# DAYANANDA SAGAR UNIVERSITY

SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT BENGALURU – 560 111, KARNATAKA.

## SCHOOL OF ENGINEERING

# SCHEME & SYLLABUS FOR BACHELOR OF TECHNOLOGY (B.Tech.) – 2021

## ELECTRONICS & COMMUNICATION ENGINEERING (ECE)

## (WITH EFFECT FROM 2021-22)

## (III & IV SEMESTERS)

## SCHEME - B.TECH – 2021-22 ONWARDS

## III SEM - ELECTRONICS & COMMUNICATION ENGINEERING

| SL | PROGRAM CODE | COURSE CODE | COURSE TITLE | CR / AU | SCHEME OF TEACHING | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | S / P | C |
| 1 | 102 | 21EN2301 | ENGINEERING MATHEMATICS-III | CR | 3 | 1 | - | - | 4 |
| 2 | 102 | 21EC2302 | ANALOG CIRCUITS | CR | 3 | - | 2 | - | 4 |
| 3 | 102 | 21EC2303 | DIGITAL SYSTEM DESIGN WITH VERILOG | CR | 3 | - | 2 | - | 4 |
| 4 | 102 | 21EC2304 | NETWORK ANALYSIS | CR | 3 | 1 | - | - | 4 |
| 5 | 102 | 21EC2305 | ENGINEERING ECONOMICS | CR | 2 | - | - | - | 2 |
| 8 | 102 | 21EC2306 | SPECIAL INITIATIVES -I | CR | - | - | - | 4 | 2 |
| | | | | | **14** | **2** | **4** | **4** | **20** |

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

## SCHEME - B.TECH – 2021-22 ONWARDS

### IV SEM - ELECTRONICS & COMMUNICATION ENGINEERING

| SL | PROGRAM CODE | COURSE CODE | COURSE TITLE | CR / AU | SCHEME OF TEACHING | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | S / P | C |
| 1 | 102 | 21EC2401 | SIGNALS AND SYSTEMS | CR | 3 | 1 | - | - | 4 |
| 2 | 102 | 21EC2402 | COMPUTER SYSTEM ARCHITECTURE | CR | 3 | 1 | - | - | 4 |
| 3 | 102 | 21EC2403 | MICROCONTROLLERS | CR | 3 | - | 2 | - | 4 |
| 4 | 102 | 21EC2404 | ELECTROMAGNETIC WAVES | CR | 3 | - | 2 | - | 4 |
| 5 | 102 | 21EC2405 | LAW FOR ENGINEERS | CR | 2 | - | - | - | 2 |
| 6 | 102 | 21EC2406 | SPECIAL INITIATIVES -II | CR | - | - | - | 4 | 2 |
| | | | | | **14** | **2** | **4** | **4** | **20** |

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

**SCHEME - B.TECH – 2020 -21 ONWARDS**

**V SEM - ELECTRONICS & COMMUNICATION ENGINEERING**

| Sl. No. | PROGRAM CODE | COURSE CODE | COURSE TITLE | $\frac{AU}{CR}$ | Scheme of Teaching | | | | | Scheme of Evaluation | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | S/ P | C | CIA | End Exam |
| 1 | 102 | 21EC3501 | Analog and Digital Communication | CR | 03 | | 02 | | 04 | 60 | 40 |
| 2 | 102 | 21EC3502 | Probability Theory and Stochastic Processes | CR | 03 | 01 | -- | | 04 | 60 | 40 |
| 3 | 102 | 21EC3503 | CMOS VLSI Design | CR | 03 | -- | 02 | | 04 | 60 | 40 |
| 4 | 102 | 21EC3504 | Digital Signal Processing | CR | 03 | | 02 | | 04 | 60 | 40 |
| 5 | 102 | 21EC35XX | Program Elective – 1 | CR | 03 | | -- | | 03 | 60 | 40 |
| 6 | 102 | 21OEXXXX | OE-1 | CR | 03 | -- | -- | | 03 | 60 | 40 |
| 7 | 102 | 21EC3505 | Special Initiatives -III | CR | -- | -- | | 04 | 02 | 60 | 40 |
| **Grand Total 900** | | | | | **18** | **01** | **06** | **04** | **24** | **420** | **320** |

**Program Elective –1**

| Sr. No. | PROGRAM CODE | COURSE CODE | COURSE TITLE |
|---|---|---|---|
| 1 | 102 | 21EC3506 | Information Theory and Coding |
| 2 | 102 | 21EC3507 | MEMS* |
| 3 | 102 | 21EC3508 | C Programming for Embedded Systems |
| 4 | 102 | 21EC3509 | PLC and SCADA |

**SCHEME - B.TECH – 2020 -21 ONWARDS**

**VI SEM - ELECTRONICS & COMMUNICATION ENGINEERING**

| Sl. No. | PROGRAM CODE | COURSE CODE | COURSE TITLE | $\frac{AU}{CR}$ | Scheme of Teaching | | | | | Scheme of Evaluation | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | S/ P | C | CIA | End Exam |
| 1 | 102 | 21EC3601 | RF and Microwave Communication | CR | 03 | -- | 02 | | 04 | 60 | 40 |
| 2 | 102 | 21EC3602 | Networking and Communication | CR | 03 | -- | 02 | | 04 | 60 | 40 |
| 3 | 102 | 21EC3603 | Power Electronics | | 03 | -- | 02 | | 04 | 60 | 40 |
| 4 | 102 | 21EC36XX | Program Elective -2 | CR | 03 | -- | -- | | 03 | 60 | 40 |
| 5 | 102 | 21EC36XX | Program Elective – 3 | CR | 03 | -- | -- | | 03 | 60 | 40 |
| 6 | 102 | 21OEXXXX | Open Elective-2 | CR | 03 | -- | -- | | 03 | 60 | 40 |
| **Grand Total 600** | | | | | **18** | **01** | **04** | **04** | **21** | **360** | **240** |

**Program Elective –2**

| Sr. No. | PROGRAM CODE | COURSE CODE | COURSE TITLE |
|---|---|---|---|
| 1 | 102 | 21EC3604 | Analog VLSI Design |
| 2 | 102 | 21EC3605 | Wireless Mobile Communication |
| 3 | 102 | 21EC3606 | Embedded System Design/Architecture |

**Program Elective –3**

| Sr. No. | PROGRAM CODE | COURSE CODE | COURSE TITLE |
|---|---|---|---|
| 1 | 102 | 21EC3607 | Digital IC Design |
| 2 | 102 | 21EC3608 | Digital Image Processing |
| 3 | 102 | 21EC3609 | Real Time Embedded system |
| 4 | 102 | 21EC3610 | Industry IOT |

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|---|---|---|---|---|---|---|
| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2301** | | | | | |
| **TITLE OF THE COURSE** | **ENGINEERING MATHEMATICS – III** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **1** | **-** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Understanding basic concepts of Complex variables and Complex integration to illustrate its importance through applications to science and Engineering.
- Understanding basic concepts of ODE to illustrate its power and utility through applications to science and Engineering.
- Understanding basic concepts of Probability and Random variables.
- Apply the concepts of Probability distribution in engineering.
- The course is discussed with theoratic as well as geometric perspectives.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | the basic notion of Complex variables and complex integration | **L3-Apply** |
| CO2 | the abstract concepts of Probability | **L3-Apply** |
| CO3 | to solve differential equations in the field of Circuit analysis and signal processing. | **L4-Analyze** |
| CO4 | apply the concept of probability and complex variables in communication. | **L3-Apply** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: COMPLEX VARIABLES** | **08Hrs** |
| Complex function, Limits, Continuity, differentiability, Analytic Functions, CR Equations, Properties of Analytic functions.<br>**Self Learning Component** : Complex number and its properties | |
| | |
| **MODULE 2: INTEGRATION IN THE COMPLEX PLANE** | **12Hrs** |
| Complex Integrals, Cauchy -Goursat Theorem, Independence of Path, Cauchy's Integral Formulas and Their Consequences, Cauchy's Two Integral Formulas, Some Consequences of the Integral Formulas, Applications.<br>**Self Learning Component :** Integration and some basic formulae | |
| | |
| **MODULE 3: DIFFERENTIAL EQUATIONS** | **12Hrs** |
| Second and higher order linear ODE with constant coefficients, General solution to the homogeneous equations, Method of variation of parameters, Method of undetermined coefficients, Cauchy-Euler and Legendre's linear equations, Power series solution for second order linear ODE.<br>**Self Learning Component:** First order ODE and its solving techniques | |
| **MODULE 4: PROBABILITY DISTRIBUTIONS** | **08Hrs** |
| | |
| Basic Probability- Probability introduced through sets and relative frequency- conditional probability- independence-Random Variable-Discrete and continuous random variables-Independent random variables-Mixed random variable<br>**Self Learning Component** : Events, Sample space | |
| | |
| **MODULE 5: PROBABILITY DISTRIBUTIONS** | **12Hrs** |
| | |
| Distribution and density function-Properties-Binomial Distribution-Poisson Distribution-Uniform Distribution-Gaussian Distribution-Exponential Distribution-Rayleigh Distribution-Conditional Distribution- Multinomial Distribution Density function-Properties<br><br>**Self-Learning Component:** Distribution of discrete and continuous random variable | |

**TEXT BOOKS:**

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1. A First course in complex analysis with applications, Dennis Zill and Patrick Shanahan, Jones and Bartlett publishers.
2. A First Course in Probability, S. Ross, Pearson International Edition, 9th Edition
3. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 11th Edition.
4. Thomas's Calculus, G.B.Thomas, M.Weir, J. Hass, Pearson , 12th edition

**REFERENCES:**


. 1. Complex Variables and applications, Brown and Churchill, Mc Graw Hill Education, Eighth Edition.

