruction cycle, Memory-reference Instructions, Register reference instructions, Input-output and Interrupt, Stack organization, Instruction formats, Addressing modes, Data Transfer and manipulation, Program control, Reduced Instruction set computer.

Module IV

Pipeline Processing and Memory Organization: Pipeline Processing- Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline, memory organization – Memory Hierarchy, Main memory, Auxiliary memory, Associative memory, Cache memory, and Virtual memory.

Module V

Input – Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt Direct memory Access, Input-Output Processor, Serial Communication.

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

- Understand the theory and architecture of central processing unit.
- Analyze some of the design issues in terms of speed, technology, cost, performance.
- Design a simple CPU with applying the theory concepts.
- Use appropriate tools to design verify and test the CPU architecture.
- Learn the concepts of parallel processing, pipelining and interprocessor communication.

- Understand the architecture and functionality of central processing unit.
- Exemplify in a better way the I/O and memory organization.
- Define different number systems, binary addition and subtraction, 2's complement representation and operations with this representation.

Text Book:

1. M .Morris Mano, Computer System Architecture, 4th edition, Pearson/PHI, 2016.

Reference Book:

1. William Stallings, Computer Organization and Architecture Designing for Performance, 6th edition, Pearson Education, 2016.
2. Carl Hamacher, Computer Organization, 5th edition, McGraw Hill Publishers, 2011.

CD-2103	Computer Organization and Architecture Lab	L-T-P-C:0-0-3-2

Course Objectives:

1. Understanding the behavior of Logic Gates, Adders, Decoders, Multiplexers and Flip-Flops.
2. Understanding the behavior of ALU, RAM, STACK and PROCESSOR from working modules and the modules designed by the student as part of the experiment.

List of Experiments:

1. Study and design of various adder, subtractor, multiplexer.
2. Design of ALU with at least 8 operations.
3. Design of simple memory with m number of address lines and n number of data lines.
4. Design of Associative/Direct mapped cache memory design
5. Using Xilinx timing analysis tools finding cycle time and pipelining gain. Using Xilinx or ModelSim (Simulator) design a pipelined processor.
6. Write or modify programs to test all the different hazard cases.

EI-2001	Analog & Linear Integrated Circuit	L-T-P-C:3-0-0-3

Course objective:

- Elucidate and design of Analog amplifier and Feedback circuits
- Acquaint with the theoretical & practical aspects of Op-amp with different linear and non-linear applications.
- Illustrates the function of application specific ICs such as Voltage regulators, PLL for different electronic applications.

Module I

Basics of Analog Amplifier: Differential amplifier, configurations, AC analysis, constant current bias, Darlington pair, current mirror, cascaded differential amplifier stages, effect of coupling, level translator.

Power Amplifiers Classification: A, B, AB, C Classes, Efficiency, Push Pull Configuration, Complimentary Symmetry, Second Harmonic & Cross Over Distortion.

Module II

Feedback Amplifier and Oscillator: Concept of feedback, types of feedback – their advantages and disadvantages, effect of feedback on frequency response & impedances, Analysis of different feedback amplifiers. Voltage-series and Current shunt Feedback amplifiers using FET.

Oscillators Stability, Barkhausen Criteria, RC, LC & Crystal Oscillators

Module III

Basics of Operational Amplifier: Op-amp (symbol, equivalent circuit and its analysis, open loop transfer characteristics), Ideal op-amp based basic configurations (inverting amplifier, non-inverting amplifier, voltage follower, summing amplifier using inverting and non-inverting configurations, differential input-differential output amplifier, difference amplifier, instrumentation amplifier, I to V converter, V to I converter, integrator, differentiator, Practical op-amp IC741 characteristics Input/output Impedance, Slew Rate, CMRR etc.

Module IV

Applications of Operational Amplifier: Design and analysis of first and higher order low pass, high pass, band pass (wide and narrow band) and band elimination (wide and narrow band) and all pass active filters;Log and anti-log amplifiers, analog multipliers, precision circuits (half-wave and full wave rectifiers, positive and negative clipper circuits, positive and negative clamper circuits, peak detector circuits), comparator and Schmitt trigger circuits, sample-and-hold circuits. Sinusoidal oscillators (oscillators based on phase-shift, Wien bridge, Hartley, Colpitt, crystal), Non-sinusoidal oscillators (square and triangular waveform generators), Data converters: Binary weighted, R-2R digital to analog converters, flash type, successive approximation type, counter type, dual slope analog to digital converters.

Module V

Special Function ICs: Timer IC-555, Multivibrators, Voltage controlled oscillator, Phase-locked loop, Voltage regulators, Voltage to Frequency converters, OTA, Opto-couplers and fibre optic IC.

Course outcome:

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

- Design Analog amplifier and feedback circuits.
- Demonstrate linear and non-linear applications of an Op-amp and special application ICs.
- Design linear and non-linear applications of operational amplifiers.

Text Book:

1. S. Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, McGraw-Hill Education, 4th Edition, 2016.
2. D. R. Choudhry and S. B Jain, “Linear Integrated Circuits”, New Age International, 5th Edition, 2018.

3. Jacob Millman and Christos C. Halkias,"Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill Education, 2nd Edition, 2011.

Reference Book:

1. S. Salivahan, "Linear Integrated Circuits", McGraw-Hill Education, 2nd Editon, 2017.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2nd Edition, 2017.

EI-2101	Analog & Linear Integrated Circuit Lab	L-T-P-C:0-0-3-2

Experiments related to Differential amplifier, Oscillator, Power amplifier, Inverting and non-inverting amplifier, Integrator and differentiator, Zero-crossing detector, Summing amplifier, Logarithmic and antilogarithmic amplifier, Schmitt trigger, Second and third order low and high pass filter, Band pass filter, square wave and triangular wave generators, Astable and monostable multivibrator, RC phase shift oscillator, D/A and A/D converter and PLL.

Project:

Mini project based on operational amplifier applications.

EI-2003	Circuit Analysis & Synthesis	L-T-P-C:3-0-0-3

Course objective:

- To develop an understanding of the fundamental laws and elements of electrical circuits.
- To learn the energy properties of electric elements and the techniques to measure voltage and current.
- To develop the ability to apply circuit analysis to DC and AC circuits.
- To understand transient and steady-state response of RLC circuits and to understand advanced mathematical methods such as Laplace transforms for solving circuit problems.
- To provide an exposure to P-Spice.

Module I

Node and Mesh Analysis: Node and mesh equation, matrix approach of complicated networkcontaining voltage and current sources, and reactance, source transformation and duality.
Network Theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, Millar's theorem, compensation and Tallegen's theorem as applied to AC. circuits.

Module II

First order circuits: RC, RL, and RLC networks with and without initial conditions, with Laplace transforms evaluation of initial conditions, Q factor.

Module III

AC Circuit Analysis: Instantaneous and average power, RMS value, apparent power and power factor, Behavior of series and parallel resonant circuits, Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero integral solutions, locations, Behavior of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Module IV

Two Port Network Analysis:

Z, Y, h, ABCD parameters and circuit analysis, Analysis of a transistor amplifier using h parameters.

Feedback and Amplifiers

Different types of feedback, Amplifiers

Course Outcome:

Upon Completion of the course, the students will be able to:

- Apply the knowledge of basic circuital laws and simplify the dc and ac networks using reduction techniques.
- Analyze the dc and ac circuits using mesh and nodal analysis and network simplification theorems.
- Analyze the series and parallel resonant circuits.
- Infer and evaluate transient response, steady state response of series, parallel and compound circuits.
- Develop Laplace transformed network for steady state and transient analysis.
- Analyze dc and ac circuits and time domain response using P-Spice.

Text Book:

1. Charles Alexander and Mathew Sadiku, "Fundamentals of Electric Circuits", 5th Edition, 2014, TMH.
2. Van Valkenburg; Network analysis, 3rd Edition, 2019, Pearson

Reference Book:

1. A. Sudhakar, S.P. Shyammohan, Circuits and Network, 5th Edition, 2017, Tata Mcgraw-Hill New Delhi.
2. Jhon Bird, Electrical Circuit Theory and Technology; 3rd Edition, 2016, PHI.

HS-2001	Management Concepts and Organizational Behavior	L-T-P-C:3-0-0-3

Course objective:

- To expose the students to basic concepts of management.
- To equip the students with requisite knowledge, skills & right attitude necessary to understand behavioral processes at individual, team and organizational level.
- To provide effective leadership in a global environment.

Module I

Introduction of Management- Meaning, definitions, nature of management; Managerial levels, skills and roles in an organization; Functions of Management: Planning, Organizing, staffing, Directing & Controlling, Interrelationship of managerial functions, scope of management & Importance of management.

Module II

Introduction of organization: - Meaning and process of Organization, Management v/s Organization; **Fundamentals of Organizational Behavior:** Concepts, evolution, importance and relationship with other Fields; Contemporary challenges and opportunities of OB. **Individual Processes and Behaviour**-**Personality**- Concept, determinants and applications; **Perception-** Concept, process and applications, **Learning**- Concept (Brief Introduction); **Motivation-** Concept, techniques and importance

Module III

Interpersonal Processes- **Teams and Groups**- Definition of Group, Stages of group development, Types of groups, meaning of team, merits and demerits of team; difference between team and group, **Conflict-** Concept, sources, types, management of conflict; **Leadership:** Concept, function, styles & qualities of leadership. **Communication –** Meaning, process, channels of communication, importance and barriers of communication.

Module IV

Organizational Processes: Organizational structure - Meaning and types of organizational structure and their effect on human behavior; **Organizational culture -** Elements, types and factors affecting organizational culture. **Organizational change:** Concept, types & factors affecting organizational change, Resistance to Change.

Course outcome: At the end of the course, student will able to

1. Apply the managerial concepts in problem-solving for effectively managing the organizational processes.
2. Apply interpersonal skills within and outside of organization effectively.
3. Understand the individuals and groups inside organizations.
4. Understand the organizational culture and change

Text Book:

1. Robbins, S.P. and Decenzo, D.A. Fundamentals of Management, Pearson.
2. Stoner, J et. al, Management, Prentice Hall of India
3. Moorhead, Griffin, Introduction to Organizational Behaviour, Cengage.
4. Hitt, Miller, Colella, Organizational Behaviour, Wiley
5. Robbins, S.P. & Judge, T.A., Organisational Behaviour, Prentice Hall of India

Reference Book:

1. Ghuman Karminder, Aswathappa K., Management concept practice and cases, Mc Graw Hill.
2. Satya Raju, Management – Text & Cases, PHI.
3. Pareek, Udai, Understanding Organizational Behavior, Oxford
4. K. Awathappa, Organizational Behavior, HPH.
5. Kavita Singh, Organizational Behavior: Text and cases, Pearson.

Semester IV

EI-2002	Electromagnetic Theory	L-T-P-C:3-1-0-4

Course objective:

- To understand the fundamental principles and laws of electromagnetic propagation and radiation effects.
- To understand operation of transmission line and waveguide.

Module I

Introduction to co-ordinate systems:-Cartesian coordinate, Cylindrical Coordinates, Spherical Coordinates, Inter Coordinate Transformation; Differential length, Area and Volume, Line, Surface and Volume Integrals; Divergence Theorem, Stokes's Theorem; Electric Field Intensity:-field of line charge, sheet charge, continuous volume charge distribution; Electric flux density, Gauss Law, Applications of Gauss Law; Definition of Electric potential, work, Energy potential difference, Potential field of different types of charges, Potential gradient, dipole and field due to a dipole, Energy density in the electric field.

Module II

Time Varying Fields and Maxwell's Equation: Gauss's law, Poisson's and Laplace's Equations, Ampere's Circuit Law, Magnetic Flux Density, Faraday's Law, Introduction of Maxwell's equations, displacement current, equations of continuity for time varying field.

Module III

Wave equation in an isotropic homogeneous medium and its solution, phasor notation, polarization of waves, reflection and refraction of plane waves at plane boundaries, Poynting vector.

Module IV

Waveguides and Planar Transmission Lines: Electromagnetic fields in parallel-plate, rectangular, and circular waveguides, TE and TM modes, wave impedance, wave velocities, attenuation in waveguides, Electromagnetic fields in microstrip lines, and co-planar waveguides.

Module V

Transmission Lines: Time-domain analysis of transmission lines; Bounce diagrams; Frequency-domain analysis of transmission lines; Standing waves; Smith chart; Transmission line matching: Single and double-stub matching, Types of antenna and their applications.

Course outcome:

- It will get you ready for advanced courses in antenna, microwave, radar, and wireless Communication.
- Ability to understand and compute Electromagnetic fields and apply them for design and

Analysis of electrical equipment and systems.

Text Book:

1. Sadiku Matthew N.O. "Elements of Electromagnetic", Oxford University Press.
2. Hayt, W. H. and Buck J. A., "Engineering Electromagnetics", Tata Mc Graw Hill.

Reference Book:

1. Pozar D.M. "Microwave Engineering", Fourth Edition, John Wiley & Sons Inc.
2. Joseph Edminister, Vishnu Priye," ELECTROMAGNETICS", Schaum's Outline Series.

EI-2004	Microprocessors and Microcontrollers	L-T-P-C:3-0-0-3

Course objective:

- Understand basics of microcontrollers and microprocessor, their architecture, internal organization and their functions, interfacing an external device with the controllers/processor.
- Design and analyze real world applications using microprocessors and microcontroller.

Module I

Introduction to 8085: Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

Module II

System Bus Structure: Basic configurations – System bus timing –System design using 8085 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors

Module III

Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Interrupt controller – DMA controller – Programming and applications

Module IV

Microcontroller: Architecture of 8051 – Special Function Registers (SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming and interfacing-system design using 8051.

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

- Recall and apply a basic concept of digital fundamentals to microprocessor based personal computer system.
- Distinguish and analyze the properties of Microprocessors & Microcontrollers.
- Interface different external peripheral devices with microprocessors and microcontrollers.

Text Book:

1. Ramesh Gaonkar, "Microprocessor architecture, programming, and application with the 8085", Penram International, 6th Edition, 2020.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.
3. Doughlas V. Hall, Microprocessors and Interfacing, TMH, 3rd edition, 2017.

Reference Book:

1. Ashok Kumar Mukhopadhyay, "Microprocessor, Microcomputer and Their Applications", 3rd Edition, Alpha Science International Limited, 2007.
2 K.Uma Rao, Andhe Pallavi, "The 8051 microcontrollers, architecture and programming and applications", Pearson, 2009.
3.Liu & Gibson, "Microcomputer Systems - The 8086/8088 Family Architecture, Programming and Design", Pearson, 2nd Edition, 2015.

EI-2104	Microprocessors and Microcontrollers Lab	L-T-P-C:0-0-3-2

Programming using 8085 kit: Simple programs based on the arithmetic and logical operation; Design of a variable time delay counter (mod 8); Measuring pulse width of a square wave.
Interfacing: stepper motor, matrix keyboard (4×4), traffic light controller; Implementing ADC, Generating triangular saw tooth and square wave; Communication between microprocessors using 8255 PPI chip; Generate various waveforms using DAC.
Simple project using Raspberry Pi and Arduino.
Programming using 8051 kit: Simple programs based on the arithmetic and logical operation; delay generation; Interfacing; waveform generation using DAC.

EI-2006	Signals and Systems	L-T-P-C:3-0-0-3

Course objective:

- Analyze signals and systems to represent real world system in terms of both the time and transform domains.
- Develop the mathematical skills to design solutions to real world problems using convolution, filtering, modulation and sampling.