2. Probability, Statistics and Statistics with Reliability, Queuing, and Computer Science Applications, Kishore Trivedi, Prentice Hall, 2nd Edition

**3.** Probability and Random Processes, S. Miller and Childers, Elsevier Inc., Second Edition

4. Advanced Engineering Mathematics, E. Kreyzsig, Wiley, 10th Edition


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|---|---|---|---|---|---|---|
| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2302** | | | | | |
| **TITLE OF THE COURSE** | **ANALOG CIRCUITS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| | | | |
| | | | |

**COURSE OBJECTIVES:**

- To study frequency response behavior of BJT and hybrid parameters
- To study biasing circuits of BJT and MOSFETs for amplification, feedback concepts
- To study the basic principles, configurations, stability and frequency response, linear and nonlinear applications, signal processing and signal generation circuits.

**COURSE OUTCOMES:**

| | **Outcomes** | **Blooms Taxonomy Level** |
|---|---|---|
| CO1 | **Demonstrate** the applications of Diode, BJT and FET | **2 - Understand** |
| CO2 | **Analyze** Frequency response behaviour of amplifiers and oscillators without feedback | **4-Analysing** |
| CO3 | **Design** rectifiers, Clippers, clampers, regulators, amplifiers and oscillators for given specifications | **6-Creating** |
| CO4 | **Analyze** stability, frequency response and infer required compensation techniques | **4 - Analyzing** |
| CO5 | **Analyze** the performance of OpAmp in linear, nonlinear circuits and data convertors | **4 - Analyzing** |
| CO6 | **Analyze** the working of active filters, oscillators and multivibrators using OpAmp | **4 – Analyzing** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Diode Applications:** | **08Hrs** |
| Review – PN Junction and Zener Diode, Types of Diodes – Construction and working of Schottky, Tunnel, Photo Diode. Performance Analysis and comparison of Half wave rectifier, Full wave Centre tap and Bridge rectifier. RC and LC power supply | |

| | |
|---|---|
| filters, Series Clipping Circuits, Shunt Clipping Circuits, Clamping Circuits. | |
| | |
| **MODULE 2: Transistors Biasing** | **08Hrs** |
| Review-BJT Concept, DC load Line and Bias point, BJT Biasing- Voltage Divider Bias, h-parameters and small signal analysis of CE configuration ,<br>Concept of Feedback, RC Tank Circuit, Introduction to Power Amplifiers<br><br>**Field Effect Transistors:** MOSFETs –Structure and types- Enhancement, Depletion, MOSFET Biasing. Application – Single Stage CS Amplifier | |
| | |
| **MODULE 3: Operational Amplifiers** | **08Hrs** |
| IC Operational Amplifier, Voltage Follower Circuit, Non-Inverting and Inverting Amplifier, Op-Amp as DC Amplifiers – Direct coupled - voltage follower, Inverting Amplifier, Non-Inverting Amplifier, Op-Amp as AC Amplifiers – Capacitor coupled voltage follower – Inverting and Non-Inverting, High Impedance Capacitor coupled Voltage follower - non-Inverting.<br>OP-Amp Frequency Response and Compensation: Op-Amp circuit stability, Op-Amps and Linear Integrated Circuits, Internally Compensated Op-Amps- frequency and phase response | |
| | |
| **MODULE 4: Op-Amp Switching Circuits-** | **08Hrs** |
| Zero Crossing Detector, Inverting Schmitt trigger, Signal Processing Circuits- Limiting Circuits and Clamping Circuits, Peak Detectors, Sample and Hold circuit, Sinusoidal oscillators: Wien Bridge and phase shift oscillators, Signal Generators-: Multivibrators, Triangular waveform generator, 555 timers monostable | |
| | |
| **MODULE 5: Instrumentation Amplifier** | **07Hrs** |
| Active Filters: First order and second order active Low-pass and high pass filters, Bandpass Filter, Band stop Filter.<br>DAC and ADC convertor: DAC using R-2R, ADC-<br>Successive approximation. Phase locked loop: Basic<br>Principles, Phase detector/comparator, VCO. | |
| | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| 1.Interpretation of data sheets- Diode, transistor, Op-Amps |
| 2. Performance Analysis of Half wave and Full wave Rectifiers, Bridge Rectifier – Discrete Components. |
| 3.Testing of Diode clipping (Single/Double ended) circuits for peak clipping, peak detection- Discrete and Simulation |
| 4.Testing of Clamping circuits: positive clamping /negative clamping. |

| |
|---|
| 5.RC coupled Single stage BJT amplifier - Determination of the gain-frequency response, input and output impedances. |
| 6.MOSFET V-I Characteristics |
| 7.Testing for the performance of BJT – Hartley & Colpitts Oscillators for given frequency |
| 8.Design of Summing Amplifier, Integrator, Differentiator, Voltage Follower |
| 9.Design of Comparators, Zero crossing detector, Schmitt Trigger, triangular waveform generator. |
| 10.IC 555 timer as Monostable and Astable Multivibrator - Discrete and Simulation |
| 11.Design of D/A converter- Weighted resistor, R-2R type, staircase waveform generator. |
| 12.Design of Active Filters - BPF, LPF, HPF for given frequency range |
| 13.Design of Precision Rectifier [ Half and Full wave] circuit. |

**TEXT BOOKS:**

1. David A.,Bell "Electronic Devices and Circuits", Oxford Higher Education Press, 5th Edition, 2010

2.David A. Bell "Operational Amplifiers and Linear ICs", 3rd edition, PHI/Pearson, 2004.

**REFERENCES:**

. 1.Millman.J. and Halkias C.C, "Electronic Devices and Circuits", Mc Graw Hill, 2007

2.Donald .A. Neamen, Electronic Circuit Analysis and Design –2nd Edition, Tata Mc Graw Hill, 2009.

3.Robert L.Boylestad and Louis Nashelesky,"Electronic Devices and Circuit Theory", 10 th
Edition, Pearson Education/PHI, 2008

4.Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4nd edition, Reprint 2006,

5.Ramakant A Gayakwad, "Op-Amps and Linear Integrated Circuits," Pearson, 4th Ed, 2015

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|---|---|---|---|---|---|---|
| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2303** | | | | | |
| **TITLE OF THE COURSE** | **DIGITAL SYSTEM DESIGN WITH VERILOG** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To translate the elements of digital system abstractions using digital logic to Boolean algebra.
- To illustrate simplification of Boolean expressions using Karnaugh Maps and Quine-McClusky TechniquesUnderstanding basic concepts of Probability and Random variables.
- To model combinational logic circuits for arithmetic operations and logical operations.
- To characterise, analyse and model bi-stable elements such as latches and flip-flops.
- To outline the concept of Mealy Model, Moore Model and apply FSM for digital design.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Discuss** the various elements of digital logic | **2 - Understand** |
| CO2 | **Simplify** Boolean Expressions in digital design | **3 - Applying** |
| CO3 | **Design** Combinational and Sequential logic circuits | **4 - Design** |
| CO4 | **Analyse** the hardware model of a digital system at different levels of abstraction in Verilog | **4 - Analyze** |
| CO5 | **Verify** the functionality of digital design | **4 - Evaluating** |
| CO6 | **Design** architectures for arithmetic and logic units, registers and counters. | **6 - Creating** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction to Logic Circuits** | **08Hrs** |
| Boolean Algebra, Logic Gates, Canonical Notation - SOP & POS forms, Introduction to Verilog, Switching Expression from truth tables, Minimization of K-maps (3,4,5) variables, Strategy for Minimization, Minimization of SOP and POS forms, Incompletely specified functions (Don't care terms), Quine-McCluskey minimization technique, Quine-McCluskey using don't care terms, Reduced prime implicant table, problems. | |
| | |
| **MODULE 2: Number Representation and Arithmetic Circuits** | **08Hrs** |
| Positional Number Representation, addition of unsigned numbers, half adder, full adder, Ripple carry adder, signed numbers, adder and subtractor unit, fast adders-CLA, Design of arithmetic circuits using CAD tools, model hierarchy in Verilog, Number representation in Verilog, BCD Representation, comparator- 2 bit. | |
| | |
| **MODULE: Combinational Circuit Building Blocks** | **07Hrs** |
| Multiplexers, decoders, demultiplexers, encoders, code converters, Design of ALU-4 bit, Verilog for combinational circuits, if else, case-casex, casez, for loop, Verilog operators, generate, task, function, design examples | |
| | |
| **MODULE 4: Flip Flops, Registers and Counters** | **08Hrs** |
| Basic Latch, Gated latches, Flip Flops SR, D, JK, T, master-slave flip-flops, flip flops with preset & clear capability, Characteristic equations, registers, binary counters – asynchronous and synchronous, mod-n counter using clocked T flip flop, BCD counter, ring counter, Johnson counter, Verilog constructs for storage elements, registers, counters, blocking and non-blocking, timing analysis. | |
| | |
| **MODULE 5: Synchronous Sequential Circuits** | **08Hrs** |
| Mealy Model, Moore Model, Finite State diagram- design steps for speed regulation of an automatically controlled vehicle, Verilog code for FSM specifying state assignments in Verilog code, Example of Serial Adder using FSM, Coin Operated Vending Machine, mod-n counter. | |
| | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| **1. Component -1 Experiments- Combinational and Sequential Circuit Design using Kits** |
| 1. Realize 4 variable Boolean expressions |
| 2. Realize and design the following combinational circuits<br>**a.** Adders and Subtractors<br>**b.** Binary to Gray Conversion and vice versa- 4 Bit<br>**c.** Applications of MUX and DEMUX as function generator |
| 3. Flip Flop: SR FF, D FF, T FF, JK FF |
| 4. Synchronous Sequential Circuits – Binary, BCD counters, Johnson Counter and Ring Counter |
| 5. A4-bit register with shift left and shift right Modes of operation and test its operation. |

| **Component -2 Experiments-Sequential and combinational Circuit Design using Verilog HDL** |
|---|
| Model, Verify and Synthesize the following |
| 6. Combinational designs - I<br>**a.** Multiplexer: 4:1, 8:1 MUX.<br>**b.** De Multiplexer: 1:4, 1:8 DEMUX.<br>**c.** Encoder with and without Priority: 8:3 and 4:2.<br>**d.** Decoder: 3:8 and 2:4. |
| 7. Adder – HA, FA, RCA using different modelling styles. |
| 8. Realize and Model an ALU (4 bit) |
| 9. Flip Flop: SR FF, D FF, T FF, JK FF and MS JK FF |
| 10. Counters: 4 bit Binary and BCD Up/Down Counter with Synchronous reset and Asynchronous reset |
| 11. Serial Adder, Mod –n counter using Mealy/Moore Model |
| 12. Speed Regulation of an automatically controlled Vehicle |
| 13. Coin operated Vending machine |

**TEXT BOOKS:**

. 1. Stephen Brown, Zvonko Vranesic (2014), "Fundamentals of Digital Logic with Verilog design", McGraw Hill.

**REFERENCES:**


1. John M Yarbrough (2014), "Digital Logic Applications and Design", Thomson Learning.
2. M. Morris Mano Michael D. Ciletti (2014), "Digital Design with an Introduction to the Verilog HDL", Pearson Education.
3. Charles Roth, Lizy K. John, Byeong Kil Lee (2016), "Digital Systems Design Using Verilog", Cengage Learning.
4. Nazein M. Botros (2006), HDL programming (VHDL and Verilog), Dreamtech Press.
5. Donald D. Givone (2015), "Digital Principles and Design", McGraw Hill.
6. Samir Palnitkar (2016), "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education.


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| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2304** | | | | | |
| **TITLE OF THE COURSE** | **NETWORK ANALYSIS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **1** | **-** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To apply the knowledge of various fundamental circuital laws and simplify complex network using reduction techniques
- Analyse the circuits using network theorems and determine current, voltage and other associated electrical parameters.
- Examine and infer steady state and transient response network functions
- Evaluate two port network parameters and analyse their interdependencies
- Apply filter concepts to design various types of filters that allow particular range of frequency and attenuates the remaining based on the requirement.
- To predict the impedances in cases like high voltage electrical and low voltage transistor applications using two port network configurations

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Apply** the knowledge to simplify complex networks using circuital laws and reduction techniques | **3- Apply** |
| CO2 | **Analyze** networks using circuit theorems and determine electrical parameters | **4 - Analyze** |
| CO3 | **Evaluate** steady state and transient response of network functions | **5- Evaluate** |
| CO4 | **Evaluate** two port network parameters and analyze interdependencies | **5-Evaluate**<br>**4- Analyze** |
| CO5 | **Solve** for two port network parameters | **2-Understand**<br>**3-Apply** |
| CO6 | Use fundamentals of network filter terminologies for designing advanced filters | **1-Remember**<br>**3-Apply** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: Basics & Network Topology** | **12Hrs** |
| Passive and active components, Series and parallel circuits, source transformation, Star – Delta transformation, Delta-Star Transformations, Kirchhoff's Laws, Mesh Analysis with and without dependent source, Super mesh, Nodal Analysis with and without dependent source, Super nodes. Graph of a network, Tree, Co-tree, Sub graph, Connected graph and loop, Incidence matrix, Tie- set matrix and Cut-set matrix. Principle of duality | |
| | |
| **MODULE: Network Theorems** | **10Hrs** |
| Superposition, Thevenin's, Norton's, Maximum power transfer, Reciprocity, Tellegen's, Millman's, Compensation theorem, Substitution theorem | |
| | |
| **MODULE 3: Sinusoidal Steady State and Transient Analysis** | **12Hrs** |
| Steady state analysis: Phasor, RLC circuits, complex power<br>Transient Analysis: Time constant, RL circuits with and without source, RC circuits with and without source, AC transients, Series RLC circuits, Laplace Transform Applications | |
| | |
| **MODULE 4: Network Parameters** | **10Hrs** |
| | |
| Z parameters, Y parameters, H parameters, ABCD parameters, Symmetry and reciprocity, Bartlett bisection theorem, Relation between two port parameters, Interconnection of two port networks | |
| | |
| **MODULE 5: Network Filters** | **08Hrs** |
| | |
| Filter fundamentals, Pass and stop bands, Characteristic impedance, Constant K- low pass filter, Constant K-high pass filter, Band pass filter, All pass filter | |

**TEXT BOOKS:**

. 1. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008.
2. Roy Choudhury, ―Networks and systems , 2nd edition, New Age International Publications, 2006

**REFERENCES:**


1. Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition., 2007
2. Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication, 2006
3. Boylestad, Robert L. Introductory circuit analysis. Pearson Education India, 2003.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EN0001** | | | | | |
| **TITLE OF THE COURSE** | **ENGINEERING ECONOMICS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **2** | | **-** | **-** | **26** | **2** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

Study of this subject provides an understanding of:-

- The scope of an entrepreneurship development, key areas of business development, sources of finance, project preparation, methods of taxation and tax benefits
- Significance of economic growth, application of engineering skills in entrepreneurial activities.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions. | **3-Apply** |
| CO2 | To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing. | **2-Uderstanding** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction** | **05Hrs** |
| Micro and Macro Economics, Relationship in Science, Engineering, Technology and Economic Development. Production Possibility Curve, Nature of Economic Laws | |
| | |

| **MODULE 2: Time Value of Money** | **06Hrs** |
|---|---|
| Concepts and application. Capital budgeting; Traditional and modern methods, Payback period method, Return on Investment Internal Rate of Return, Equity value analysis, Net Present Value (with the help of case studies) | |
| | |
| **MODULE 3: Costing** | **06Hrs** |
| Meaning of Production and factors of production, Law of variable proportions and returns to scale. Internal and external economies and diseconomies of scale. Concepts of cost of production, different types of costs; accounting cost, sunk cost, marginal cost, and Opportunity cost. Break even analysis, Make or Buy decision (case study). Relevance of Depreciation towards industry. | |
| **MODULE 4: Market and supply** | **04Hrs** |
| | |
| Meaning of market, types of market, perfect competition, Monopoly, Monopolistic, Oligopoly. (Main features). Supply and law of supply, Role of demand and supply in price determination. | |
| | |
| **MODULE5: Indian Economy** | **05Hrs** |
| | |
| Indian Economy, nature and characteristics. Basic concepts; fiscal and monetary policy, Liberalization Privatization Globalization, Inflation, Sensex, General Agreement on Tariffs and Trade, World trade organization and International Money Fund. Difference between Central bank and Commercial banks. | |

**TEXT BOOKS:**

. 1. Jain T.R., Economics for Engineers, VK Publication.
2. SinghSeema, Economics for Engineers, IK International.