Module I

Introduction to Signals and Systems: Signal basics, classification of signals, Elementary signals, Transformations of the independent variables, Exponential and Sinusoidal signals, signal operations, signal properties, Sampling and Reconstruction of signals, System basics, classification of systems, Continuous-Time Systems, Discrete-Time Systems, system properties, linearity, time/shift-invariance, causality, stability.

Module II

Linear Time-invariant Systems: Continuous-time Linear Time-invariant (LTI) system, Discrete-time LTI system, Properties of LTI systems, Impulse response and step response, response to an arbitrary input, Convolution, Correlation, System representation through linear constant coefficient differential equations.

Module III

Frequency Analysis of Signal and Systems: Fourier series representation of continuous-time periodic signals, Properties of continuous-time Fourier series, Fourier series and LTI systems, Representation of aperiodic signals, The Fourier transform for periodic signals, Properties of the Continuous-time Fourier transform (CTFT), Convolution and multiplication properties and their effect in the frequency domain. Frequency Analysis of Continuous-Time Signals, Frequency Analysis of Discrete-Time Signals, Properties of Discrete-Time Fourier Transformation (DTFT), Frequency-domain characteristics of Liner-Invariant Systems

Module IV

Laplace Transform and Z -Transform: The Laplace transforms for continuous-time signals and systems, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform, z-transformation, Properties of the Z-Transformations, Inversion of the z-transform, The One-Sided Z-transformation, Analysis of Linear-Time-Invariant Systems in the Z-Domain.

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

- Classify signals and systems based on their properties and determine the response of LTI system using convolution.
- Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.
- Analyze system properties based on impulse response and Fourier analysis.
- Apply the Laplace transform and Z- transform to analyze continuous-time and discrete-time signals and systems.

Text Book:

1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, “Signals and Systems”, Prentice Hall, 2nd Edition, 2003.
2. B.P. Lathi, “Principles of Linear Systems and Signals”, Oxford University Press, 2nd Edition, 2009.

Reference Book:

1. M. J. Roberts, “Fundamentals of Signals & Systems”, Tata McGrawHill, 2007.
2. R. E. Zeimer, W. H. Tranter and R. D. Fannin, “Signals & Systems - Continuous and Discrete”, Pearson Education, 2007.
3. S. Haykin and B. V. Veen, “Signals and Systems‖ 2nd Edition”, Wiley, 2007.

EI-2008	Analog Communication	L-T-P-C:3-0-0-3

Course objective:

- To analyzed nature of transmission and reception of baseband signals.
- To introduce the students to various modulation and demodulation techniques of analog communication i.e. amplitude, angle and pulse modulation.
- To analyze the noise performance of the communication system.

Module I

Introduction to Fourier Series and Fourier Transform; Energy and Power Spectral Densities; Introduction of communication, Elements of Communication System-Transmitters, transmission channels and receivers; Concepts of modulation and need for modulation.

Module II

Amplitude modulation (AM): Time domain expression of baseband signal; modulation index, frequency domain (spectral) representations, phasor diagram, AM transmission bandwidth; AM for a single tone message- carrier and side band components; Transmission requirements for AM, normalized power and side band power. Double side band suppressed carrier modulation (DSB-SC) - time and frequency domain expressions; Transmission requirements for DSB, bandwidth and transmission power for DSB-SC; Generation of DSB-SC, square law modulators, balanced modulators, ring modulators, switching modulators. Single side band modulation (SSB):Basic concept, SSB with suppressed/reduced carrier, advantages and generation of SSB; transmit band width and power, side band filter examples; Vestigial side band modulation (VSB)- Basic concept and application

Module III

Demodulation of AM signals- square law and envelope detectors; The super heterodyne receiver for standard AM radio; Synchronous demodulation of AM, DSB and SSB using synchronous detection, Effects of frequency and phase errors in the local oscillator in DSB and SSB Demodulation of SSB with pilot carrier, use of SSB in telephony. Phase-Locked Loop (PLL): Carrier recovery circuits, Basic operation of PLL, mathematical analysis, applications.

Module IV

Angle Modulation (FM/PM): Instantaneous frequency instantaneous phase, time domain representation for FM and PM; Narrow band angle modulation with frequency and phase,

modulation index, Phasor diagram; FM and PM signals for a single tone message, spectral representation, power and effective bandwidth; Generation of wide band FM using Armstrong method, commercial FM requirements. Detection of FM and PM signals, limiter discriminator; Demodulation of PM using PLL; FM broadcasting and stereo FM radio.

Module V

Noise Performance of Analog Communication Systems: Signal-to-noise ratio (SNR) in linear modulation, synchronous detection of DSB; SNR for AM, DSB and SSB; comparison of DSB, SSB and AM; Effect of noise in envelope and square law detection of AM, threshold effects in nonlinear detectors; SNR for FM, SNR improvement using pre-emphasis and de-emphasis. FM threshold effects; Comparison of linear and exponential modulation system for additive white band-limited noise channels.

Module VI

Pulse Modulation, Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation & demodulation of PWM, PPM, Generation and demodulation of PPM.

Course outcome:

This course is designed to cover the fundamentals, principles, concepts, and techniques of analog communication systems like i.e. amplitude, angle and pulse modulation. The outcome of course are:

- Student will understand the various modulation technique and its practical implementation.
- Analyze the communication system in presence of noise in communication the channel.

Text Book:

1. J. G. Proakis and M. Salehi, "Communication Systems Engineering", Pearson Education India; 2nd edition (2015).
2. S. Haykin, "Introduction to Analog & Digital Communication Systems", Wiley, 2nd edition (2012).

Reference Book:

1. T. Schilling, "Principles of Communication system", McGraw Hill Education, 4th edition (2017).
2. G. Kennedy, B. Davis, S. Prasanna, "Electronic Communication Systems", McGraw Hill, 5th edition (2011).
3. B. P Lathi, "Modern Analog & Digital Communication Systems", Oxford; 4th edition (2011)

EI-2108	Analog Communication Lab	L-T-P-C:0-0-3-2

To design, verification and analyses the concepts of Sampling Theorem, Amplitude, DCB-SC, Frequency, Pulse Amplitude, Pulse Width, Pulse Position Modulation and Demodulation through software and hardware equipment. Also, analyses the white noise and limit the wide band & narrow band frequency range of the noise, Analog Multiplexing and Demultiplexing.

EI-2010	Control System	L-T-P-C:3-0-0-3

Course objective:

- To be able to analyze a working mathematical model of control systems.
- To be perform time-domain and frequency-domain analyses of the mathematical model to predict the transient and steady state system performance.
- Design a stable control system satisfying requirements of stability and reduced steady state error.

Module I

Introduction: Motivation, Examples and case studies of control systems, Control system Components: Sensors, Actuators, Computational blocks, And feedback control systems: open loop and closed loop control system.

Mathematical modelling: Mathematical modelling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. State-space modelling of dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula.

Module II

Time-domain analysis of closed loop systems: Test signals, time response of first and second order systems, Time domain performance specifications, e. g. rise time, peak time, settling time, peak overshoot for the second and higher order system. Effects of a Pole and Zero on the Second-Order System, Steady state error and error constants for type 0, type 1 and type 2 system.

Feedback control actions: Proportional, derivative, integral control and PID control.

Module III

Solution of state equation: Eigen values & eigenvectors digitalization state transitive matrix, stability Routh-Hurwitz stability analysis. Characteristics equation of closed loop system root loci, construction of loci, Effect of adding, poles and Zeros on the loci, Stability by root loci

Module IV

Frequency Domain analysis: Bode and Nyquist plots, Effect of adding, poles and Zeros, Polar plot, Nyquist stability analysis, Relative stability: Gain and phase margins.

Module V

Frequency-Domain compensation: lead lag, Lag-lead compensation, Design of compensating networks. State Space Analysis: Transfer Matrix, Controllability and Observability.

Course outcome:

- After the successful completion of the course the students will be able to:
- Develop the mathematical model of the physical systems.
- Analyze the response of the closed and open loop systems.
- Analyze the stability of the closed and open loop systems.
- Design the various kinds of compensator.
- Develop and analyze state space models.

Text Book:

1. Nise Norman S., Control Systems Engineering, Wiley India, 7th edition (2018)

2. I. J. Nagrath and M. Gopal, Control system Engineering, New Age International, 5th edition (2009).

Reference Book:

1. Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition, (2000).
2. 2. Kuo B.C., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition, (1991).

ES-2002	Environmental Sciences & Green Technology	L-T-P-C:2-0-0-2

Course objective:

- To develop an understanding of the environment, resources and climate change issues.
- To enable the students to assess the environmental impact.
- To understand the linkage between biology, physics, chemistry, earth and atmospheric sciences.

Course content:

Module I

Introduction to Environmental Pollution: Introduction to Environmental Pollution: Environmental Awareness, Concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow.

Module II

Atmosphere & Air Pollution: Air pollution- Introduction, Layers of atmosphere and their significance; Ozone depletion, Greenhouse effect and Global warming; Classification of air pollutants, Indoor air pollution, Smog-photochemical and Acid rain.

Module III

Air Pollution Monitoring & Control: Pollution Sources: Stationary & Mobile Emission Sources, Monitoring & Control of air pollutants using high volume sampler, cyclone separators, wet scrubbers, electrostatic precipitators, etc.

Module IV

Water Pollution: Water Resource; Water Pollution: Definition, Classification, Sources of Contamination, Pollutants & their Detrimental Effects; Water Quality Monitoring, Municipal Water Treatment: Slow and Rapid Sand Filter, Disinfection – Methods, Advantages & Disadvantages, and Sterilization.

Module V

Soil and Noise pollution: Lithosphere and Soil profile, Soil contamination, sources of soil contamination, Important environmental properties of soil contaminants, Ecological & Health effects, Exposure & Risk Assessment. Noise pollution: Brief introduction to noise pollution, source, measurement and prevention of noise pollution

Module VI

Radioactive Pollution: Radioactive pollutant: units of radiation and instruments for their measurements, types of radioactive pollutants and risk factor associated with these radiations Radioactive waste and their disposal, accidental leakage of radiation from nuclear reactors.

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

- Identify formula and solve environmental problems
- Apply engineering equipment to solve environmental problem.
- Develop equipment for Green Technology in the society.

Text Book:

1. De. A. K., Environmental Chemistry: New Age International (P) Ltd. Publishers.
2. Environmental Engineering, S.C. Sharma, Khanna Publishing House
3. Basic Environmental Engineering, R.C. Gaur, Newage Publications

Reference Book:

1. Miller, T. G. Jr., Environmental Science, Wadsworth Publishing House, USA
2. Connell, D. W., Basic Concepts of Environmental Chemistry
3. Environmental Engineering, Dr. AK Jain (ISBN: 978-93-86173560), Khanna Publishers

Semester V

CD-3005	Database Management Systems	L-T-P-C:3-0-0-3

Course objective:

- The focus of this course is on database design, architecture, and relational models.
- Normal forms, Internal schema and Database design would also be explored
- Also Focus on DBMS Transactions and Introduction to distributed Databases.

Module I

Introduction: Basic concepts, Advantages of a DBMS over file-processing systems, Data abstraction, Data Models and data independence, Components of DBMS and overall structure of DBMS, Data Modeling, entity, attributes, relationships, constraints, keys E-R diagrams, Components of E-R Model.

Module II

Relational Mode: Relational Model: Basic concepts. Attributes and domains, concept of integrity and referential constraints, schema diagram. Relational Query Languages: Relational Algebra and Relational Calculus: Tuple relational and domain relational calculus.

Module III

SQL: Introduction to SQL, Characteristics and advantages of SQL, SQL Data Types and Literals, DDL, Tables: Creating, modifying, deleting, Views: Creating, dropping, Updating using Views, DML, SQL Operators, SQL DML queries, SELECT query and clauses, Set Operations, Predicates and Joins, Set membership, Tuple variables, set comparison, ordering of tuples, aggregate

functions, nested queries, Database modification using SQL Insert, Update and Delete queries, Dynamic and Embedded SQL and concept of stored procedures, Query-by-example.

Module IV

Relational Database Design: Notion of normalized relations, functional dependency, decomposition and properties of decomposition, Normalization using functional dependency, Multi-valued dependency and Join dependency. Storage and File Systems: Secondary Storage, RAID, File Organization, Indices, Static and Dynamic Hashing, B-trees and B+ Trees

Module V

Query Management and Transaction Processing: Measures of query cost, Selection operation, sorting and join operation, Transaction Concept, Components of transaction management, Concurrency and recovery system, Different concurrency control protocols such as timestamps and locking, validation, Multiple granularity, Deadlock handling, Different crash recovery methods such as log-based recovery, shadow paging, Buffer management and Remote backup system.

Module VI

Object-Based Databases: Nested Relations, Complex Types and Object Orientation, Querying with Complex Types, Creation of Complex Values and Objects, Comparison of Object-Oriented and Object-Relational Databases. Database Architectures: Database system Architecture: Centralized, Client Server, Parallel and Distributed Systems. Web enabled System.

Course outcome:

- Learner would appreciate the systematic design and principals involved in any database development.
- The importance of canonical normal forms and its design in large scale database systems would be a secondary outcome of this course

Text Book:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database system concepts", 5th Edition, McGraw Hill International Edition.
2. 2. Raghu Ramkrishnan, Johannes Gehrke, "Database Management Systems", Second Edition, McGraw Hill International Editions.

Reference Book:

1. Rob Coronel, "Database systems: Design implementation and management", 4th Edition, Thomson Learning Press.
2. 2. Ramez Elmasri and Shamkant B. Navathe, "Fundamental Database Systems", Third Edition, Pearson Education, 2003.

CD-3105	Database Management Systems Lab	L-T-P-C:0-0-3-2

1. ER diagrams exercise and SQL, PL-SQL: Modeling exercises for ER Diagrams, Identification of Attributes & Keys. Design Discussions. SQL Commands and Queries (20-25 Queries to be written and data retrieved)
2. Writing SQL Triggers & Assertions.
3. Mini Project implementation (Details of following are given to the students with functional components with project tasks:
4. Draw ER Diagram, Schema of each table required in Project, Normalize all table up to 3NF, Implementation Task: User Interface creation and Report generation.
5. Each student is assigned with a problem. The student is to develop a logical and physical database design for the problem.
6. The logical design performs the following tasks: Map the ER/EER diagrams to a relational schema. Be sure to underline all primary keys, include all necessary foreign keys and indicate referential integrity constraints.
7.Perform physical design based above logical design using Oracle/MSSQL on Windows platform and MySQL/PostgreSQL on Linux platform
8.Perform DML and DDL using all possible SQL commands and with the help anyone host languages like C, C++, VB etc. (i.e. embedded SQL)
9. Perform DML and DLL using PL/SQL and PL/pgSQL for the above problems.
10. Assignment based on object based database.
11. Assignment based on Indexing.
12. Design a mini project for any live problem as per SE constraints and implement using the techniques studied for above assignments.

EI-3001	Digital Communication	L-T-P-C:3-0-0-3

Course objective:

- To present the basic principles that underline the analysis and design of digital communication systems.
- Transmission of information in digital form from a generating source to one or more destinations.
- Analysis and design of communication systems affected by the characteristics of physical channels through which the information is transmitted.

Module I

Representation and processing of signals, Comparison of analog and digital communication, Conversion of analog signal to digital form, Baseband signal, Band pass signal, Block diagram of digital communications, Signal processing operations in digital communications, Quantitative analysis of modulation schemes

Module II

Baseband and Bandpass transmission through AWGN channel, PAM, Pulse code modulation, Delta modulation, Multiplexing, Correlation receiver, Matched filter, Digital modulation schemes-M-ary PSK, M-ary QAM, and M-ary FSK, Coherent and noncoherent modulation techniques

Module III

Receiver structure and error performance, Comparison of modulation schemes. Digital transmission through band-limited (BL) channel, Design of BL signals with zero ISI; Design of BL

signals for controlled ISI- partial response signals; Design of transmitter and receiver for known channel, Synchronization.

Module IV

Channel capacity and coding, channel models, channel capacity and bounds on communication, Source coding and channel coding for reliable communication, Multiple Access Communication: TDMA, FDMA, DS SS, FHSS, OFDM and their applications.

Course outcome:

- Model a digital communication system.
- Understanding of the fundamental concepts and techniques, used in the design, performance analysis, and implementation of current communication systems and useful in the development of the communication systems of the future.

Text Book:

1. J. G. Proakis and M. Salehi, Communication Systems Engineering, Pearson.
2. B. Sklar, Digital Communication: Fundamentals and Applications, Pearson, 2001.

Reference Book:

1. B.P. Lathi, Zhi Ding,"Modern Digital And Analog Communication Systems"4th Edition, Oxford press.
2. J. G. Proakis, Digital Communications, McGraw-Hill, 5th Ed.
3. S. Benedetto and E. Biglieri, Principle of Digital Transmissions, Kluwer.
4. Simon Haykin, "Communication System" 5th Edition, John Wiley and sons.
5. A. B. Carlson, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, McGraw-Hill.
6. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques: Signal Design and Detection, PHI.

EI-3101	Digital Communication Lab	L-T-P-C:0-0-3-2

Random binary signals, Unipolar NRZ, Polar NRZ line codes, Unipolar RZ and Polar RZ line codes, Conversion of analog signal into PCM format, Delta Modulator**,** ASK Modulator and demodulator, PSK Modulator and demodulator, FSK Modulator and demodulator, BER calculation using Monte Carlo simulation, Impairments of signals generated for different modulation formats, Multiplexer and de-multiplexer of digital signals.

Project:

Familiarization with digital communication system design

EI-3003	Embedded Systems	L-T-P-C:3-0-0-3

Course objective:

- Understand architecture and advanced features of embedded processors.

- Understand ARM processor registers, instruction pipeline, interrupts and architecture.
- Understand building blocks of Internet of Things and characteristics.

Course Content:

Module-I

Introduction to Embedded Systems: Definition of embedded system, classification, embedded systems v/s general computing, details of various embedded components, sensors & actuators, major application area, purpose if embedded system, characteristics and quality attributes of embedded systems

Module-II

Arduino: The Arduino Platform, Block diagram, Architecture, Pin functions, overview of main features such as I/O Ports, timers, interrupts serial port, PWM and Arduino programming.

Module-III

ARM: ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families. Instruction Sets: Data processing instructions, addressing modes, branch, load, store instructions, PSR instructions, and conditional instructions, ARM programming and case studies.

Module-IV

Embedded Firmware Design: Embedded firmware design approaches and development languages. **Operating System for Embedded System:** Types of operating system, tasks, process and threads, multiprocessing and multitasking, task scheduling, task synchronization, how to choose an Operating system.

Module-V

IoT: Internet of Things basics and vision, IoT Platform overview, IoT architecture and applications, Security aspects in IoT, IoT Application protocols, case study & advanced IoT applications.

Course outcome:

Upon Completion of the course, the students will be able to:

- Understand architecture and instruction set for advanced embedded processors and controllers.
- Work with suitable embedded processors for a specific real world application.
- Learn application of IoT in Industrial and Commercial Automation along with Real World Design Constraints.

Text Book:

1. K. V. Shibu, “Introduction to embedded system”, McGraw Hill.
2. R. S. Kaler, “Microprocessors and Microcontrollers”, Wiley, Third Edition.
3. A. N. Sloss, D. Symes, and C. Wright, "ARM system developer's guide: Designing and optimizing system software", Elsevier, 2008
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hand Approach)”, 1st Edition, VPT, 20142.

Reference Book:

1. Daniel Tabak, “Advanced Microprocessors”, McGraw Hill. Inc., 1995.

2. SteaveFurber, “ARM system-on-chip architecture”, Addison Wesley, 2000.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013.

EI-3103	Embedded system lab	L-T-P-C:2-0-0-2

Lab Experiment related to ARM Assembly program for Arithmetic and Logical Operations, ARM Assembly program for Multi-byte Operations, ARM Assembly program for Control Manipulation, ARM Assembly program for String Manipulation, ARM Assembly program for Thumb Instructions, Embedded C Programming using Keil Simulator – Simple C Programs, Port Programming. Peripheral Interfacing – Keypad, Motor, LED.

Software Requirement:

System Software: Microsoft windows/ Linux. Programming Languages: Keil, Embedded C.

EI-3005	Microwave Engineering	L-T-P-C:3-0-0-3

Course objective:

- Analyze transmission-line circuits at RF and microwave frequencies
- Use the Smith chart for solving transmission-line problems
- Design impedance matching in transmission-line networks
- Perform transient analysis of transmission-line networks
- Analyze EM transmission characteristics of planar-lines and waveguides
- Design planar-line sections for RF and Microwave circuits
- Perform Scattering parameter analysis of RF networks.

Module I

Introduction: Introduction to Microwave Engineering, Microwave System, Microwave Frequencies, Millimetre waves, Lumped and Distributed Elements, Applications of Microwave Engineering, Maxwell’s Equation.

Module II

Microwave Waveguides: General Solutions for TE, TM, TEM waves, Parallel Plate Waveguide, Rectangular Waveguide, and Circular Waveguide, Coaxial line, Strip line, Microstrip line.

Module III

Microwave Components: Hybrid microwave circuits – Waveguide Tees, Magic Tees, Hybrid rings. Microwave Cavities – Circular cavity and Rectangular Cavity Resonator. Circulators, Isolators, Directional Couplers, Power Dividers.

Module IV

Microwave Devices: Schottky diode, PIN diode, Varactor diodes, IMPATT diode, TRAPATT diode, BARITT diode, Tunnel diode, Gunn diode, MBT, HBT

Module V

Microwave Tubes: Klystrons, Multicavity Klystron, Reflex Klystrons, TWTs, Magnetron.

Course outcome:

- This course will provide students with a strong background in microwave and RF engineering enabling them to contribute to research and development for the emerging high speed and wireless information infrastructure.
- Students focused on the communication field or wanting to get involved in the design and applications of RF and microwave circuits and devices will need to take this course.
- Analysis and design techniques at these high frequencies are different from those followed at the lower frequencies as they involve the use of scattering parameters as well as distributed (rather than lumped) analysis approaches.

Text Book:

1. Pozar D.M. "Microwave Engineering", Fourth Edition, John Wiley & Sons Inc., 2012, ISBN: 978-0-470-63155-3.
2. Liao S.Y. "Microwave Devices and Circuits", Third Edition, Prentice Hall (Pearson Education), 2003, ISBN: 978-81-7758-353-3

Reference Book:

1. K. C. Gupta, R. Garg, and I. J. Bahl, "Microstrip Lines and Slot lines",Artech House, Dedham, Mass., 1979.

HS-3001	Entrepreneurship Development	L-T-P-C:2-0-0-2

Course objective:

- To develop entrepreneurial quality and motivation in students for entrepreneurship.
- To enable students to identify and create business opportunities that may be commercialized.
- To make the student understand the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

Module I

Introduction to Entrepreneurship: Meaning of Entrepreneur, Types of Entrepreneur, Entrepreneurial Traits and skills, Role of Entrepreneurship in Economic Development, Ethics and Social responsibility of Entrepreneurs, Entrepreneurship - its Barriers.

Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition.

Module II

Enterprises and Ownership Structure: MSME industries, Forms of Business Ownership, Advantages and the disadvantages of the three major forms of ownership: the sole proprietorship, the partnership, and the corporation. Registration of company in India.

Module III

Business: Components of macro and micro business environment. Creating and Starting the Venture Sources of new Ideas. **Business Plan:** The Business Plan Nature and scope of Business plan, Elements of Business Plan: Marketing plan, financial plan and the organizational plan, Writing Business Plan, Evaluating Business plans.

Module IV

Financing and Managing the new venture Sources of capital: Understanding capital requirements, identifying the sources of finance, angel investing and venture finance, managing cash flow. Break-even analysis, Project analysis.

Marketing and sales controls: Marketing concept and evolution, marketing process, E-commerce, Internet advertising.

Module V

Institutional support to Entrepreneurship: Institutional support towards the development of entrepreneurship in India, DICs, IDC, SFCs, SSIDCs, KVIC, NSIC, SIDBI.

Course outcome:

- The students will be able to understand the systematic process to select and screen a business idea.
- The students will be able to write a business plan.
- The student will aware about industry structure and how to start up a company

Text Book:

1. Khanka. S.S., Entrepreneurial Development, S.Chand
2. Nandan, H., Fundamentals of Entrepreneurship, PHI

Reference Book:

1. Donald F Kuratko, Entreprenuership – Theory, Process and Practice, Cengage
2. Hisrich R D, Peters M P, Entrepreneurship, TMH
3. Rajeev Roy, Entrepreneurship, Oxford

Semester VI

EI-3002	Industrial IOT	L-T-P-C:3-0-0-3

Course objective:

- While the promise of the Industrial Internet of Things (IIoT) brings many new business prospects, it also presents significant challenges ranging from technology architectural choices to security concerns.
- Students acquire upcoming Industrial IoT: Roadmap to the Connected World Course offers important insights on overcoming the challenges and thrive in this exciting space.

Module I

Introduction & Architecture: What is Industrial IOT and connected world? Difference between IOT and Industrial IOT, Architecture of Industrial IOT, IOT node, Challenges of Industrial IOT.

Module II

Industrial IOT Components: Fundamentals of Control System, introductions, components, closed loop & open loop system. Introduction to Sensors (Description and Working principle): What is sensor? Types of sensors, working principle of basic. **Sensors:** Ultrasonic Sensor, IR sensor, Temperature and Humidity Sensors Digital switch, Electro Mechanical switches.

Module III

Communication Technologies of Industrial IOT: Communication Protocols: IEEE 802.15.4, ZigBee, Bluetooth, RFID. Industry standards communication technology, wireless network communication.

Module IV

Visualization and Data Types of Industrial IOT: Front-end EDGE devices, Enterprise data for Industrial IOT, Emerging descriptive data standards for Industrial IOT, Cloud data base, Could computing, Edge computing.

Connecting an Arduino/Raspberry pi to the Web: Introduction, setting up the Arduino/Raspberry pi development environment, Options for Internet connectivity with Arduino.

Module V

Retrieving Data: Extraction from Web: Grabbing the content from a web page, Sending data on the web, Troubleshooting basic Arduino issues, Types of IOT interaction, Machine to Machine interaction (M2M).

Module VI

Application of IIOT: Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Course outcome:

- Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
- Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices

Text Book:

1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014.
2. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi,
3. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication).
4. Internet of Things, RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan , wiley.

Reference Book:

1 .Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun, Springer.

2. The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition,Willy Publications

EI-3102	Course Title: Industrial IOT Lab	L-T-P-C:3-0-0-2
Course objective: • Students will learn the new evolution in hardware, software, and data.		
1. Measurement of temperature & pressure values of the process using raspberry pi. 2. Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi. 3. Device control using mobile Apps or through Web pages. 4. Digital logic gates programming using ladder diagram. 5. Implementation of Boolean expression using ladder diagram. 6. Simulation of PLC to understand the process control concept.		
Course outcome:	• Examine technological developments that will likely shape the industrial landscape in the future	

EI-3004	Advanced Embedded Processors and Microcontrollers	L-T-P-C:3-0-0-3

Course Objective:

- Understand architecture and advanced features of embedded processors and microcontrollers.
- Understand PIC/ARM processor registers, instruction pipeline, interrupts and architecture.
- Learn about instructions, addressing modes, conditional instructions and programming of advanced embedded processors and microcontrollers.

Module I

Embedded and Microcontroller Concepts: Introduction to embedded processors, Application Areas, Categories of embedded processors, Hardware architecture, Software architecture, Application software, Communication software, Introduction to Harvard & Von Neuman architectures, CISC & RISC Architectures.

Module II

PIC Microcontrollers: Introduction to PIC microcontrollers, architecture and memory organization, registers, I/O ports, interrupts, timer, instruction sets, PIC programming in assembly and C, Sensor interfacing, motor control, SPI bus protocols.

Module III

ARM: ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families. Instruction Sets: Data processing instructions, addressing modes, branch, load, store instructions, PSR instructions, and conditional instructions.

Module IV

Raspberry Pi: Raspberry Pi board and its processor, Programming the Raspberry Pi using Python, Communication facilities on Raspberry Pi (I2C,SPI, UART), Interfacing of sensors and actuators.

Module V

Intel Galileo or Edison microprocessors for Embedded System and IoT.

Course Outcome:

Upon Completion of the course, the students will be able to:

- Implement architecture, instruction set and programming of advanced embedded processors and controllers.
- Design suitable microprocessor / microcontroller based projects for a specific real world application.

Text Book:

1. Muhammod Ali Mazidi, Rolin D. Mckinlay & Danny Sansey, "PIC Microcontroller and Embeded System SPI, UART using Assembly & C for PICI8," Pearson International Edition, 2008.
2. A. N. Sloss, D. Symes, and C. Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2008
3. S. Monk, "Programming the Raspberry Pi" McGraw-Hill Education, 2013

Reference Book:

1. John .B.Peatman , "Design with PIC Microcontroller", Prentice Hall.
2. Steave Furber, "ARM system-on-chip architecture", Pearson, 2nd Edition, 2015.

EI-3006	Sensor and Actuators	L-T-P-C:3-0-0-3

Course objective:

- To understand the fundamental concept of sensor and transducer.
- To discuss about units, standards, error analysis and characteristics of measurement systems.
- To describe the principle of operation, construction and characteristics of resistance, inductance and capacitance & other transducers and its applications.

Course content:

Module-I

Introduction to Sensor- Based Measurement Systems: General Concepts and Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials For Sensors, Microsensor Technology.

Module -II

Resistive, Reactance Variation, Electromagnetic Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas Sensors, Liquid Conductivity Sensors, Signal Conditioning For Resistive Sensors: Resistance Measurement, Voltage Dividers, Dynamic Measurements, Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors.

Module -III

Flow, Pressure and Level Transducers: Flow Transducers Like Differential Pressure, Variable Area, Positive Displacement, Electromagnetic, Anemometer, Ultrasonic Flow Meter, Turbine Flow Meter, Vortex Flow Meter, Electromagnetic Flow Meter, Coriolis Effect Flow Meter, Pressure Transducers Like Mercury Pressure Sensor, Bellows, Membranes and Thin Plates, Piezoresistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Sensors, Vacuum Sensors, Level Transducers Like Displacer, Float, Pressure Gages, Balance Method, Time-of-Flight Measurements, Level Measurements By Detecting Physical Properties.

Module -IV

Self-Generating Temperature Sensors: Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Pyroelectric Sensors, Electrochemical Sensors, Acoustic Temperature Sensors, Nuclear Thermometer, Magnetic Thermometer, Semiconductor Types, Thermal Radiation, Quartz Crystal, NQR, Spectroscopic Noise Thermometry, Heat Flux Sensors.