**REFERENCES:**


. 1. Chopra P. N., Principle of Economics, Kalyani .
2. Dewett K. K., Modern economic theory, S. Chand
3. H. L. Ahuja., Modern economic theory, S. Chand.
4. Dutt Rudar & Sundhram K. P. M., Indian Economy
5. Mishra S. K., Modern Micro Economics, Pragati Publications.
6. Pandey I.M., Financial Management; Vikas Publishing House.


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| **SEMESTER** | **III** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2373** | | | | | |
| **TITLE OF THE COURSE** | **SPECIAL INITIATIVES – I** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | | | **-** | **4** | **52** | **2** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Understand the problem and identify the modules.
- Simulate the identified modules and check for the feasibility.
- Outline the specifications as per the design.
- Build and test the modules and integrate the modules.
- Demonstrate the project work, enhance the communication skills, and report writing.
- Learn the simulation software TINA/PSpice.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Formulate the project problem and identify the feasible modules. | **2-Understanding**<br>**3-Applying** |
| CO2 | Simulate the modules and test for functionality. | **3-Applying**<br>**4-Analyzing**<br>**5-Evaluating** |
| CO3 | Choose the design specifications and interpret the data sheet by selecting the required components. | **5-Evaluating** |
| CO4 | Develop the prototype of the simulated modules. | **6-Creating** |
| CO5 | Demonstrate and explain the developed project. | **5-Evaluationg** |

| | | |
|---|---|---|
| CO6 | Organize the design, specifications with results of the project work in the form of document. | **3-Applying** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **List of Minor Projects to be carried out using discrete components and TINA/Pspice** | **26Hrs** |

1. Capture moister, temperature, fire and earth quake related information using sensors and send alerts using IoT technology.
2. Real time identification of crops, weeds, diseases and pest damage and nutrient deficiency symptoms.
3. Waste Management.
4. Monitoring of electricity at household level.
5. Developing a Prototype for Smart Traffic Management and Street Light Control System.
6. Developing Self-Powered IOT based Patient Health Monitoring System.
7. Design of ultra-low power circuits for IOT application.
8. Air and Water Quality Care System.
9. Tracking parking designated for employee in an organization.
10. Smart domestic electric energy management system.

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| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2401** | | | | | |
| **TITLE OF THE COURSE** | **SIGNALS AND SYSTEMS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **1** | **-** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | I/II | 19EN1101&19EN1201 | Engineering Mathematics I and II |
| 2 | | | |

**COURSE OBJECTIVES:**

- Understanding of signals, their classification and signal transformations
- Develop input output relationship for linear shift invariant system and understand the c
- onvolution and correlation operator for continuous and discrete time system
- Knowledge of Fourier Series as an important tool to analyze periodic signals for continuous and discrete time signals
- Knowledge of Fourier Transform and Z -Transform for the frequency domain description of continuous and discrete time signals and systems
- Basics of sampling for discretization of continuous time signal
- Build foundation for advanced courses such as signal processing, control system and communication

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Define** and model the continues and discrete time signals | **2 - Understanding** |
| CO2 | **Illustrate** signals in coordinate systems. | **2 - Understanding** |
| CO3 | **Model** the LTI system and study the response to various input signal | **4 - Analyzing** |
| CO4 | **Explain** the concept of convolution and correlation. | **2 - Understanding** |
| CO5 | **Apply** the Fourier transform and Z- transform to continuous-time and discrete-time signals for stability analysis | **3 -Applying** |
| CO6 | **Explain** the process of sampling to convert an analog signal into discrete signal and methods of signal reconstruction. | **3-Applying** |

**COURSE CONTENT:**

**MODULE 1: Introduction to signal** **12Hrs**

Continuous and discrete time signals: Classification of Signals – Periodic aperiodic even – odd – energy and power signals – Deterministic and random signals – complex exponential and sinusoidal signals – periodicity – unit impulse – unit step – Transformation of independent variable of signals: time scaling, time shifting.

Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions.

**MODULE 2: Introduction to Systems and Behavior of LTI systems** **10Hrs**

System properties: linearity: Additivity and Homogeneity, Shift-invariance, Causality, Stability, Realizability.

Impulse response and step response, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

**Module 3: Convolution and Correlation Of Signals** **08Hrs**

Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Convolution property.

Concept of correlation, Cross correlation and Auto correlation of functions, properties of correlation functions, Energy density spectrum, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation.

**MODULE 4: Fourier and z- Transforms** **12Hrs**

Representation of Fourier series for Continuous time periodic signals , Dirichlet's conditions, properties of Fourier series, Exponential Fourier series, Relationship between Exponential Fourier series and trigonometric Fourier series, Complex Fourier spectrum. Fourier transformation of continuous and discrete time signals and their properties.. Parseval's theorem.

Basic principles of z-transform - z-transform definition –, Relationship between z-transform and Fourier transform, region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform.

**MODULE 5: Sampling and Reconstruction** **10Hrs**

The Sampling Theorem and its implications. Types of sampling Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Sampling of band pass signals.

**TEXT BOOKS:**


1. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, ―Signals and Systems Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
2. Simon Haykins and Barry Van Veen, ―Signals and Systems, 2nd Edition,2004


**REFERENCES:**

.


1. Michael Roberts, ―Fundamentals of Signals & Systems, 2nd edition,Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, ―Signals and Systems Pearson Education Asia PHI, 2nd edition, 1997. India Reprint 2002.
3. H. P Hsu, R. Ranjan, ―Signals and Systems‖, Scham‘s outlines, TMH
4. B. P. Lathi, ―Linear Systems and Signals‖, Oxford University Press, 2005.
5. Ganesh Rao and Satish Tunga, ―Signals and Systems, Pearson/SanguineTechnical Publishers, 2004.


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| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2402** | | | | | |
| **TITLE OF THE COURSE** | **COMPUTER SYSTEM ARCHITECTURE LERS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **1** | **-** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To make students know about the Parallelism concepts in Programming
- To give the students an elaborate idea about the memory hierarchy.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputers.
- To study about data flow computer architectures

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Explain** the concept of evolution of computer systems, classification of computers on their ability to perform multiprocessing | **L2-Understanding** |
| CO2 | **Explain** the study of parallel computer architecture various trends towards parallel processing | **L2-Understanding** |
| CO3 | **Analyze** the advanced processor technologies **Categorize** memory organization and explain the function of each element of a memory hierarchy | **L3- Applying** **L4- Analyze** |
| CO4 | **Explain and compare** the architectures of multiprocessors, and multicomputer, and their interconnecting mechanisms | **L4-Analyze** |
| CO5 | **AnAnalyse** different message passing mechanisms Explain how pipelining is implemented in various computer architecture | **L4-Analyze** |
| CO6 | **ExExplain** the advance concepts of improving the performance of multiprocessor by using different techniques | **L2-Understanding** **L3 - Applying** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: Parallel computer models** | **10Hrs** |
| Parallel computer models – Evolution of Computer Architecture, System Attributes to performance, Amdahl's law for a fixed workload. Multiprocessors and Multicomputers, Multivector and SIMD computers, Architectural development tracks, Conditions of parallelism. | |
| | |
| **MODULE 2: Processors and memory hierarchy** | **12Hrs** |
| Processors and memory hierarchy – Advanced processor technology- Design Space of processors, Instruction Set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar and vector processors, Memory hierarchy technology | |
| | |
| **MODULE 3: Multiprocessors System Interconnects** | **12Hrs** |
| Hierarchical bus systems, Cross bar switch and multiport memory, Multistage and combining networks. Cache Coherence and Synchronization Mechanisms, Cache Coherence Problem, Snoopy Bus Protocol, Directory Based Protocol, Hardware Synchronization Problem | |
| **MODULE 4: Message Passing Mechanisms** | **10Hrs** |
| | |
| Message Routing schemes, Flow control Strategies, Multicast Routing Algorithms. Pipelining and Superscalar techniques – Linear Pipeline Processors and Nonlinear pipeline processors | |
| | |
| **MODULE 5:** | **08Hrs** |
| | |
| Instruction pipeline design, Arithmetic pipeline deign - Super Scalar Pipeline Design Multithreaded and data flow architectures - Latency hiding Techniques, Principles of multithreading – Multithreading Issues and Solutions | |

**TEXT BOOKS:**

. **1.** K. Hwang and Naresh Jotwani, Advanced Computer Architecture, Parallelism, Scalability, Programmability, TMH, 2010.