Module -V

Digital and Semiconductor Sensors: Position Encoders, Resonant Sensors, SAW Sensors, Sensors Based on Semiconductor Junctions, Sensors Based on MOSFET Transistors, Charge-Coupled and CMOS Image Sensors, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors.

Module -VI

Sensors for Robotics: Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors

Course outcome:

After completion of the course student will be able to:

- Idea behind working of measurement systems and different types of sensors and transducers.
- Sensor to measure various physical parameters used in Industry and normal measurement applications.
- Working principle of resistive, inductive and capacitive transducers and their applications.
- Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications.
- Understanding of acoustic, optical sensors and other sensors and their applications.
- Understanding of digital and proximity sensors and their applications.

Text Book:

1. Patranabis D., "Sensors and Transducers", Prentice-Hall India, 2nd Ed., 2004.
2. Ramon Pallas & John G. Webster, "Sensors and Signal Conditioning", John Wiley & Sons, 2nd Ed., 2001.
3. Shawhney A. K., "Electrical and Electronics Measurements and Instrumentation", DhanpatRai& Sons, 1994.

Reference Book:

1. Webster John G., "Instrumentation and Sensors Handbook", CRC Press, 1st Ed., 1999.
2. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004.

EI-3106	**Sensor and Actuator Lab**	**L-T-P-C:3-0-0-2**
Course Objective:	Student will learn about sensors	

1. Study of basic principles of sensing and actuation techniques used in electronics systems.
2.Study of characteristics of temperature sensors
3.Study of Characteristics of Load Cell
4.Study of Characteristics of LVDT
5.Study of Characteristics of Pressure Sensor
6.Study of different of micro-fabrication technologies for smart sensors
7.Study of Characteristics of opto-electrical sensor
8.Study of Characteristics of different pneumatic and hydraulic systems
9.Study of Characteristics of different electrical actuating systems
10.Study of Characteristics of piezoelectric actuator

EI-3008	VLSI & MEMS	L-T-P-C:3-0-0-3

Course objective:

- To teach the fundamentals of micromachining and micro fabrication techniques
- Understanding of the different design steps required to carry out a complete digital VLSI (Very-Large-Scale Integration) design in silicon, computer aided simulation and synthesis tool for hardware design.

Module I

Introduction: Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macro cell based design, Field programmable devices, design quality

Module II

Process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. IC fabrication: nMOS fabrication, n-well and p-well process, Stick diagram. Layout and Layout design rules

Module III

Basic bipolar process technologies: NMOS technology and its limitations, CMOS Technology, advanced CMOS processes. Design rules for NMOS and CMOS technologies for Layouts.

Module IV

Fundamentals of MEMS/NEMS Design & Fabrication: Needs of MEMS, MEMS material, MEMS Features, design limits and safety factors, processing techniques: Lithography, GalvanikAbforming (LIGA), Lift-off, Chemical Mechanical Polishing, Surface micromachining, Bulk micromachining, Deep Reactive Ion Etching, Application of MEMS, Recent trends in MEMS/NEMS. Challenges and opportunities associated with bringing MEMS to market, Basic MEMS operating principles

Course outcome:

At the end of the course the students will be able to:

- Know the basic concepts of micro systems and advantages of miniaturization.
- Design digital systems using MOS circuits (Static and Switching characteristics of inverters).
- Able to learn Layout, Stick diagrams, Fabrication steps.
- Understand the fundamentals of micromachining and micro fabrication techniques.

Text Book:

1. S.M. Sze, "VLSI Technology", TMH, 2nd edition, 2003.
2. S.K. Gandhi, "VLSI Fabrication Principles", John Willey & Sons, 2nd edition, 2008.
3. S.D Senturia, "Microsystems design". Kluwer Academic Publishers, 2001.
4. N.P. Mahalik, "MEMS", Tata McGraw Hills Publishers, 2007.

Reference Book:

1. G.T.A. Kovacs, "Micromachined transducer", McGraw Hill, 1998.
2. Pucknell, Douglas A. and Eshraghian, Kamran, "Basic VLSI Design", Prentice – Hall (India), 3rd edition, 2004.
3. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design", McGraw-Hill, 4th edition, 2016.

Semester VII

EI-4001	Optical Sensors	L-T-P-C:3-0-0-3

Course objective:

- To prepare students to understand concepts of fiber optic sensor technology.
- To acquire the concept of optical sensors working principle, and to have knowledge on the various grating, magnetic, chemical and bio sensors.

Module I

Sensor Technology: The Emergence of Fiber Optic Sensor Technology, Optical Fibers, Light Sources, Optical Detectors, Optical Modulators, Intensity-Based and Interferometric Sensors - Fabryperot, Mach Zender, Michelson and Sagnac.

Module II

Grating Sensors: Multimode Grating and Polarization Sensors, Sensors Based on Relative Movement of Opposed Gratings, Grating Period Modulation, and Sensors Based on the Photoelastic Effect, Retardation Plates, Fiber Grating Sensors.

Module III

Distributed and Magnetic Sensors: Fiber Optic Distributed and Magnetic Sensor, Distributed Sensing, Basic Principles of Sensor Multiplexing, Interferometric Sensor Multiplexing, Faraday effect sensors, Magneto strictive, Lorentz force sensors, Evanescent Field Absorption Sensors

Module IV

Chemical and Biosensor: Reagent Mediated sensor, Humidity sensor, pH sensor, Hydrogen sensor, CO_2 sensor, Ammonia sensor, Chloride sensor, Glucose sensor, Oxygen sensor, Surface Plasmonic Resonance based sensor

Module V

Applications: Industrial Applications of Fiber Optic Sensors: Temperature, Pressure, fluid level, flow, position, vibration, rotation measurements, Current-voltage measurement, Chemical analysis.

Course outcome:

After studying this course, the students will be able to

- Describe the fundamentals of optical sensors.
- Describe the advantage and need of fiber optics sensor technology.
- Gain knowledge and understanding about real time applications of optical sensors.

Text Book:

1. Bishnu P. Pal, "Fundamentals of fiber optics in telecommunication and sensor systems", Wiley Eastern.
2. Dakin J and Culshow B., "Optical fiber sensors", Artech House.

3. Francis T.S Yu, Shizhuo Yin, “Fiber Optic Sensors”, Marcel Dekker Inc., New York.

Reference Book:

1. Jose Miguel Lopez-Higuera (Ed), “Handbook of optical fiber sensing technology”, John Wiley and Sons Ltd.
2. Eric Udd, William B. Spillman, Jr., “Fiber Optic Sensors: An Introduction for Engineers and Scientists”, John Wiley & Sons.
3. Francis T.S. Yu, Shizhuo Yin, Paul B. Ruffin, “Fiber Optic Sensors”, CRC Press Publisher.

EI-4101	Optical Sensors Lab	L-T-P-C:0-0-0-3
PC-based Measurement of the Numerical Aperture of a Multimode Step-index; Optical Fiber; PC-based Measurement of MFD of a Single-mode Fiber; Characterization of Optoelectronic Source (LED and ILD); Fiber-optic Proximity Sensor; PC-based Fiber-optic Reflective Sensor; PC-based Fiber-optic Angular Position Sensor; Fiber-optic Differential Angular Displacement Sensor		

B.Tech ECE Electives Syllabus

Hons. Elective I (Fifth Semester)

HC-3001	Computational Intelligence	L-T-P-C:3-1-0-4

Course objective:

- To provide a strong foundation on fundamental concepts in Computational Intelligence.
- To enable Problem-solving through various searching techniques.
- To apply these techniques in applications which involve perception, reasoning and learning.
- To apply Computational Intelligence techniques for information retrieval and machine learning

Module I

Introduction to soft computing : Soft computing constituents and conventional Artificial intelligence, soft computing characteristics;

Module II

Fuzzy Sets, Fuzzy Rules and Fuzzy reasoning : Introduction, Basic definitions and terminology; Set theory operations : Fuzzy union, Intersection and Complement, Extension principal and fuzzy relations, Fuzzy IF rules, MF formulation and parameterization; Fuzzy interference System : Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models;

Module III

Artificial Neural Network : Supervised Learning Neural Network, Preceptron, Adaline, multi-layer neural networks, back propagation algorithm, Radial basis function networks; Functional Link Artificial Neural network : update algorithms, trigonometric and power series expansions; Unsupervised Learning Neural Network : Competitive learning networks, Kohonen self-organizing networks, Hopfield network;

Module IV

Introduction to NeuroFuzzy Networks : Genetic Algorithm, Adaptive Genetic Algorithm, Ant Colony Algorithm, Bacteria Foraging Algorithm, Particle Swarm Optimization; Introduction to other soft computing technique.

Text Book:

1. Neuro-Fuzzy and soft Computing –J.S.R. Jng, C.T.Sun and E.Mizutani, PHI.

2. Neural Networks A Comprehensive foundation-Simon Haykin, Pearson Education.

Reference Book:

2. Neutral Networks, Fuzzy Logic and Genetic Algorithm Rajasekaran, G.A. Vijayalaksmi, PHI.

HC-3003	Optical Communication	L-T-P-C:3-1-0-4

Course objective:

- To provide in-depth knowledge of modern optical communication systems
- To understand the characteristics and limitations of system components
- To analyze the performance of optical fiber systems

Module I

Optical communication system evolution, Generic optical system, wireless optical systems, Applications and design challenges, Mode theory for circular waveguides, Optical fibers, Wave propagation in optical fiber, Ray and wave theory

Module II

Physical and electrical characteristics of fiber, Fiber nonlinearities, Polarization, Interference, Fiber materials, Fiber fabrication, Attenuation in fibers, Absorption and scattering losses, Bending losses, Dispersion

Module III

Basic concepts of optical sources, semiconductor lasers, distributed feedback lasers, Frequency chirping, LED, Source to fiber power launching, Lensing schemes, Fiber to fiber joints, Fiber splicing, Fiber connectors, Optical modulators

Module IV

Optical detectors, Principles of photo detector, PIN and avalanche photo diode, Phototransistor, Responsivity, Bandwidth, Noise, Optical amplifiers and filters

Module V

Optical transceivers, Direct detection and coherent receivers, Noise in detection process, WDM, Modulation techniques, BER, System design, Power budgeting, Rise time budgeting, OTDR principles, Maximum transmission distance due to attenuation and dispersion, Attenuation and dispersion limits

Course outcome:

- Identify and characterize different components of an optical fiber communication link.
- Compute optical fiber link design parameters

- Design considerations and assess the performance of optical devices and systems

Text Book:

1. P Chakrabarti, “Optical Fiber Communication, McGraw Hill Education (India)Private Limited, 2016

2. Gred Keiser,”Optical Fiber Communication, McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.

3 .Govind P. Agrawal, Fiber-optic communication systems, third edition, John Wiley and sons, 2004.

Reference Book:

1. John M.Senior, Optical fiber communication, Pearson Education, second edition.2007.

2. Rajiv Ramaswami, Optical Networks , Second Edition, Elsevier , 2004.

3. J.Gower, Optical Communication System, Prentice Hall of India, 2001.

HC-3005	**Wireless Communication 2.5 G and Beyond**	**L-T-P-C:3-1-0-4**

Course objective:

- To realize the vision of "Optimally Connected Anywhere, Anytime" supported by all system levels from access methods and networks to service platforms and services.
- To realize and characterize the systems beyond 2.5G as a horizontal communication model, where different terrestrial access levels and technologies are combined to complement each other in an optimum way for different service requirements and radio environments.

Course content:

Module I

An overview of cellular systems, Wireless communication and the layer model, co-channel and adjacent channel interference, location management, handoff management; Concept of mobile IP for mobility management issues. Road map for higher data rate capability in 5G, Wireless 5G systems, Future wireless networks, Standardization activities for cellular systems.

Module II

Wireless Channel Modeling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Ocumura and Hata Path Loss Model; Channel Modelling: Stochastic, Flat Fading, Wideband Time-Dispersive Channel Modelling

Module III

Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation. Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms.

Module IV

Ad-hoc wireless networks: Design Challenges in Ad-hoc wireless networks, concept of cross layer design, security in wireless networks, energy constrained networks. MANET and WSN. Wireless system protocols: mobile network layer protocol (mobile IP, IPv6, dynamic host configuration protocol), mobile transport layer protocol (traditional TCP, classical TCP improvements), support for mobility (wireless application protocol).

Course outcome:

- Understand the evolution of cellular communication systems upto and beyond 3G
- Design a cellular link and estimate the power budget.
- Choose proper multiple accessing methods depending on channel model
- Identify traffic channels for call processing
- Calculate key performance metrics of a cellular communication system.

Text Book:

1. Wireless Communications- Principles and Practice, T S Rappaport, Pearson Education India, Second Edition.

2. Wireless Communication and Networks, Upen Dalal, Oxford university Press, First Edition, 2015.

3. Wireless Communication and Networks 3G and Beyond, Iti Saha Misra, Tata McGraw Hill Education Pvt. Ltd, Second Edition, 2009.

Reference Book:

1. Mobile Communication Engineering – Theory and Applications W C Y Lee, TMH Publication, Second Edition, 2008.

2. Wireless Communication, Andrea Goldsmith, Cambridge University Press, 2005

3. Fundamentals of Wireless Communication, David Tse and Pramod Viswanath, Cambridge University Press, 2005

HC-3007	Semiconductor Material & Device Characterization	L-T-P-C:3-1-0-4

Course objective:

- To learn the Measurement of Semiconducting parameters
- To realize the Electrical characterization of Junction based devices
- To understand the physical, optical and structural properties of semiconductor materials and their characterization.

Module I

Introduction to the Measurement of Semiconducting parameters : Resistivity measurement: Four-point probe, Correction factors, Resistivity of arbitrarily shaped samples, Resistivity profiling: Anodic oxidation-four point probe, spreading resistance, contact less resistivity methods, conductivity type measurements, Carrier and doping concentration measurements: Capacitance measurements, Differential capacitance, Maximum-Minimum MOS-C capacitance, Integral capacitance. Current-Voltage measurements, Second harmonic, MOSFET substrate voltage-gate voltage, MOSFET threshold voltage.

Module II

Characterization of Junction based Devices: Metal-Semiconductor Contacts: Contact resistance, Measurement techniques (introduction only), Hall effect and Mobility: Mobility, Conductivity mobility, Basic equations for uniform layers or wafers, Magnetoresistance mobility, MOSFET mobility: Effective mobility, field-effect mobility and Saturation mobility, Oxide and interface trapped charge: Characterization using Capacitance-Voltage curves only.

Module III

Optical Characterization: Optical Microscopy: Resolution, Magnification, Contrast, Differential Interference Contrast, Defect etches, Ellipsometry: theory and applications, Transmission measurements: theory and instrumentation, Fourier Transform Infrared spectroscopy, Reflection Measurements, Line width measurements, Photoluminescence, PL Spectroscopy, UV-Vis Spectroscopy, Raman Spectroscopy, FTIR.

Module IV

Morphological and Structural Characterization: Scanning Electron Microscopy (SEM), Auger Electron Spectroscopy, Electron Microprobe, Secondary Ion Mass, Spectroscopy and X-ray Photoelectron Spectroscopy (Principle, instrumentation and its applications), Transmission Electron Microscopy (TEM), Electron Beam Induced Current, LEED and RHEED, Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), High Resolution X-Ray Diffraction study (HRXRD), Scanning Probe Microscopic Analysis (SPM)

Course outcome:

At the end of this course students will be able to

- Understand the Engineering of the Electrical, Optical, and material characterization.

- Interpret the results obtain from different characterization technique.
- Familiar with the optical and structural characterization techniques and the related lab work

Text Book:

1. Dieter K. Schroder, "Semiconductor Material and Device Characterization" John Wiley & Sons, 3rd edition, 2015.

Reference Book:

1. Streetman, B. and Banerjee, S., Solid State Electronics Device, 7th edition, Prentice Hall India, (2014).
2. Sze, S.M., M.K. Lee, Semiconductor Devices, Physics and Technology, John Wiley, (2015).
3. Tyagi, M.S., Introduction to semiconductor materials and devices, John Wiley, (2015).
4. Mishra, Umesh K. and Singh, Jaspreet, Semiconductor Device Physics and Design, 1st edition, Springer, (2008).

HC-3009	**Advanced digital image processing**	**L-T-P-C:3-0-0-3**

Course objective:

- To discuss advanced topics in image processing and analysis that build on the introduction course
- To enable students to implement solutions for complex image processing problems.
- To enable students to better understand novel, advanced methodology that is discussed in the image processing and image analysis literature.

Course content:

Module I

Review of basic digital image processing – Spatial domain image processing – Frequency domain image processing, Color models, representation, and image processing – RGB, CMYK, HSI models– Color transformations – Color image filtering and enhancement

Module II

Wavelets and multiresolution processing – Multiresolution representations – Subband coding and filter banks – bandpass sampling (related to subband coding) – Wavelet transforms in 1-D and 2-D **Image compression** – Information content (entropy) of an image – Lossless versus lossy compression algorithms – Compression standards

Module III

Morphological image processing – Intro to image morphology – Binary operations – Grayscale operations – Applications of morphological image processing • **Image segmentation** – Edge

detection – Edge linking and boundary detection – Thresholding – Other methods of segmentation, Graph-based techniques, Active Contours, Active Shape Models, Active Appearance Models,

Module IV

Image representation and object recognition – Descriptors: boundaries, regions, global – Pattern recognition as applied to images, **Image Features** - Harris corner detector, Scale Invariant Feature Transform (SIFT), Speeded Up Robust Features (SURF), edge detection, Hough Transform,

Module V

Image Quality - Natural scene statistics, quality assessment based on structural and statistical approaches, blind quality assessment, **Statistical tools** - Kalman Filter, Hidden Markov Models, **3d image visualization** Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images. estimation, compression

Course outcome:

- To conduct independent study and analysis of feature extraction techniques.
- To design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.
- To understand the concepts of image quality assessment and object representation and recognition.
- To analyze the constraints in image processing when dealing with 3D data sets and to apply image processing algorithms in practical applications.

Text Book:

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.

Reference Book:

1. Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
Current Literature.

HC-3011	MEMS and lab on chip	L-T-P-C:3-0-0-3

Course objective:

- To learn the basics of MEMs
- To learn about various components and applications of MEMS

Module I

Introduction: MEMs Fabrication Technologies, Materials and Substrates for MEMs, Processes for Micromachining, Characteristics, Sensors/Tranducers, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor

Module II

Mechanics of Beam and Diaphragm Structures: Stress and Strain, Hooke's Law, Stress and Strain in a bent beam, Bending Moment and the Moment of Inertia, Displacement of Beam Structures under weight

Module III

Air Damping: Viscosity of a fluid, Viscous flow of a fluid, Drag Force Damping, The Effects of Air Damping on Micro-Dynamics, Reynold's Equations for Squeeze-Film Air Damping, Basic Equation for Slide-film Air Damping

Module IV

Electrostatic Actuation: Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, Electrostatic Driving of Mechanical Actuators.

Module V

Thermal Effect: Temperature Coefficient of Resistance, Thermoelectricity, Thermocouples Thermal and Temperature Sensors

Module VI

Applications of MEMS in RF: MEMS Resonator Design Considerations, One Port Micromechanical Resonator Modeling, Micromechanical Resonator Limitations

Course outcome:

After studying this course, students will be able to:

- MEMS fabrication enables to integrate microelectronic and micromechanical structures in one system.
- Laboratory processes can be combined on a single chip.

Text Book:

1. Foundations of MEMS by Chang Liu, Pearson Education India; 2012.

2. MEMS by N. Mahalik, Tata McGraw-Hill Education; 2008 .

Reference Book:

1. MEMS & Microsystems: Design and Manufacture by Tai-Ran Hsu, 2016.

2. RF MEMS: Theory, Design and Technology by Gabriel M., John Wiley & Sons; 2004 Feb 6.

Open Elective I (in sixth semester) – open to both CSE & ECE

OE-3012	Quantum Computing	L-T-P-C:3-0-0-3

Course objective:

This course aims to provide a first introduction to quantum computing.

We will highlight the paradigm change between conventional computing and quantum computing, and introduce several basic quantum algorithms.

Module I

Introduction: Elementary quantum mechanics:, linear algebra for quantum mechanics, Quantum states in Hilbert space,The Bloch sphere, Density operators, generalized measurements, no-cloning theorem

Module II

Fundamental concepts- Bits/Qubits, Quantum Gates, Quantum Circuits, Turing Machine, Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT

Module III

Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm

Module IV

Quantum entanglement, Quantum Teleportation, Quantum Fourier Transform, QSA.

Course outcome:

On successful completion, students will gain understanding of:

- The basic principles of quantum computing.
- The fundamental differences between conventional computing and quantum computing.
- Several basic quantum computing algorithms.
- The classes of problems that can be expected to be solved well by quantum computers.

Text Books:

1. Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information: 10th Anniversary Edition, Cambridge University Press, 2010
2. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).

Reference Books:

1. Jack D. Hidary, Quantum Computing: An Applied Approach (2021).
2. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).

OE-3016/CD-3006	Design Thinking	L-T-P-C:3-0-0-3

Course objective:

- To understand the basic concepts of Design Thinking
- To learn the general approaches and stages of Design Thinking

Module I

Design Thinking Overview: What Is Different About Design thinking?, Exercise: Design Thinking in the Workplace, Design Thinking Skills, Exercise: Design Thinking Skills, Design Thinking Mindset, Principles of Design Thinking, Exercise: Design Thinking Principles

Module II

General Approaches to Design Thinking: The Basis for Design Thinking, Design Thinking Frameworks, Exercise: Build a Design Thinking Framework, The Design Thinking Team, What Constitutes a Design Thinking Team?, Exercise: Create a Design Thinking Team, Design Thinking Workshops and Meetings, Characteristics, Types of Workshops

Module III

A Design Thinking Approach in Stages: Apply the Design Thinking Frameworks, Class Exercise: Review the Case Study, Empathize with the Customers and/or Users, Exercise: Engage the Customer /User, Define the Problem, Exercise: Review and Follow-Up, Exercise: Define the Point of View, Ideate, Exercise: Develop Potential Solutions, Exercise: Feedback on the Solutions, Prototype Alternate Solutions, Exercise: Create a Prototype of the Solution, Exercise: Review the Prototype and Gain Feedback, Test the Solutions, Exercise: Prepare Test of the Prototype and Solution

Module IV

Design Thinking Techniques: Listening and Empathizing Techniques**,** Engagement**,** Exercise: Ask the Right Questions**,** Observation**,** Exercise: Setting Up the Observation**,** Showing Empathy**,** Define and Ideation Techniques**,** Unpacking**,** Exercise: Unpack to the Wall**,** Personas**,** Exercise: Create Personas for the Case Study**,** Pattern Recognition and Connecting the Dots**,** Prototype and Test Techniques**,** Types of Prototypes**,** Exercise: Revise Franken Prototype to Refined Prototype**,** Forms of Testing in Design Thinking**,** Exercise: Prepare and A / B Test of the Prototype

Module V

General Design Thinking Practices: Visualization Techniques and Diagrams, Use of Diagrams and Maps in Design Thinking, Exercise: Create an Empathy Map, Exercise: Revisit the Wall, Exercise; Create an Affinity Diagram, Exercise: Create a Mind Map, Exercise: Create a Journey Map, Story Telling Techniques, Story Telling Throughout the Design Thinking Process, Improvisation, Exercise: Tell a Story, Scenarios, Exercise: Create a Set of Scenarios for the Case Study, K-Scripts, Exercise: Create a Set of K-Scripts for the Case Study, Exercise: Perform Role Playing of Scenarios for the Case Study

Course outcome:

After studying this course, students will be able to:

- Know the application of design thinking in research management and design.
- Articulate the concepts of design thinking in the field of Education and Information Technology.

Text Book:

1. Design thinking: The handbook, F. Uebernickel, L. Jiang, W. Brenner, B. Pukall, T. Naef, B. Schindlholzer, World Scientific; 2020.
2. Design Thinking by Teun den Dekker, Routledge, 2020.

Reference Book:

1. Design Thinking For Dummies by C. Muller-Roterberg, John Wiley & Sons; 2020.

OE-3022	Exploratory Data Science	L-T-P-C:3-0-0-3

Course objective:

- Given a complex set of observations, often EDA provides the initial pointers towards various learning techniques.
- The data is examined for structures that may indicate deeper relationships among cases or variables.

Module I

Exploratory Data Analysis (EDA): What is Data, Numerical Summarization, Measures of similarity and Dissimilarity, Visualization, R Scripts

Module II

Linear Regression: Linear Methods, Point Estimate, Example Results, Theoretical Justification, R Scripts

Module III

Variable Selection: Variable Selection for the Linear Model, R Scripts

Module IV

Regression Shrinkage Methods: Ridge Regression, Compare Squared Loss for Ridge Regression, More on Coefficient Shrinkage (Optional), The Lasso, Summary

Module V

Principal Components Analysis: Singular Value Decomposition (SVD), Principal Components, Principal Components Analysis (PCA), Geometric Interpretation, R Scripts, More Examples

Module VI

Dimension Reduction Methods: Principal Components Regression (PCR), Partial Least Squares (PLS)

Course outcome:

After studying this course, students will be able to:

- Know the application of numerical and visual summarization of data.
- State the role of this course in the the data analysis domain.

Text Book:

1. The Popularity of Data Analysis Software by R. A. Muenchen, 2012.
2. Exploratory data analysis with MATLAB, W. L. Martinez, A. R. Martinez, J. L. Solka, Chapman and Hall/CRC; 2017.

Reference Book:

1. R Programming for Data Science, R. D. Peng, Victoria, BC, Canada, Leanpub, 2016.

OE-3014	Advanced Algorithms	L-T-P-C:3-0-0-3

Course objective:

- Understand advanced concepts of computer algorithms and learn modern techniques of problem solving
- Learn complexity classes and limit of computation
- Learn role of randomness and approximation to solve intractable problems

Course content:

Module I

Preliminaries: Problem vs. Solutions. Algorithms vs. Programs. Properties of Algorithm. Complexity Measures. Model of Computation – RAM model (Architecture, instruction set, usage) Turing Machine (concept, usage, DTM and NDTM as lanuage acceptors, Universal TM). Cellular Automata as a natural model of computation. Examples.

Module II

Revisit of Asymptotic Notation and Basic Algorithm techniques: Growth of function over input size – Big-Oh, Big-Omega, Big-Theta Notation and their relationship. Master's theorem. Recursion tree. Searching techniques – Linear search vs Binary search. Different sorting techniques – sort by insertion, sort by exchange, sort by selection, sort by merging, special purpose sorting. Lower Bound Theory. Hashing. Divide and conquer vs Greedy Strategy – when to use what. Examples.

Module III

Limit of Computation: Classes of languages. Entscheidungs Problem and Decidability. Computability theory: enumerability/countability, Recursively Enumerable vs. Recursive languages, partial and total function, Effectively Computable, Efficient algorithm, Church-Turing Hypothesis, padding lemma, computability theorems. Russell's Paradox. Halting Problem. Inconsistency. Reducibility. Classes of Problems: P, NP, NPC, NP hard problems. Turing Equivalence and Turing degree. Turing Test. Examples.

Module IV

Randomized Algorithms: Use of randomness in computing. Average case analysis – Case study: Quick sort.

Module V

Approximation Algorithms: Optimization Problems – Efficiently solvable and Intractable optimization problem, Pseudo-polynomial time algorithm, Weakly and Strongly NP-Completeness. Approximation ratio, Absolute approximation, Relative Approximation, Approximation scheme – Polynomial time approximation scheme, fully polynomial time approximation scheme (FPTAS). Example – Solution of Travelling Salesperson Problem using Triangular Inequality, FPTAS solution for Knapsack problem

Text Book:

1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein
2. Fundamentals of Computer Algorithms – Horowitz and Sahni
3. The Design of Approximation Algorithms – David P. Williamson and David B. Shmoys, First Edition, 2011.

Reference Books:

1. The Design and Analysis of Computer Algorithms – Aho, Hopcroft and Ullman
2. The Art of Computer Programming (Vol 1 & 3) – Donald E Knuth
3. Approximation Algorithms – Vijay V. Vazirani, First Edition.
4. A New Kind of Science – Stephen Wolfram

Hons. Elective II (sixth semester)

HI-3002	Wireless Sensors and Networks	L-T-P-C:3-0-0-3

Course objective:

- To understand the WSN node Architecture and Network Architecture
- To identify the Wireless Sensor Network Platforms

Module I

Introduction to Wireless Sensor Networks, Motivation, Performance Requirement Wireless Sensor Network Architecture: Protocols and Standards, OSI Model and TCP/IP Protocol Suite, Sensing and Communication Range, Applications of Sensor Networks., Bluetooth, IEEE 802.11a/b/g/n series of wireless LANs; ZigBee; Radio-frequency identification (RFID).

Module II

Fundamentals of MAC Protocols, Performance Requirements, Types of MAC protocols - Schedule-Based and Random Access-Based Protocols, Sensor-MAC, Zebra-MAC. Fundamentals of Routing Protocols, Performance Requirements, Routing Strategies in Wireless Sensor Networks-Flooding and its variants, LEACH, Power-efficient Gathering in Sensor Information Systems, Directed diffusion, Geographical routing.

Module III

Operating system for Wireless Sensor Networks, Localization and Tracking, Clock Synchronization, Markov Chain, State Space Representation, Tracking Events, Time Domain, and Space Domain Data Analysis.Traditional Transport Control Protocols-TCP, UDP; Feasibility of Using TCP or UDP for WSNs, Transport Protocol Design Issues, Existing Transport Control Protocols- CODA (Congestion Detection and Avoidance), ESRT (Event-to-Sink Reliable Transport) Performance of Transport Control Protocols.

Module IV

Physical Environment, Wireless Sensor Network Data Bases, DataBase Query, Data Aggregation. WSN Middleware Principles, Middleware Architecture, Existing Middleware-MiLAN (Middleware Linking Applications and Networks), and IrisNet.

Module V

Fault Tolerance in Wireless Sensor Networks, Time synchronization protocols based on sender/receiver synchronization, Localization approaches.

Course outcome:

- To develop wireless sensor systems for different applications
- Understand protocols of Wireless Sensors Network

Text Book:

1. F. Zhao and L. Guibas, Wireless Sensor Network: Information Processing Approach, Elsevier, 2009
2. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols:, CRC Press, 2009

Reference Book:

1. H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley Publishers, 2005

2.A. Hac, Wireless Sensor Network Designs, John Wiley & Sons,2009

3. Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge University Press.