**REFERENCES:**


. 1. H P Hayes, Computer Architecture and Organization, McGraw Hill, 1978.
2. K. Hwang & Briggs , Computer Architecture and Parallel Processing, McGraw Hill International, 1986
3. M J Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House, 2012.
4. M Sasikumar, D Shikkare and P Raviprakash, Introduction to Parallel Processing, PHI, 2014.
5. P M Kogge, The Architecture of Pipelined Computer, McGraw Hill, 1981.
6. P V S Rao , Computer System Architecture, PHI, 2009.

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| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2403** | | | | | |
| **TITLE OF THE COURSE** | **MICROCONTROLLERS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | I/II | 19EN1103 | Computer Programming and Problem Solving |
| 2 | | | |

**COURSE OBJECTIVES:**

- To understand the architecture of microcontroller and the basics of assembly language programming.
- To explore the Programming model, Instruction set and Addressing modes supported by microcontroller.
- To understand Memory Structure related to Program and Data memory.
- To gain knowledge on Parallel and serial data transfer methods.
- To discuss various interrupt handlers and their implementations.
- To understand programming microcontrollers using Embedded C and interfacing logic with various peripherals.

**COURSE OUTCOMES:**

| CO No. | Outcomes | Bloom's Taxonomy Level |
|---|---|---|
| CO1 | **Outline** the architectural details of Microcontrollers and ARM Processor. | **2 - Understanding** |
| CO2 | **Classify** the instruction sets and various addressing modes. | **4 -Analyzing** |
| CO3 | **Understand** the Memory Organization of the PIC Microcontroller | **5 - Evaluating** |
| CO4 | **Interpret** and configure interrupt control logic. | **2 -Understanding** |
| CO5 | **Analyze** the timing diagram for communication Protocol | **4- Analyzing** |
| CO6 | **Demonstrate** interfacing logic for various Sensors and Actuators | **3 -Demonstrate** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction to Microcontroller** | **08Hrs** |
| Microprocessor and Microcontroller Characterization, Components of a Microcontroller, Microcontroller Architecture.<br><br>**Main Characteristics of PIC Microcontrollers** - Arithmetic and Logic Unit (ALU), Working Register in PIC Microcontrollers, Machine Cycles and Execution of Instructions, Pipelining for Instruction Execution, Oscillators, Configuration Bits, Reset Options, Low-Power Consumption Mode, Watchdog Timer, Program Counter,RISC, Compare Harvard architecture with von Neumann architecture. | |
| | |

| **MODULE 2: Memory in Microcontrollers** | **08Hrs** |
|---|---|
| Memory Organization, RAM, Data Memory, EEPROM, Flash Memory.<br><br>**Instruction Set and Assembler Language Programming** - Arithmetic Instructions, Logic and Compare instructions, Rotate Instruction and Data Serialization, Branch Instructions and Looping, Call Instructions and Stack | |
| | |
| **MODULE 3: Programming In C** | **08Hrs** |
| Data Types and Time Delays, bit-addressable I/O, Logic Operations, Data Serialization, ROM & RAM Allocation | |
| **MODULE 4: Timers and Interrupts** | **08Hrs** |
| | |
| Instruction Pipeline, Timers, The CCP Module, Interrupt, Examples of Timer and Interrupt Applications.<br><br>**Parallel and Serial Communication** – Parallel IO, Serial IO, advantages of serial communication over parallel, Streaming Parallel Port, USART, SPI, I2C | |
| | |
| **MODULE 5: Sensors and Actuators** | **07Hrs** |
| Interfacing LED, LCD, Keypad, ADC, DAC, Buzzer, Sensor, Relays, Stepper & DC Motor | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| 1. Check Register and Memory with MPLAB IDE |
| 2. Develop and Execute Programs on Arithmetic, Logic & Compare instructions |
| 3. Develop and Execute Programs on Rotate instructions and Data Serialization |
| 4. Develop and Execute Programs on BCD and ASCII code conversion. |
| 5. Develop and Execute Programs on branching instructions and Looping. |
| 6. Develop and Execute Programs on Call instructions and Time Delay. |
| 7. Develop and execute programs on Timers and Counters |
| 8. Develop and execute programs on Different Interrupt handling |
| 9. Develop and execute program on I/O Port programming, Serial & Parallel Communication. |
| 10. Interface ADC & DAC |
| 11. Interfacing Sensors & Actuators |
| 12. Interfacing Motors and speed control using PWM |

**TEXT BOOKS:**

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1. Fernando E. Valdes-Perez, Ramon Pallas-Areny, "Microcontrollers - Fundamentals and Applications with PIC", CRC Press, 1st Edition, 2009.
2. Mazidi M. A., McKinlay R. D., Causey D., "PIC Microcontroller And Embedded Systems.", Pearson Education International, 2008

**REFERENCES:**

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1. Myke Predko, "Programming and Customizing the PIC Microcontroller", Mc Graw Hill Education, 3rd Edition, 2008.
2. John B. Peatman, "Design with PIC Microcontrollers", Prentice Hall, 1997.
3. Verle Milan, "PIC Microcontrollers – Programming in C", Mikroelektronika, 1 st Edition, 2009

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| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2404** | | | | | |
| **TITLE OF THE COURSE** | **ELECTRO-MAGNETIC FIELD THEORY** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To introduce and analyse the concepts of electrostatics, electric potential, energy density and their applications.
- To understand and apply the concepts of magnetostatics, magnetic flux density, scalar and vector potential to the engineering applications.
- To apply the knowledge of electrostatics and magnetostatics for time varying fields.
- To study uniform plane waves and its characteristic parameters

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Explain** the concept of vector calculus for different co-ordinate systems. | **L3- Applying** |
| CO2 | **Apply** Coulomb's Law and Gauss Law for the **evaluation** of electric fields produced by different charge configurations. | **L4 – Analyze**<br>**L5- Evaluate** |
| CO3 | **Calculate** the energy and potential due to a system of charges. **Discuss** the behavior of electric field across a boundary condition. **Explain** the Poisson's, Laplace equations with applications | **L4- Analyze** |
| CO4 | **Explain and apply** various laws involved in magneto statics | **L3- Applying** |
| CO5 | **SoSolve** Maxwell's equations for time varying electric and magnetic fields | **L3- Applying** |
| CO6 | **ExExplain and analyse** EM wave propagation and its properties. | **L3 - Applying**<br>**L4 – Analyze**<br>**L5- Evaluate** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Electrostatics -1** | **08Hrs** |
| Introduction: Vector analysis, 3 Coordinate systems; Coulomb's Law and Electric Field Intensity, Electric Field due to line charge, volume Charge and Sheet Charge, Related Problems.<br>Gauss' Law: Electric flux, Electric Flux Density, Gauss' Law, Applications of Gauss' Law , Maxwell's first equation, Introduction to 'del' operator and Divergence Theorem, Related Problems | |
| | |
| **MODULE 2: Electrostatics - 2** | **08Hrs** |
| **Energy and Potential**: Energy and potential in a moving point charge in an Electric Field, Line Integral, Definition of Potential Difference , Potential field of a moving charge , Potential Gradient, conductor properties and boundary conditions, boundary conditions for perfect dielectric materials.<br><br>**Poisson's and Laplace's Equations**: Poisson's and Laplace's Equations, Uniqueness Theorem, Applications of Laplace's and Poisson's Equations, Related Problems | |
| | |
| **MODULE 3: The Steady Magnetic Field** | **07Hrs** |
| Biot-Savart Law, Applications of Biot-Savart's law, Ampere's Circuital Law, Curl, Stokes' Theorem, Magnetic Flux and Flux Density, Scalar and Vector Magnetic Potentials, Magnetic Boundary Conditions, Energy in Magnetic Field Related Problems | |
| **MODULE 4: Time Varying Magnetic Field** | **08Hrs** |
| | |
| Faraday's Law of e.m.f, Inconsistency of Ampere's law, Displacement Current, Maxwell's Equation in Point and Integral Form of different media, The retarded potential, Boundary Conditions: Dielectric –Dielectric boundary. Related Problems | |
| | |
| **MODULE 5: Uniform Plane Waves** | **08Hrs** |
| | |
| Wave propagation in free space and dielectrics, Propagation in Conductors: Skin Effect, The Poynting Vector and Power Considerations, Power loss in plane conductor, Wave Polarization, Reflection of uniform plane waves at normal Incidence, for perfect conductor-dielectric boundary & dielectric-dielectric boundary, Standing Wave Ratio, Introduction to transmission lines and waveguide | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| Part-A:Software<br>MATLAB /MATHEMATICA/SONNET/MAGICAD/HFSS |
| 1. Vector addition in 3 dimensional coordinate system:To understand the meaning of vectors, plotting vectors in 2 D and 3 D and rotating them in space. |
| 2. Gradient of scalar field: With positive and negative charges. |
| 3. Divergence of vector:To understand vector with positive and negative divergence. |
| 4. Curl of a vector: To understand curl and rotational field. |