HI-3004	Information and Coding Theory	L-T-P-C:3-1-0-4

Course objective:

- Understand error–control coding.
- Be familiar with the methods for the generation of these codes and their decoding techniques.
- Be aware of compression and decompression techniques.
- Learn the concepts of multimedia communication

Module I

Introduction: Introduction to information theory & error control coding, Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Channel Capacity.

Module II

Source Coding: Shannon's Source Coding Theorem, Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Rate Distortion Theory.

Module III

Channel Capacity & Coding: Channel Coding Theorem, Markov Sources, Discrete Channel with discrete Noise, BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO system, Bandwidth-S/N Trade-off.

Module IV

Block Codes: Galios Fields, Hamming Weight and Hamming Distance, Linear Block Codes, Encoding and decoding of Linear Block-codes, Parity Check Matrix, and Bounds for block codes, Hamming Codes, Syndrome Decoding.

Module V

Cyclic Codes: Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation of cyclic codes, Burst error correction, BCH codes.

Module VI

Convolutional Codes: Introduction to Convolutional Codes, Polynomial description of Convolutional Codes, Generating function, Matrix description of Convolutional Codes, Viterbi Decoding of Convolutional code, Introduction to Turbo Code.

Module VII

Coding for Secure Communications: Introduction to Cryptography, Overview of Encryption Techniques, Secret-Key Cryptography, Data Encryption, Standard (DES), Public-Key Cryptography, RSA algorithm, Digital signature, One- way Hashing.

Course outcome:

- Design an application with error–control.
- Use compression and decompression techniques.
- Apply the concepts of multimedia communication

Text Books:

1. "Communication Systems "S. Haykin, 4th Edition, Wiley-Publication, 2001.
2. Information Theory, Coding & Cryptography", by Ranjan Bose, TMH, Second Edition.

Reference Books:

1. "Elements of Information Theory" by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
2. "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.
3. "Cryptography and Network Security", Fourth Edition, by William stallings.
4. "Multimedia Communications, Applications Networks Protocols and Standards", Fred Halsall, Pearson Education, Asia 2002;

HI-3006	**Metamaterial sensors**	**L-T-P-C:3-0-0-3**

Course objective:

- To develop an ability to understand about left-handed metamaterial and its characteristics and properties
- To develop an ability to analyse the physical realization of left-handed metamaterials using the resonant approach.
- To develop an ability to analyse the physical realization of left-handed metamaterials using the non-resonant approach
- To develop and ability to understand the guided-wave applications of left-handed metamaterials

Course content:

Module I

Introduction to Metamaterials: Definition of Metamaterials and left-handed Metamaterials. Theoretical speculation by Viktor Veselago. Wave Propagation in Left-Handed Media, Energy Density and Group Velocity, Negative Refraction, Fermat Principle, Inverse Doppler Effect, Backward Cerenkov Radiation, Negative Goos–Hanchen Shift, Waves at interfaces, Waves through left-handed slabs, Phase Compensation and Amplification of Evanescent Modes , Perfect Tunneling, The Perfect Lens , Losses and Dispersion.

Module II

Realization of Metamaterials using Resonant Approach: Scaling Plasmas at Microwave Frequencies, Metallic Waveguides and Plates as One- and Two-Dimensional Plasmas, Wire Media, Spatial Dispersion in Wire Media, Synthesis of Negative Magnetic Permeability, Design and Analysis of the Edge and Broad Coupled SRR, The Double and Multiple Split SRR, Spirals Resonators, Higher-Order Resonances in SRRs, Isotropic SRRs, Scaling Down SRRs to Infrared and Optical Frequencies , 1/2/3 Dimensional SRR-Based Left-Handed Metamaterials, Ferrite Metamaterials, Chiral Metamaterials.

Module III

Realization of Metamaterials using Non-Resonant Approach: Ideal homogeneous CRLH TLs, Fundamental TL Characteristics, Equivalent MTM Constitutive Parameters, Balanced and Unbalanced Resonances, lossy CRLH TL model, LC Network Implementation, Difference with Conventional Filters, Transmission Matrix Analysis, Input Impedance, Cutoff Frequencies, Analytical Dispersion Relation, Bloch Impedance, Real Distributed 1D CRLH Structures, General Design Guidelines, Microstrip Implementation, Parameters Extraction.

Module IV

Guided-Waves Applications of Metamaterials: Dual-Band Components, Dual-Band Property of CRLH TLs, Quarter-Wavelength TL and Stubs, Quadrature Hybrid and Wilkinson Power Divider, Enhanced-Bandwidth Components, Principle of Bandwidth Enhancement, Rat-Race Coupler, Tight Edge-Coupled Coupled-Line Couplers, Generalities on Coupled-Line Couplers, Symmetric Impedance Coupler, Asymmetric Phase Coupler, Negative and Zeroth-Order Resonator. SRRs based Filters and Diplexers Design.

Module V

Radiated-Wave Applications of Metamaterials: Fundamental aspects of Leaky-Wave Structures, Principle of Leakage Radiation, Uniform and Periodic LW Structures, Backfire-to-Endfire (BE) leaky-wave (LW) antenna, electronically scanned LW antenna, Passive Retro-Directive Reflector, Two-Dimensional LW Radiation, Conical-Beam Antenna, Full-Space Scanning Antenna, Zeroth Order Resonating Antenna, Dual-Band CRLH-TL Resonating Ring Antenna, Heterodyne Phased Array, Non-uniform Leaky-Wave Radiator, The Future of MTMs.

Course outcome:

- Demonstrate insight the guided-wave applications of left-handed metamaterials.
- Demonstrate insight the radiated-wave applications of left-handed metamaterials.

Text Book:

1. “Metamaterials with Negative Parameters, Theory, Design and Microwave Applications,” by Ricardo Marques, Ferran Martin, and Mario Sorolla “Wiley Series in Microwave and Optical Engineering, Wiley Interscinces 2007” (T1)
2. “Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications, The Engineering Approach,” Christophe Caloz and Tatsuo Itoh, John Wiley & Sons, Inc., Hoboken, New Jersey 2006. (T2)

Reference Book:

1. Foundations for Microwave Engineering; Second Edition; By Robert E. Collin; McGraw Hill International Edition; 1992. (R1)
2. Microwave Engineering; Second Edition; by David M. Pozar; John Wiley & Sons; Inc. Copyright 2001. (R2)

Hons. Elective III (Seventh semester)

HI-4001	CAD for VLSI	L-T-P-C:3-1-0-4

Course Objective:

- Learn VLSI CAD tools and its related concepts & algorithms,
- Understand design automation of FPGA and high-level synthesis.

Course content:

Module I

Introduction: VLSI design flow, challenges. Verilog/VHDL: introduction and use in synthesis, modeling combinational and sequential logic, writing test benches.

Module II

Logic synthesis: two-level and multilevel gate-level optimization tools, state assignment of finite state machines. Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding. Technology mapping.

Module III

Synthesis of reversible logic circuits. Basic concepts of reversible circuits and synthesis. Exact, transformation based, and ESOP based synthesis methods.

Module IV

Physical design automation. Review of MOS/CMOS fabrication technology. VLSI design styles: full-custom, standard-cell, gate-array and FPGA. Physical design automation algorithms: floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs.

Course outcome:

After studying this course, the students will be able to:

- Apply VLSI design automation concepts in real life applications.
- Implement the algorithms for VLSI Design Automation.

- Experiment high level synthesis.

Text Book:

1. Pucknell, Douglas A. and Eshraghian, Kamran, "Basic VLSI Design", Prentice – Hall (India).
2. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design", McGraw-Hill, 2018.
3. J. Bhasker, "Verilog VHDL synthesis: a practical primer", B S Publications.

Reference Book:

1. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley Pub. Co., 2010.
2. S. Ramachandran, "Digital VLSI systems design", Springer, 2007.

HI-4003	Adaptive Signal Processing	L-T-P-C:3-1-0-4

Course objective:

- To provide rigorous foundations in multirate signal processing, power spectrum estimation and adaptive filters.
- Adaptive signal processing concerns with processing of signals where the processing parameters are adjusted continuously to suit time varying signal environmental conditions.
- This course demonstrates the design of important class of adaptive filters, LMS, RLS and Kalman filters.

Module I

Adaptive systems: Definitions, characteristics, applications, properties, and examples. Linear optimum filtering and adaptive filtering, linear filter structures, adaptive equalization, noise cancellation and beam forming. Optimum linear combiner and Wiener-Hopf equations, orthogonality principle, minimum mean square error and error performance surface.

Module II

LMS algorithm and its applications, learning characteristics and convergence behaviour, misadjustment. Normalized LMS and affine projection adaptive filters. Frequency domain block LMS algorithm.

Module III

Least squares estimation problem and normal equations, projection operator, exponentially weighted RLS algorithm, convergence properties of RLS algorithm. Kalman filter as the basis for RLS filter. Square-root adaptive filtering and QR- RLS algorithm. Systolic-array implementation of QR –RLS algorithm.

Module IV

Forward and backward linear prediction. Levinson-Durbin algorithm, Lattice predictors, gradient-adaptive lattice filtering, least-squares lattice predictor, QR-decomposition based least-squares lattice filters.

Module V

Adaptive coding of speech, Adaptive equalization of wireless channels, Antenna array processing.

Course Outcome:

- Students will become familiar with the concepts, algorithms and applications of adaptive signal processing in wireless communication systems.
- Use computer based simulation tools to understand the theoretical concepts of adaptive signal processing in various communication applications.

Text Book:

1. Simon Haykin., "Adaptive Filter Theory", Pearson Education, 4th Edition, 2002.
2. Widrow, B. and Stearns, S.D., "Adaptive Signal Processing", Pearson Education, 1st Edition, 2002.
3. B. Farhang-Boroujen, Adaptive Filters: Theory and Applications, John Wiley and Sons, 2013.76
4. TulayAdali, Simon Haykin, "Adaptive Signal Processing – Next Generation Solutions", Wiley Publications, 2012.

Reference Book:

1. Sayed Ali, H., "Fundamentals of Adaptive Filtering", John Wiley & Sons, 2003
2. Diniz, P.S.R., "Adaptive Filtering: Algorithms and Practical Implementation", Kluwer Academic Publishers, Boston, MA, 2nd Edition, 2002.

HI-4005	Robotics	L-T-P-C:3-1-0-4

Course objective:

- Describe the different physical forms of robot architectures.
- Kinematically model simple manipulator and mobile robots.
- Mathematically describe a kinematic robot system.
- Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, control, and uncertainty.

Module I

Introduction History of robots: Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

Module II

Drive systems and Sensors: Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

Module III

Kinematics and Dynamics of Robots: 2D, 3D Transformation, Scaling, Rotation, Translation,

Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning.

Module IV

Robot Control: Programming and Applications Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples. Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.

Course Outcome:

Upon Completion of the course, the students will be able to:

- Compute forward and inverse kinematics for a small serial kinematic chain.
- Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
- Perform stability analysis of a controller-robot system, and describe why it is important.
- Model uncertainty in robot processes.

Text Book:

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Book:

1. S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning. 2009.

HI-4007	Communication Protocol for IOT	L-T-P-C:3-0-0-3

Course objective:

Explore IoT technologies, architectures, standards, and regulation.

Module I

Introduction: IoT architecture outline, standards - IOT Technology Fundamentals-Devices and gateways, Local and wide area networking, Data management, Business processes in IOT, Everything as a Service,M2M and IOT Analytics

Module II

IOT Reference Architecture: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints-Introduction, Technical Design constraints.

Module III

IOT data link layer & network layer protocols: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6,ND, DHCP, ICMP, RPL, CORPL, CARP

Module IV

IOT transport & session layer protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

Module V

IOT service layer protocols & security protocols**:** Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer.

Course outcome:

- Understand the impact of Professional Engineering solutions in societal and environmental context, commit to professional ethics and communicate effectively.

Text Book:

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

Reference Book:

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

OPEN ELECTIVE –II/III/IV (Seventh Semester)

OE-4007	Optimization Techniques	L-T-P-C:3-0-0-3

Course objective:

- To acquire the knowledge of optimization techniques and application of understanding to transportation, assignment, sequencing, and scheduling problems.
- To prepare students to understand various linear and non-linear programming problems applicable in industries.

Course content:

Module I

Introduction: Introduction to optimization techniques; classification of optimization problem based on objective function, constraints, and variables; classical optimization techniques, constrained, unconstrained, multivariable problems.

Module II

Linear Programming Problem: Introduction to Linear Programming Problem (LPP), Formulation, Graphical method, corner point method, ISO profile method, Simplex and Revised simplex method, Big-M method, Two-phase method, Standard primal form and canonical form, Duality, Dual Simplex Method.

Module III

Post Optimality Analysis: Sensitivity analysis; change in technological coefficients, costs and availabilities; Addition of new variable and constraints; Deletion of constraints and variable.

Module IV

Optimization Problems: Formulation of transportation problem, basic feasible solution, North-West corner method, Least cost entry method, Vogal's approximation method, Test of optimality. Formulation of Assignment problem, Hungarian algorithm, travelling salesman problem. Sequencing problem with jobs and machines. Project scheduling, network diagrams, critical path method, time cost optimization algorithm.

Module V

Non-Linear Programming Problem: Unconstrained non-linear programming problems; direct search methods – univariate method, pattern search method; Indirect search methods – steepest descent method; constrained optimization problems; direct method – complex method, Zoutendijk method; indirect method – transform techniques, penalty function method.

Course outcome:

After studying this course, the students will be able to

- Understand importance of optimization of industrial process management.
- Apply basic concepts of mathematics to formulate an optimization problem.
- Model engineering minima/maxima problems as optimization problems.
- Analyze and appreciate variety of performance measures for various optimization problems.

Text Book:

1. Rao S. S., 'Engineering Optimization, Theory and Practice' - New Age International Publishers.
2. Chander Mohan, Kusum Deep, "Optimization Techniques", New Age International Private Limited.
3. S. K. Yadav, S. R. Yadav, A. K. Malik, "Optimization Techniques", I K International Publishing House.

Reference Book:

1. E. K. P. Chong And S. Zak, “An Introduction To Optimization” John Wiley And Sons (Asia) Pvt. Ltd., Singapore.
2. R. Fletcher, “Practical Methods Of Optimization”, Wiley, New York.
3. J. Nocedal And S. Wright, “Numerical Optimization”, Springer-Verlag, New York.
4. R. K. Sundaram, “A First Course In Optimization Theory”, Cambridge University Press, Cambridge.

OE-4033	Cloud Computing	L-T-P-C:3-0-0-3

Course objective:

- To impart basic concepts in the area of cloud computing.
- Bring in-depth understanding on architectures and models for Cloud Computing with Internet of Things.
- To impart knowledge in web-based applications of cloud computing.

Course content:

Module I

Introduction to Cloud Computing: Nutshell of cloud computing, feature Characteristics and components of Cloud Computing. Challenges, Risks and Approaches of Migration into Cloud. Evaluating the Cloud's Business Impact and economics, Future of the cloud.

Module II

Networking Support for Cloud Computing. Ubiquitous Cloud and the Internet of Things. Cloud Computing Architecture: Cloud Reference Model, Layer and Types of Clouds, Services models, Data center Design and interconnection Network, Architectural design of Computer and Storage Clouds.

Module III

Cloud Programming and Software: Fractures of cloud programming, Parallel and distributed programming paradigms, High level Language for Cloud. Introduction to Map Reduce, GFS, HDFS, Hadoop Framework.

Module IV

Virtualization Technology: Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms,

Hypervisor, VMware, KVM, Xen. Virtualization of CPU, Memory, I/O Devices, Virtual Cluster and Resources Management, Virtualization of Server, Desktop, Network, and Virtualization of data-center.

Module V

Web-Based Application, Pros and Cons of Cloud Service Development, Types of Cloud Service Development, Software as a Service, Platform as a Service, Web Services, On-Demand Computing, Discovering Cloud Services, Development Services and Tools, Amazon Ec2, GoogleApp Engine, IBM Clouds.

Course outcome:

At the end of the course student will be able

- Have an overall understanding on various hardware and software necessary for cloud computing.
- Design and develop various cloud computing applications.

Text Book:

1. Cloud Computing: Principles and Paradigms, Raj Kumar Buyya, JemesBroberg, Andrzej M.Goscinski.
2. Dan C Marinescu, Cloud Computing, Theory and Practice, MK, Elsevier

Reference Book:

1. Distributed and Cloud Computing : Kai Hawang, Geoffrey C. Fox, Jack J. Dongarra

OE-4043	**Data Analytics forIoT**	**L-T-P-C:3-0-0-3**

Course objective:

- This course is designed for Engineers we also train basic knowledge in C Programming to Implement IoT Solutions.
- IOT realtime project using Ardunio
- IOT Protocol Suite & Its Connectivity
- Wireless IOT
- Cloud Computing IOT

Course content:

Module I

Introduction to IOT, Understanding IoT fundamentals, IOT Architecture and protocols, Various Platforms for IoT, Real-time Examples of IoT, Overview of IoT components and IoT Communication Technologies, Challenges in IoT

Module II

Arduino Simulation Environment, Arduino Uno Architecture, Setup the IDE, Writing Arduino Software, Arduino Libraries, Basics of Embedded C programming for Arduino
Interfacing LED, push-button and buzzer with Arduino Interfacing Arduino with LCD

Module III

Sensor & Actuators with Arduino, Overview of Sensors working
Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino., Interfacing of Relay Switch and Servo Motor with Arduino

Module IV

Data Collection using IoT Devices, Data Analysis and Data Visualization, Collecting Data from sensors locally, Sending Sensor Data to IoT Cloud (Thingspeak), Thingspeak IoT Cloud Overview, Thingspeak Account Creation, Thingspeak API

Module V

Cloud Platforms for IOT, Virtualization concepts and Cloud Architecture, Cloud computing, benefits
Cloud services — SaaS, PaaS, IaaS, Anamoly Detection, Z score Analysis,

Course outcome:

- To learn IoT and Data Analytics
- Learn how to program NOdeMCU (ESP8266), collecting data and data analysis.

Text Book:

1. Andrew Minteer, Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices.

Reference Books:

1.Anand Tamboli, Build Your Own IoT Platform: Develop a Fully Flexible and Scalable Internet of Things Platform in 24 Hours

2.Hwaiyu Geng, Internet of Things and Data Analytics Handbook, John Wiley & Sons.

OE-4057	Advanced Embedded Control Systems	L-T-P-C:3-0-0-3

Course Objective:

- Learn the application of control system in embedded systems.
- Understand the role of control system in sensing and interfacing of embedded devices.

Course Content:

Module I

Control System Basics: Z-transforms, performance requirements, block diagrams, analysis and design, sampling theory, difference equations.

Module II

Control System Implementation: Discretization method, fixed point mathematics, nonlinear controller elements, gain scheduling, controller implementation & testing in embedded systems. Case study of robotic control system.

Module III

Input Devices: Keyboard basics, keyboard scanning algorithm, character LCD modules, LCD module display configuration, time-of-day clock, timer manager, interrupts, interrupt service routines, interrupt-driven pulse width modulation.

Triangle waves analog vs. digital values, auto port detect, capturing analog information in the timer interrupt service routine, multiple channel analog to digital data acquisition.

Module IV

H Bridge, relay drives, DC/ Stepper Motor control, optical devices.

Module V

Sensors: Linear and angular displacement sensors: resistance sensor, induction displacement sensor, digital optical displacement sensor, pneumatic sensors. Speed and flow rate sensors: electromagnetic sensors, fluid flow sensor, thermal flow sensor. Force sensors: piezoelectric sensors, strain gauge sensor, magnetic flux sensor, inductive pressure sensor, capacitive pressure sensor. Temperature sensors: electrical, thermal expansion, optical.

Course outcome:

Upon Completion of the course, the students will be able to:

- Implement application of control systems in embedded systems.
- Describe I/O devices used in control systems.

Text Book:

1. Jim Ledin, “Embedded control systems in C/C++”, CMP Books, 2004.
2. TimWiscott, “Applied control for embedded systems”, Elsevier Publications, 2006.

Reference Book:

1. Jean J. Labrosse, “Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C”, The publisher, Paul Temme, 2011.
2. Ball S.R., “Embedded microprocessor Systems - Real World Design”, Prentice Hall, 3rd Edition.

OE-4059	Real-time operating system	L-T-P-C:3-0-0-3

Course objective:

The syllabus deals with the adequate understanding of Real time operating system. Student will be able to understand and design real time operating systems which are backbone of embedded industry.

Module I

Introduction to Real time systems:-Need for RTOS, Structure of RTOS, Classification of Real time system, Difference between GPOS and RTOS:- Real Time, Issues in real time operating system. Performance measures for real time system:- Properties, traditional performance measures, cost functions, hard deadlines, and Estimating program run times. Introduction to LINUX/ UNIX OS.

Module II

Performance metrics and scheduling Algorithms: - Performance Metrics of RTOS, Task Specifications, Task state. Real Time Scheduling algorithms:- Cyclic executive, Rate monotonic, IRIS and Least laxity scheduling, Schedulability Analysis.

Module III

Features of Real Time Operating System:- Messages, queues, mailboxes, pipes, timer function events, memory management. Interrupt basic system design using an RT (OS design principles, interrupt routines, task structures and priority.) Current research in RTOS.

Module IV

Real Time Databases:-Real time v/s general purpose databases, main memory databases, transaction priorities, transaction aborts. Concurrency control issues:- pessimistic concurrency control and optimistic concurrency control, Disk scheduling algorithms.

Module V

Fault Tolerance Techniques:-Causes of failure, Fault types, Fault detection, Fault and error containment. Redundancy:- hardware redundancy, software redundancy, Time redundancy, information redundancy. Data diversity, Integrated failure handling.

Course outcome:

- Student will be able to solve scheduling problems and can apply them in real time applications in industry.
- Student can also design a RTOS and will be able to interpret the feasibility of a task set to accomplish or not.

Text Book:

1. David E. Simon, "An Embedded Software Primer", Pearson Education Asia Publication, ISBN: 9780201615692
2. C.M. Krishna and Kang G. Shin," Real Time Systems", TMH Publication, ISBN : 9780070701151

Reference Book:

1. Raj kamal ," Embedded system: Architecture Programming and Design", TMH Publication, ISBN : 9780070667648
2. Mazidi," PIC Microcontroller and Embedded Systems" , Pearson, ISBN:9788131716755

OE-4061	Intelligent Visual Surveillance System	L-T-P-C:3-0-0-3

Course objective:

- To understand the different types image transformation techniques.
- To identify the different types of classifier and tracking method.
- Explore the principles of Intelligent Surveillance system.

To provide in-depth knowledge of Intelligent visual surveillance systems.

Course content:

Module I

Introduction to image processing methods, Image transforms, Wavelet transform, JPEG image compression, Video compressor standard: H. 261, H. 263, H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection, Color spaces- RGB, CMY and HSI

Module II

Motion analysis: Real versus apparent motion, Motion modeling and segmentation techniques. Shape based object classification, motion based object classification, Silhouette-

based Method for object classification, Viola jones object detection framework, Multiclass classifier boosting

Module III

Classification of multiple interacting objects from video, Region-based tracking, Contour-based tracking, Feature-based tracking, Model-based tracking, Hybrid tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects

Module IV

Template based activity recognition, Human Recognition Using Gait, HMM Framework for Gait Recognition, Hidden Markov Models (HMMs), Dynamic Time Warping (DTM), Finite-State Machine (FSM), Nondeterministic-Finite-State Automaton (NFA), Time-Delay Neural Network (TDNN), Applications and Challenges

Module V

Types of CCTV (closed circuit television) camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocol) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras

Course outcome:

- Identify and characterize different components of an intelligent visual surveillance system. Understand video signal analysis and detection.

Text Book:

1. Murat A. Tekalp, "Digital Video Processing", Prentice Hall, 1995.
2. Y. Ma and G. Qian (Ed.), "Intelligent Video Surveillance: Systems and Technology", CRC Press, 2009.
3. J.K. Petersen, Introduction to Surveillance Studies, CRC Press, 2013.
4. Proakis, John G. Digital signal processing: principles algorithms and applications. Pearson Education India, 2001

Reference Book:

1. H. Aghajan and A. Cavallaro (Ed.), Multi-Camera Network: Principles and Applications‖, Elsevier, 2009.
2. A senior (Ed.), Privacy Protection in Video Surveillance‖, Elsevier, 2009.
3. Dr. Richard Szeliski, Computer Vision: Algorithms and Applications‖, Springer Publication, 2010.

OE-4063	Antenna for IOT	L-T-P-C:3-0-0-3

Course objective:

- Understand related physical phenomena and antennas in order to provide a unified view of methodologies to address the study of various classes of antenna systems for research and project purposes in telecommunication and aerospace applications.

Module I

Antenna Fundamentals: Introduction, Types of Antennas, Radiation Pattern and mechanism, Antenna Parameters, Antenna Losses, Duality Theorem, Reciprocity Theorem.

Module II

Elementary Antennas: Linear Wire Antennas, Monopole, Infinitesimal Dipole, Small Dipole, Finite Length Dipole, Half Wavelength Dipole, Loop Antenna, Small Circular Loop.

Module III

Microstrip Antennas: Basic Characteristics of Microstrip Antennas, Antenna Miniaturization, Feeding Methods, Introduction to Patch and its types, Methods of Analysis, Design of Rectangular and Circular Patch Antennas. Quality Factor, Bandwidth, Efficiency.

Module IV

MIMO Antennas: Single Input Single Output (SISO), SIMO Single Input Multiple Output (SIMO), Multiple Input Single Input (MISO), Multiple-Input-Multiple-Output (MIMO) Technology, MIMO Antenna Performance Criteria- Envelope Ccorrelation Ccoefficient (ECC), Diversity Gain (DG), Total Active Reflection Coefficient (TARC), Mean effective gain (MEG), Channel Capacity, Channel Capacity Loss (CCL), Spectral Efficiency, Transmitted and Reflected Powers, Transmission Coefficient (Isolation).

Module V

Importance And Uses Of Microstrip Antenna In IOT: Birth of internet of things, Design of microstrip antenna for IOT applications, Design of microstrip antenna for IOT applications, Multiband microstrip patch antenna for IOT applications, Design of a handy triple band micro-strip patch antenna for satellite-based IOT applications, 3D miniature antenna design for RFID applications in iot environment, Design challenges of antenna for IOT applications, current trends in the design of antennas for IOT applications.

Course outcome:

- To understand the fundamental working principle of an antenna.
- To describe/explore the different antenna parameters like input impedance, far-field radiation patterns, reflection coefficient, etc.
- To design the wire antennas, microstrip antennas, etc.
- To design the antenna for IoT applications.

Text Book:

1. Balanis C.A., "Antenna Theory and Design", 3 rd Edition, John Wiley & Sons., 2005, ISBN:978-81-265-2422-8.
2. Sharawi, M. S. (2014). *Printed MIMO antenna engineering*. Artech House.

Reference Book:

1. Marhefka, Ronald J., and D. D. Kraus. "Antennas for all Applications." *Antennas for all applications* (2002).
2. Collin, Robert E. "Antennas and radiowave propagation." (1985).
3. Patil, Wani V. "Importance and Uses of Microstrip Antenna in IoT." Smart Antennas: Recent Trends in Design and Applications 2 (2021): 57.

OE-4065	IoT Architecture & Cloud Computing	L-T-P-C:3-0-0-3

Course objective:

- To learn how to design and implement IoT applications that manage big data, streaming data, and/or distributed data
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications.

Module I

Fundamentals of IoT: Evolution of Internet of Things, Enabling Technologies, IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture

and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects

Module II

IoT Protocols: IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN, Zigbee protocol, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT

Module III

Design and Development: Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino–Board details, IDE programming, Raspberry Pi and Interfaces

Module IV

Data Analytics and Supporting Services: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning-No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG, Kibana, Fault-tolerant data processing on devices

Module V

Case Studies/Industrial Applications: Cisco IoT system, IBM Watson IoT platform, Manufacturing, Converged Plantwide Ethernet Model (CPwE), Power Utility Industry, GridBlocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Course outcome: At the end of the course, student will able to

- Describe the term IoT in different contexts.
- Analyze various protocols for IoT.
- Design a PoC of an IoT system using Rasperry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT.
- Analyze applications of IoT in real time scenario

Text Book:

1 .David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals:Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

2.Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, Universities Press, 2015

Reference Book:

1. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things – Key applications and Protocols, Wiley, 2012
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, DavidBoyle, From Machine-to-Machine to the Internet of Things –Introduction to a New Age of Intelligence, Elsevier, 2014.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
4. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

OE-4067	**Embedded systems in Biomedical application**	**L-T-P-C:3-0-0-3**

Course objective:

- To impart knowledge on the integration of hardware circuits with software
- To introduce the concepts of programming in an IDE and download it into a processor
- To learn about the practical aspects of data acquisition and analysis
- Understand the basics of Bio Potentials and Physiological Signals.

Course content:

Module I

Definition and Classification – Overview of Processors and hardware units in an embedded system – Software embedded into the system – Exemplary Embedded Systems – Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits - Embedded Hardware Architecture, Communication Interface Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems.

Module II

Embedded system evolution trends. Round - Robin, robin with Interrupts, function-One-Scheduling Architecture, Algorithms. Introduction to-assembler-compiler-cross compilers and Intergrated Development Environment (IDE). Object Oriented Interfacing, Recursion, Debugging strategies, Simulators. Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues-Timer Function, Events-Memory Management, Interrupt Routines in an RTOS environment, basic design Using RTOS, Different types of embedded processors and controllers.

Module III

Design Thinking and Protocols: Introduction, Characteristics, Physical design, Protocols, Logical design, Enabling technologies, IoT Levels, Domain Specific IoTs, IoT vs M2M. IOT design methodology, IoT systems management, IoT Design Methodology Specifications

Module IV

IoT In Health Care Applications: Ethical Issues In Health Care: (8 Hours) Ethical implications of digital health technologies- privacy, confidentiality and security of personal health data-ethical framework and guidelines in digital health, principles of biomedical ethics. IoT based health care-physiological parameter monitoring system- future challenges in health carehealth care echo system with IoT- IoT for personalized health care- wearable device characteristics analysis of power aware protocols.

Module V

Case Study: Embedded medical applications: Ophthalmology - Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems, Social network analysis in health care embedded health care system for senior resident using IoT.