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| 5. To study the wave propagation in conductor and dielectrics using HFSS tool. |
| 6. To verify Maxwell's equations |
| 7. Introduction to magnetometer/Gaussmeter |

**TEXT BOOKS:**

. 1. Engineering Electromagnetics-William H. Hayt Jr. and John A. Buck, Tata McGraw Hill, 6th Edition, 2001
2. Electromagnetic Waves and Radiating systems – E. C. Jordan and K.G. Balman, PHI, 2nd Edition.

**REFERENCES:**

. 1. Field theory –S.P.Basavaraju, Edition 2011

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|---|---|---|---|---|---|---|
| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EN0002** | | | | | |
| **TITLE OF THE COURSE** | **LAW FOR ENGINEERS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **2** | | **-** | **-** | **26** | **2** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Apply the knowledge of the constitutional literacy to become aware of the fundamental rights and duties in their role as Engineers
- Understanding of ethical and legal aspects of advertising, consumer problems and their redressal mechanism related to product and service standards.
- Demonstrate an advanced and integrated understanding of the nature and extent of the corporate entity principle and to understand how this principle applies to corporate groups
- Critically evaluate the extent and application of the Corporate Law.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Understand process of ethical and moral **analysis** in decision making scenarios and inculcate ethical behavior as a trait for professional development. | **L2-Understanding**<br>**L4- Analyze** |
| CO2 | **Apply** the knowledge to solve practical problems with regard to personal issues & business enterprises | **L4- Analyze** |
| CO3 | **Identify** the conflict management in legal perspective and judicial systems pertaining to professional environment; strengthen the ability to contribute to the resolution of human rights & Ragging issues and problems through investigative and analytical skills | **L3- Applying**<br>**L4- Analyze** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: Introduction** | **5Hrs** |
| Introduction to Indian legal system, Review of Constitution of India, Sources of Law and Judicial system.<br>Contracts and its Elements: Employment contracts, Contract Interpretation, service contract, Contract of Indemnity, Law of Agency, Employment Agreement | |
| | |
| **MODULE 2: Legal documentation** | **6Hrs** |
| Legal documentation: Drafting of legal documents including Non-Disclosure Agreements (NDA), Request for proposal (RFP), Collaboration Agreement , Joint Venture Agreements, Tendering and sub-contracting. | |
| | |
| **MODULE 3: Property Rules, Trademarks & Copy Rights** | **6Hrs** |
| Intellectual Property Rules (IPR) Overview, Trademarks , Copy Rights , Patents with special emphasis in Biotechnology Inventions, Software Circuits and Design, Protection in Foreign Countries | |
| **MODULE 4: Introduction to Labour and Environmental Laws** | **4Hrs** |
| | |
| Labour Laws: Provident Fund, ESIC, Gratuity, Bonus, Perquisites, Contract labour, Health, Safety and welfare of construction workers,Introduction to Environmental Law, Concept of Law & Policy , Environment and Governance ,Sustainable Development and Environment , Understanding Climate Change and its processes – CDP, CDMs and Carbon Off Setting, Overview of International Environmental Laws, Introduction to Environment and IPR | |
| | |
| **MODULE 5: Cyber Laws & Taxation** | **5Hrs** |
| | |
| Cyber Laws , E-Commerce and E-Governance, Taxation: Income Tax, Service Tax, VAT, Excise Duty, RTI Act. | |

**TEXT BOOKS:**

. 1. V.S. Datey, Indirect Taxes: Law and Practice, Taxmann Publications (P) Ltd, Latest Edition Publications (P) Ltd, latest Edition.
2. S.C. Srivastava, Industrial Relations and Labour Laws, Vikas Publishing House Pvt. Ltd.
3. Joseph Minatiur, Indian Legal System, Indian Law Institute, New Delhi.

**REFERENCES:**

. 1. Kamith Seth, Computer Internet and New Technology Laws, LexisNexis, First Edition 2013.
2. Prafulla C Pant, The Arbitration and Conciliations Act, 1996, ButterworthsIndia, New Delhi.
3. J. Beatson, Anson’s Law of Contract, Oxford University Press.

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| **SEMESTER** | **IV** | | | | | |
| **YEAR** | **II** | | | | | |
| **COURSE CODE** | **21EC2473** | | | | | |
| **TITLE OF THE COURSE** | **SPECIAL INITIATIVES – II** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | | | **-** | **4** | **26** | **2** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Understand the problem and identify the modules.
- Simulate the identified modules and check for the feasibility.
- Outline the specifications as per the design.
- Build and test the modules and integrate the modules.
- Demonstrate the project work, enhance the communication skills, and report writing.
- Learn the simulation software TINA/PSpice

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Formulate the project problem and identify the feasible modules. | **2-Understanding**<br>**3-Applying** |
| CO2 | Simulate the modules and test for functionality. | **3-Applying**<br>**4-Analyzing**<br>**5-Evaluating** |
| CO3 | Choose the design specifications and interpret the data sheet by selecting the required components. | **5-Evaluating** |
| CO4 | Develop the prototype of the simulated modules. | **6-Creating** |
| CO5 | Demonstrate and explain the developed project. | **5-Evaluationg** |
| CO6 | Organize the design, specifications with results of the project work in the form of document. | **3-Applying** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **List of Minor Projects to be carried out using discrete components and TINA/Pspice.** | **26Hrs** |

1. Capture moister, temperature, fire and earth quake related information using sensors and send alerts using IoT technology.
2. Real time identification of crops, weeds, diseases and pest damage and nutrient deficiency symptoms.
3. Waste Management.
4. Monitoring of electricity at household level.
5. Developing a Prototype for Smart Traffic Management and Street Light Control System.
6. Developing Self-Powered IOT based Patient Health Monitoring System.
7. Design of ultra-low power circuits for IOT application.
8. Air and Water Quality Care System.
9. Tracking parking designated for employee in an organization.
10. Smart domestic electric energy management system.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3501** | | | | | |
| **TITLE OF THE COURSE** | **ANALOG AND DIGITAL COMMUNICATION** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV | 19EC2404 | ELECTROMAGNATIC WAVES |
| 2 | | | |

**COURSE OBJECTIVES:**

- To study the basic concepts of Analog and Digital communication systems.
- To compare the various modulation and demodulation techniques.
- To understand the trans receiver design and the effect of noise in communication system.
- To understand the process of digitization through Sampling and Quantization.
- To determine the performance of line codes and methods to reduce inter symbol interference.
- To interpret the detection process using analytical methods.
- To compute the probability of error of digital communication systems.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Explain** the basic elements of a communication system. | **2 - Explain** |
| CO2 | **Analyse** baseband signals in time domain and frequency domain. | **4 - Analyse** |
| CO3 | **Interpret** the various modulation and demodulation techniques. | **2 - Interpret** |
| CO4 | **Analyse** the behavior of a communication system in presence of noise. | **4 - Analyse** |
| CO5 | **Estimate** the performance of a communication system using analytical methods. | **5 - Estimate** |
| CO6 | **Determine** the probability of error analysis for different modulation techniques. | **5 - Determine** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction to Communication System** | **8 Hrs** |
| INTRODUCTION and AMPLITUDE MODULATION - Elements of Communication System, Need of Modulation, Applications, Time and Frequency Domain Representation of AM, Modulation Index and Transmission Power Calculation, DSB-SC, SSB, VSB. Generation of AM waves-square law Modulator, Principle of Detection of AM Wave-envelope detector.<br>Generation of DSBSC Waves, Balanced Modulators, Coherent detection of DSB-SC Modulated waves.<br>Phase discrimination method for generating AM SSB Modulated waves. Demodulation of SSB Waves using Coherent detection, Frequency Division Multiplexing. | |
| | |
| **MODULE 2: Angle Modulation and Noise** | **8 Hrs** |
| ANGLE MODULATION - Time and Frequency Domain Representation, FM, NBFM, WBFM and PM, Modulation Index of FM and PM, Transmission bandwidth of FM waves, Relation between FM and PM. Generation of FM waves: Indirect FM, Direct FM. Demodulation of FM waves: Balanced frequency discriminator, Zero-crossing detector.<br><br>TRANSMITTER, RECEIVER AND NOISE –AM Transmitter, FM Transmitter, Tuned radio frequency receiver, Superheterodyne receiver, Comparison of FM receiver with AM Receiver, Source of noise, Noise in AM using envelop detector, Noise in FM, Pre-emphasis & de-emphasis in FM. | |
| | |
| **MODULE 3: SAMPLING AND QUANTIZATION** | **8 Hrs** |
| SAMPLING PROCESS - Block diagram of Digital communication system, Sampling process, Sampling theorem, quadrature sampling of bandpass signals, multirate sampling, sampling rate conversion, Signal distortion in sampling, Practical aspects of sampling and signal recovery.<br><br>QUANTIZATION - Quantization & Coding, Quantization error, Companding in PCM systems, Differential PCM system, Delta modulation (DM) and its drawbacks, adaptive delta modulation. | |
| **MODULE 4: Baseband data transmission** | **8 Hrs** |
| | |
| BASEBAND SHAPING FOR DATA TRANSMISSION - Line Coding, Characteristics of Line coding, Discrete PAM signals, Power spectra of discrete PAM signals, Inter symbol Interference, Nyquist criterion for distortion less baseband binary transmission, Correlative coding, Eye pattern.<br><br>DETECTION OF SIGNALS - Orthogonal signals, Geometric interpretation of signals, Correlation receiver, Matched filter, Properties of matched filter, ML detector. | |
| | |
| **MODULE 5: Pass Band Modulation Techniques** | **7 Hrs** |
| PASS BAND MODULATION AND DEMODULATION -Coherent modulation techniques-ASK, FSK, PSK, QPSK, signal representation, Generation and detection, deriving probability of error for coherent ASK, FSK, PSK, QPSK, Non | |

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|---|---|
| coherent binary modulation techniques. | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| PART-A<br>List of Experiments using MATLAB |
| 1. Design and testing of AM modulator and demodulator circuit and analysis spectrum using spectrum analyser |
| 2. Design and testing FM modulator and demodulator circuit and analysis spectrum using spectrum analyser |
| 3. Design and testing DSBSC modulator and demodulator circuit. |
| 4. Spectrum analysis of modulated signal using spectrum analyse |
| 5. To study and observe the effect on input signal using pre-emphasis and de-emphasis circuit. |
| 6. Verification of sampling theorem, demonstrate over sampling and under sampling. |
| 7. To study the Pulse Amplitude Modulation & demodulation. |
| 8. To study Pulse width modulation, Pulse Position modulation and demodulation. |
| 9. To study Phase lock loop(PLL) and calculate its capture range, lock range and free running VCO. |
| 10. To analyse a ASK & FSK modulation systems and interpret the modulated & demodulated waveform |
| 11. Using Linear block codes-the error received through a noisy channel can be removed/minimized by error detection and correction code. |
| 12. To study Cyclic encoding & decoding of BCD bit sequence and error detection & correction of bits' sequence. |
| 13. To employ one of the convolution codes and observe its error correcting performance and decode-ability. |
| 14. Verify the Encoding and Decoding process of Delta Modulator |
| 15. To implement μ-law companding and A-law companding for compression and expanding of a signal. |

**TEXT BOOKS:**

. 1. Simon Haykin, Michael Moher " Introduction to analog and Digital communication 4th edition, John and Wiley & Sons

**REFERENCES:**


1. Principles of Communication Systems–Taub & Schilling, Gautam Sahe, TMH, 3rdEd
2. Communication Systems Second Edition – R.P. Singh, SP Sapre, TMH, 2007.
3. Modern Analog and Digital Communication Systems, 3rd Edition, Oxford University – B.P. Lathi,
4. Electronics & Communication System – George Kennedy and Bernard Davis, TMH

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|---|---|---|---|---|---|---|
| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3502** | | | | | |
| **TITLE OF THE COURSE** | **PROBABILITY THEORY AND STOCHASTIC PROCESSES** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **1** | | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| | | | |
| | | | |

**COURSE OBJECTIVES:**

- Understand probability, random variable and random process concepts and their importance in Electronics and Communication Engineering.
- Calculate statistics related to Random variables and operation such as mean, variance etc.
- Evaluate standard distribution functions highlighting the application scenarios.
- Discuss inequality bounds considering the importance of moment generating function.
- Extend the various operations to multiple random variables and apply them to analyse practical problems.
- Explain the concept of random process and its classifications.

**COURSE OUTCOMES:**

| | **Outcomes** | **Blooms Taxonomy Level** |
|---|---|---|
| CO1 | Understand basics of probability through set theory, the axiom formulation and the need of random variables for the analysis of random phenomena. | **2 - Understand** |
| CO2 | Characterize the standard distributions and demonstrate various operations performed on the random variable. | **2–Demonstrate** |
| CO3 | Compare the various inequality bounds and probabilistic limits. | **2–Compare** |
| CO4 | Evaluate and Apply moments & characteristic functions for single and multiples random variables. | **3–Apply** |
| CO5 | Outline the importance of Central limit theorem and the concepts of random processes. | **2- Outline** |

| | | |
|---|---|---|
| CO6 | Simplify the complex operations by approximating to standard distributions and theorems for estimating the probable value. | **5 - Estimate** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Probability Theory and Density Functions** | **10Hrs** |
| Probability introduced through Sets and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms, Mathematical Model of Experiments, Probability as a Relative Frequency, Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem and Independent Events, Engineering application- probability of error in optical communication system. | |
| | |
| **MODULE 2: Random Variables** | **10Hrs** |
| Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous random variables, Mixed Random Variable, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, distributions, Conditional Distribution and density functions, properties. Engineering application- study of system reliability and failure rates. | |
| | |
| **MODULE 3: Operations on Single Random Variable** | **10Hrs** |
| Functions of a Random Variable, Expected Value of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Markov Inequality, Chebychev's Inequality, Chernoff Inequality, Characteristic Function, Moment Generating Function. Engineering application- scalar quantization, Entropy and source coding. | |
| | |
| **MODULE 4: Multiple Random Variables** | **12Hrs** |
| Introduction, Vector Random variables, Joint Distribution and its properties, Marginal Distribution Functions, Joint density and its properties, Conditional Distribution and Density, Statistical independence, Sum of Two Random Variables, Sum of Several Random Variables Central limit theorem, Operations on multiple random variables-Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments. Engineering application- concept of mutual information, channel capacity and channel coding in a digital communication system. | |
| | |
| **MODULE 5: Random Processes** | **10Hrs** |
| Random process concepts, Classification of Random process, Deterministic and Nondeterministic Processes, concept of Stationary and Statistical Independence. First-Order Stationary Processes, Second- Order Wide-Sense Stationary, (N-Order) and Strict-Sense Stationary, AutoCorrelation, Cross correlation and Covariance Functions, Gaussian Random process, Time Averages and Ergodicity, Random signal response of linear systems, noise in an amplitude modulation communication system, noise in a simple control system. | |
| | |

**TEXT BOOKS:**


1. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, TMH, 4th Edition, 2001.
2. Probability and Random Processes- Scott Miller and Donald Childers, AP, 2nd Edition, 2012.