Course outcome:

- Select appropriate microcontroller for design Calculate memory requirement and other on-chip/off-chip peripheral requirement
- Understand requirement of a project as well as inputs and outputs of the system
- Design software for the target processor/controller
- Understand different communication protocols to make the system as a part of network
- Analyse the application of Embedded systems in surgical devices, medical imaging, clinical laboratory equipment etc

Text Book:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill

3. Tim Wilmshusrst, Designing Embedded Systems with PIC, Newnes publishing.
4. Subhas Chandra Mukhopadhyay and Aime Lay-Ekuakille, “Advances in Biomedical Sensing Measurements, Instrumentation and Systems”, Springer, 2012.
5. Robert B. Northrop, “Noninvasive Instrumentation and Measurement in Medical Diagnosis”, CRC Press, 2019

Reference Book:

1. Steve Heath, Embedded Systems Design.
2. David E. Simon, An Embedded Software Primer, Pearson Education Asia.
3. Roberts. H. Istepanian and Bryan Woodward, “m-Health Fundamentals and Applications”, Wiley, 2017.

OE-4069	Advanced Digital Design	L-T-P-C:3-0-0-3

Course objective:

- To learn how to design digital systems, from specification and simulation to construction and debugging.
- To learn techniques and tools for programmable logic design
- To understand the limitations and difficulties in modern digital design, including wiring constraints, high-speed, etc.
- To design, construct, test, and debug a moderate-scale digital circuit.

Module I

Combinational Logic Design: Combinational-Circuit Synthesis, Programmed Minimization Methods, Timing Hazards, Circuit Timing, Decoders, Encoders, Three-State Devices, Multiplexers, Exclusive-OR Gates and Parity Circuits, Comparators, Adders, Subtractors, ALUs, Combinational Multipliers.

Module II

Sequential Logic Design: Bistable Elements, Latches and Flip-Flops, Counters, Shift Registers, Clocked Synchronous State, Machine Analysis and Design, Designing State Machines Using State Diagrams, State-Machine Synthesis Using Transition Lists, State-Machine Design Example, Decomposing State Machines, Feedback Sequential Circuits, Feedback Sequential-Circuit Design

Module III

Computer-aided design: Overview of Digital Design with Verilog HDL, Hierarchical Modeling Concepts, Basic Concepts, Modules and Ports, Gate Level Modeling, Dataflow Modeling, Behavioral Modeling, Tasks and Functions, Useful Modeling Techniques, Timing and Delays, User Defined Primitives, Logic Synthesis with Verilog HDL, Testbenches for verification of HDL models, Tools for mapping to PLDs and FPGAs

Module IV

Memory, FPGAs and ASICs: MOSFETs, FPGAs Integrated circuits Circuit boards, High-speed circuits, controlling impedances Read-Only Memory, Read/Write Memory, Static RAM, Dynamic RAM, Complex Programmable Logic Devices, Field-Programmable Gate Arrays, Types of ASICs, ASIC Design flow, Economics of ASICs.

Course Outcome:

Upon Completion of the course, the students will be able to:

- Design digital circuits and subsystems using Verilog HDL.
- Have basic understanding of Memory, CPLDs, FPGAs and ASICs.

- Design dynamic architectures using FPGA's.
- Implement, Design and develop embedded system using EDA tools

Text Book:

1. M.J.S. Smith, "Application Specific Integrated Circuits", 2nd Edition, Pearson, 2016.
2. Peter Ashenden, "Digital Design using VHDL", 3rd Edition Elsevier, 2017.

Reference Book:

1. W.Wolf, "FPGA based system design", 3rd EditionPearson, 2014.
2. Clive Maxfield, "The Design Warriors's Guide to FPGAs", 1st Edition Elsevier, 2014

OE-4071	**Embedded sensing technology**	**L-T-P-C:3-0-0-3**

Course objective:

- Select the right sensor for a given application.
- Design basic sensor circuit building blocks.
- Simulate, synthesize, and layout a complete IoT sensor system.

Course content:

Module I

Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization. -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

Module II

Sensing Principle of different IoT sensors: Thermal, Magnetic, Radiation, Optical, pH Sensor, Gas Sensor, Bio Sensor, Flow Sensor, Soil Sensor, Motion Sensor, Image sensor, Velocity and Acceleration Measurement, Position, Direction, Displacement and Level measurement, Calibration and Interfacing.

Module III

Industrial 4.0 sensors: Description & Characteristics–First Generation of Advanced Generation Integrated Industrial IoT Sensors, Description & Characteristics of Sensors' Swarm, Description & Characteristics of Printed Electronics, Industrial sensor network.

Module IV

Case study: Sensing technology for in bio medical, automotive, robotics, agriculture, sports application

Course outcome:

- Use concepts in common methods for converting a physical parameter into an electrical quantity
- Design and develop sensors using optical methods with desired properties
- Evaluate performance characteristics of different types of sensors
- Create analytical design and development solutions for sensors.

Text Book:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.

Reference Book:

1. GerdKeiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi.
2. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition,CRC Press, Florida.
3. Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey.
4. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York

OE-4073	**Smart Grid Technologies & IoT**	**L-T-P-C:3-0-0-3**

Course objective:

- Smart electric power grids, including definition, design criteria, technology and IoT.
- Information processing and communications to the power grid.
- Understanding the development of the smart grid.
- Smart grid design, implementation, evaluation and management of smart electricity infrastructure.

Module I

Introduction To Smart Grid: Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers

Module II

Energy Management System: Energy Management System (EMS) - Smart substations - SubstationAutomation-FeederAutomation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

Module III

Distribution Management System: Distribution Management System (DMS) – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles

Module IV

Smart Meters: Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing**.**

Module V

Communication Networks & IOT: Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) – Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

Course outcome:

- Get acquainted with different smart devices and smart meters
- Describe how modern power distribution system functions
- Identify suitable communication networks for Smart Grid applications

Text Book:

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid:Technology and Applications', Wiley, 2012

Reference Book:

1.Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015

2. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.

OE-4075	**IoT edge notes**	**L-T-P-C:3-0-0-3**

Course objective:

- Introducing the basic concepts of Physical & Logical design of IoT and analyses of Machine to Machine Concepts.
- Exposing students to the usage of Protocol Standardization for IoT with IoT Edge and Gateway Network with Communication protocols.
- Preparing the students to know the basics of protocol stacks for the edge devices and design challenges.
- Providing IoT Solutions with sensor based application through embedded system platform.

Course content:

Module I

Introduction to IoT: Defining IoT; Characteristics of IoT; Physical design of IoT; Logical design of IoT; Functional blocks of IOT; Communication Model and API's Actuators, Controllers and Sensors.

Module II

IoT Protocols: Protocol Standardization for IoT; Efforts of M2M and WSN Protocols; SCADA and RFID Protocols; Unified Data Standards; Protocols IEEE 802.15.4; Network layer; 6LowPAN; MQTT; COAP

Module III

IoT Edge and Gateway Network: IoT Edge basic introduction; What and where is the "Edge"; Edge/Fog computing Value of keeping data local; An edge-first approach; The power of edge to cloud; IoT Edge cloud interface; Communication protocols and protocol stacks for the edge devices Overview of Edge Networks in IoT; Implementation of IoT Edge Gateway; Edge Architecture : CloudPath; A Multi-Tier Cloud Computing Framework Femto Clouds; Leveraging Mobile Devices to Provide.Cloud Service at the Edge Fast; Scalable and Secure Onloading of Edge Functions Using Air Box

Module IV

Challenges in IoT: Design challenges; Development challenges; Security challenges; Other challenges.

Module V

Developing IoT Solutions : Introduction to IoT tools; Developing applications through IoT tools; Developing sensor based application through embedded system platform; Edge Analytics, Edge Security and Artificial Intelligence (AI). Home automation; Industry applications; Surveillance applications; Other IoT applications.

Course outcome:

At the end of the course the student should be able to

- Comprehend and analysis concepts of Physical design and Logical design of IoT
- Compute response analysis of Machine to Machine Concepts of IoT.
- Comprehend the Protocol Standardization for IoT with Efforts of M2M and WSN Protocols
- Comprehend the operation of IoT Edge and Gateway Network with Communication protocols
- Understand the issues on Development challenges and Security challenges in IoT.
- Comprehend the ideas of Developing IoT Solutions
- Provide suitable solution for domain specific applications of IoT
- Use tools to practice IoT enabling Technologies.

Text Book:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things — A hands-on approach", Universities Press, 2015.
2. Ovidiu Vermesan, Peter Friess, "Internet of Things — From research and innovation to market deployment", 2014, River Publishers Series in Communication, USA.
3. David Boswarthick, "M2M Communications — A Systems Approach", 2012, Wiley, USA.

4. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice" Wiley Publications 2010

Reference Book:

1. IBM Bluemix: The Cloud Platform for Creating and Delivering Applications, 2010 John Wiley & Sons Ltd
2. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann , Elsevier, 2010.
3. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley Publications 2010.
4. Ian F. Akyildiz, and Mehmet Can Vuran, Wireless Sensor Networks, 2010, Wiley, USA
5. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers 2013.

OE-4077/CD-4001	**Deep and reinforced learning**	**L-T-P-C:3-0-0-3**

Course objective:

- This course introduces two of the most sought-after disciplines in Machine Learning: Deep Learning and Reinforcement Learning.
- Learn about the theory behind Neural Networks, which are the basis of Deep Learning, as well as several modern architectures of Deep Learning.
- The course will focus on Reinforcement Learning, a type of Machine Learning that has caught up more attention recently

Course content:

Module I

Introduction: General introduction to machine learning, neural networks, deep neural networks, recurrent neural networks, and reinforcement learning, Successful application examples, especially in areas where superhuman performance has been achieved

Module II

Fundamental principles and techniques to deep learning and reinforcement learning, Machine Learning Fundamentals Neural networks and deep feedforward neural networks, Regularization techniques for deep learning, Optimization techniques for training deep neural networks, Convolutional neural networks

Module III

Recurrent and recursive neural networks, Deep learning applications with a focus on the ones that have achieved superhuman performance (in face recognition, object recognition, speech recognition, natural language processing (machine translation))

Module IV

Reinforcement learning framework, Dynamic programming algorithms for reinforcement learning, Monte Carlo methods for reinforcement learning, Temporal-difference learning and n-step bootstrapping algorithms for reinforcement learning, Function approximation algorithms for reinforcement learning, Case studies of reinforcement learning applications that have achieved superhuman performance, Active research topics in deep and reinforcement learning, Term project

Course outcome:

- Implement and use backpropagation algorithms to train deep neural networks
- Apply regularization techniques to training deep neural networks
- Apply optimization techniques to training deep neural networks
- Construct and train convolutional neural networks
- Construct and train recurrent neural networks

Text Book:

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (MIT Press, 2016)
2. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto

Reference Book:

1. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012)
2. David Silver's course on Reinforcement Learning

OE-4079	**Evolutionary and heuristic algorithms**	**L-T-P-C:3-0-0-3**

Course objective:

- Develop an understanding of issues in the computing using evolutionary and heuristics algorithms.
- Study theoretical as well practical issues. Prepare oneself for independent research in the area.
- Learn how the knowledge of evolutionary computing can be used in application areas

Course content:

Module I

Introduction, Definitions and Concepts: Optimization, Operational Research (OR), Engineering Optimization, Definition of an Optimization Problem, Feasibility Problem., Classification of the Optimization Problems, Classification of the Optimization Techniques, Heuristic Algorithms vs. Metaheuristics, Swarm Intelligence, Population-Based Optimization, Multi-objective Optimization, Parallelization, Evaluation of the Optimization Algorithms

Module II

An Overview of Classical Optimization: Techniques: Linear programming, Nonlinear Programming, An Overview of Heuristic Optimization Algorithms: Neighborhood Search, Hill Climbing Methods, Greedy Algorithms, Simulated Annealing, Evolutionary Algorithms, Tabu Search, Ant Colony Optimization, Particle Swarm Optimization

Module III

Simulated Annealing: Real Annealing and Simulated Annealing, Metropolis Algorithm, Simulated Annealing Algorithm, Continuous Simulated Annealing, One-loop Simulated annealing, Temperature Scheduling, Convergence of Simulated Annealing, Applications, Normalization of the Parameters, Tuning the Parameters of an algorithm, More on Evolutionary Algorithms Methods of encoding, Operators of Evolution, Models of Evolution, Genetic Algorithms, Steady State Gas, Genetic Programming, Memetic Algorithms, Differential Evolution, More on Tabu Search: Basic Tabu Search, Short-term Memory, Long-term Memory, Diversification and Intensification, Continuous Tabu Search

Module IV

Ant Colony Optimization: Collective Behavior of Social Insects, Basic ACO Algorithms, Ant Algorithms for TSP, Adaptation to Continuous Problems, Applications, More on Particle Swarm Optimization: Canonical PSO Algorithm, Important Parameters, Neighborhood, Topologies

Module V

Extensions of Heuristic Algorithms: Multi-objective Algorithms, Parallelization of the Optimization Algorithms, Heuristics to handle constraints, Handling Dynamic Optimization Problems, Handling Noisy Problems, Handling Expensive Cost Functions

Course outcome:

- Utilize state of the art heuristic optimization algorithms in their research activities.
- Design and propose new and hybrid optimization algorithms.
- Customize heuristic optimization algorithms for special applications

Text Book:

1. D. Simon, “Evolutionary Optimization Algorithms”, Wiley, 2013.
2. S. S. Rao, "Engineering Optimization: Theory and Practice", 3rd edition, John Wiley & Sons, Inc., 1996.

Reference Book:

1. Z. Michalewicz and D. B. Fogel, "How to Solve it: Modern Heuristics", Springer, 2004.
2. Xin She Yang, Nature-inspired Metaheuristic Algorithms, Luniver Press, 2014.
3. S. N. Sivanandam and S. N. Deepa, "Introduction to Genetic Algorithms", Springer, 2008.
4. Fred Glover, Manuel Laguna, "Tabu Search", Klawer Academic Publishers, Norwell, MA, 1997.
5. M. Dorigo and T. Stutzle, "Ant Colony Optimization", MIT Press, 2004.
6. M. Clerc, "Particle Swarm Optimization", ISTE Ltd, 2006

OE-4081	Energy Harvesting And Power Management For IOT Devices	L-T-P-C:3-0-0-3

Course objective:

The objectives of the course are to learn the techniques in involved in Energy harvesting, to understand the various energy sources and energy harvesting based sensor networks, to learn about the various Piezoelectric materials and Non-linear techniques, to understand the various Power sources for WSN and to learn about the applications of Energy harvesting systems.

Module I

Energy Harvesting Systems: Introduction – Energy sources – energy harvesting based sensor networks –photovoltaic cell technologies – generation of electric power in semiconductor PV cells– types

Module II

Piezo-Electric Energy Harvesting And Electromechanical Modeling: Piezoelectric materials – transducers – harvesters – micro generators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed-form solutions.

Module III

Electromagnetic Energy Harvesting And non-Linear Techniques: Basic principles – micro fabricated coils and magnetic materials – scaling – power maximations –micro and macro scale implementations. Non-linear techniques –vibration control & steady state cases

Module IV

Energy Harvesting Wireless Sensors: Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting microelectronic circuits – power conditioning and losses.

Module V

Case Study: Case studies for Implanted medical devices – Bio-MEMS based applications –harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes

Course outcome:

- Understand the various energy sources and energy harvesting based sensor networks
- Learn about the various Piezoelectric materials and Non-linear techniques
- Understand the various Power sources for WSN
- Learn about the applications of Energy harvesting systems.

Text Book:

1.Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva Veríssimo Paulino, “CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications”,springer, 2016

Reference Book:

1.Danick Briand, Eric Yeatman, Shad Roundy, “Micro Energy Harvesting”, 2015