**REFERENCES:**

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1. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unni krishna Pillai, PHI, 4th Edition, 2002.
2. Probability and Random Processes with Application to Signal Processing – Henry Stark and John W. Woods, Pearson Education, 3rd Edition.
3. Probability Methods of Signal and System Analysis. George R. Cooper, Clave D. MC Gillem, Oxford, 3rd Edition, 1999.
4. Statistical Theory of Communication - S.P. Eugene Xavier, New Age Publications.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3503** | | | | | |
| **TITLE OF THE COURSE** | **CMOS VLSI DESIGN** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | III | 19EC2302 | ANALOG CIRCUITS |
| 2 | | | |

**COURSE OBJECTIVES:**

- Study the IC Fabrication process and to define the rules governing the process
- Analyze MOS device properties and short channel effects.
- Illustrate stick diagrams, layouts for various CMOS circuits and other MOS logic structures.
- Analyse Sequential MOS logic structures.
- Study advanced VLSI Circuits.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Understand** the basic Physics and Modelling of MOSFETs. | **2 - Understand** |
| CO2 | Learn the basics of Fabrication and Layout of CMOS Integrated Circuits | **2 - Understand** |
| CO3 | **Illustrate** stick diagrams, layouts for various CMOS circuits and other MOS logic structures. | **2 - Understand** |
| CO4 | **Analyse** Sequential MOS logic structures | **4 - Analyze** |
| CO5 | **Demonstration** of DC, AC and transient responses of the CMOS logic gates. | **4 - Analyze** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: CMOS Technologies** | **08Hrs** |
| Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology<br>MOS layers, Stick diagrams- NMOS and CMOS Design Rules and Layout, Fabrication-NWELL, PWELL, Twin-Tub, BiCMOS.<br>Scaling Of MOS Circuits: Scaling models and factors. | |
| | |
| **MODULE 2: MOS Transistor** | **08Hrs** |
| Introduction, Ideal I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, MOS Device Parameters, Detailed MOS Gate Capacitance Model, Non-ideal I-V Effects, Mobility Degradation and Velocity Saturation, Channel Length Modulation, Threshold Voltage Effects, Junction Leakage, Body effect, Tunneling, CMOS Inverter, DC Characteristics, Transient Response, Beta Ratio Effect, Noise Margin. NAND NOR DC characteristics, Inverter Switching Characteristics | |
| | |
| **MODULE 3: Combinational Circuit Design** | **08Hrs** |
| Introduction: CMOS Logic, Inverter, NAND Gate, NOR Gate, Combinational Logic, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers.<br>Circuit Families, Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits,<br>Complementary Pass-Transistor Logic Circuits, BICMOS Circuits | |
| | |
| **MODULE 4: Sequential Circuit Design** | **08Hrs** |
| Behavior of Bistable Elements, SR Latch Circuit, Clocked Latch Flip-Flop Circuits, CMOS D-latch and Edge Triggered Flipflop, Semiconductor Memories,DRAM Cells -1T, 2T, 3T, 4T, 6T, SRAM-Resistive Load, Depletion Load | |
| | |
| **MODULE 5: Advances in VLSI Design** | **07Hrs** |
| Introduction to FINFET, Memristors | |
| | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| **Schematic Entry, Simulation, DC, AC, Transient Analysis, Layout Design, DRC, LVS and QRC extraction, and verification using post layout simulation of** |
| a. All Basic logic gates using various circuit families |
| b. Flip flops using MOS |
| c. Simple memory design. |

**TEXT BOOKS:**

. 1. CMOS VLSI Design, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, 2006, Pearson Education, ISBN: 0321149017.
2. CMOS Digital Integrated Circuits, Sung MO Kang, Yousf Leblebici, 3rd Edition, Tata McGrawHill, ISBN: 0-7923-7246-8.

**REFERENCES:**


7. Basic VLSI Design, Douglas.A.Pucknell, Kamaran Eshraghian, 3rd Edition 2010 ,PHI, ISBN: 0-321-26977-2.
8. Fundamentals of Ultra-Thin-Body MOSFETs and FinFETs, Jerry G. Fossum , Vishal P. Trivedi , 1St Edition 2013, Cambridge University Press, ISBN-13: 978-1107030411.


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| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3504** | | | | | |
| **TITLE OF THE COURSE** | **DIGITAL SIGNAL PROCESSING** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV | 19EC2401 | SIGNAL AND SYSTEM |
| 2 | | | |

**COURSE OBJECTIVES:**

- Familiarize with the behavior of a system in terms of both its time domain and frequency domain representations.
- Understand the importance of FFT algorithms.
- Identify the correct type of filter required for a given problem and be able to demonstrate the design and implementation of such a digital filter.
- Explain the concept of aliasing and its effect on the design and use of practical systems.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Apply** transform methods to analyze the analog and digital linear time-invariant systems. | **3-Applying** |
| CO2 | Convert between time and frequency domain representations of signals and systems. | **3-Applying** |
| CO3 | **Infer** the practical aspects of sampling, reconstruction and select a suitable sampling rate for a given signal processing problem. | **2- Understanding** |
| CO4 | **Analyze** and design analog and digital filters for a given Specification. | **4- Analyzing** |
| CO5 | Interpret and demonstrate the applications of the discrete Fourier transform and implement the digital filters. | **2- Understanding 5-Evaluating** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Discrete Fourier Transforms (Dft)** | **08Hrs** |
| Frequency domain sampling and reconstruction of discrete time signals. DFT as a linear transformation, its relationship with other transforms.<br>Properties of DFT, multiplication of two DFTs- the circular convolution, additional DFT properties. | |

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|---|---|
| **MODULE: FFT Algorithms** | **08Hrs** |
| Use of DFT in linear filtering, overlap-save and overlap-add method. Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms) Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and decimation-in-frequency algorithms. Goertzel algorithm, and chirp-z transform. | |
| | |
| **MODULE 3: IIR Filter Design** | **08Hrs** |
| Characteristics of commonly used analog filters –Butterworth and Chebysheve filters, analog to analog frequency transformations. Design of digital IIR filters from analog filters (Butterworth and Chebyshev) - impulse invariance method. Mapping of transfer functions: Approximation of derivative (backward difference and bilinear transformation) method, Matched z transforms | |
| | |
| **MODULE 4: FIR Filter Design** | **08Hrs** |
| | |
| Introduction to FIR filters, design of FIR filters using - Rectangular, Hamming, Bartlet and Kaiser Windows, FIR filter design using frequency sampling technique. | |
| | |
| **MODULE 5: Digital Signal Processor** | **07Hrs** |
| | |
| Elementary idea about the architecture and important instruction sets of TMS320C 6XXX processor, writing of small programs in Assembly Language. | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| PART-A<br>List of Experiments using MATLAB |
| 16. MATLAB program for Linear Convolution of two right sided and two sided sequences.[ (i) standard equation (ii) DFT & IDFT ] |
| 17. MATLAB program for Verification of sampling theorem for Sine & Cosine at different frequencies. |
| 18. MATLAB program for Impulse response of a given system. |
| 19. MATLAB program for Computation of N-point DFT of a given sequence and to get magnitude & phase spectrum. |
| 20. MATLAB program for Circular Convolution of two given sequences using (i) standard equation (ii) DFT & IDFT |
| 21. MATLAB program for DFT computation using FFT function for sine and cosine sequence. |
| 22. MATLAB program to solve a given difference equation with and without initial condition. |
| 23. MATLAB program for verification of Autocorrelation and Cross-correlation of a given sequence. |

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|---|
| 24. MATLAB program to design FIR low pass, high pass, band pass and band stop filter using Rectangular and Hamming window. |
| 25. MATLAB program to design Butterworth IIR low pass, high pass, band pass and band stop filter. |
| PART-B<br>List of Experiments using DSP Processor |
| 26. Linear and circular convolution of two given sequences. |
| 27. Computation of N-point DFT of a given sequence. |
| 28. Realization of an FIR filters to meet given specification. |
| 29. Impulse response of first order and second order system. |
| 30. Audio application such as to plot a time and frequency display of a Microphone plus a cosine using DSP. |

**TEXT BOOKS:**

. 1. Digital signal processing – Principles Algorithms &Applications, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007.
2. Digital Signal processing – A Computer Based Approach, S. K. Mitra, TMH Publishing Co.
3. Digital Signal Processing Signals using MATLAB, Vinay K. Ingle, III edition, Cengage Learning

**REFERENCES:**

4. Digital Signal Processing, P. Rameshbabu, Scitech Publications (India).
5. Digital Signal Processing, S.Salivahanan, A.Vallabraj & C. Gnanapriya, TMH Publishing Co.
6. Digital Signal Processing; A Hands on Approach, C. Schuler & M.Chugani, TMH Publishing Co.
7. Texas Instruments DSP Processor user manuals and application notes

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| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3506** | | | | | |
| **TITLE OF THE COURSE** | **INFORMATION THEORY & ERROR CONTROL CODING** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Understand the performance characteristics of an ideal and noisy communication system.
- Interpret the encoding and decoding concepts
- Analyze the performance of discrete communication channels and measure the rate of information transmission and channel capacity of discrete channel.
- Apply suitable coding /decoding schemefor digital communication applications.
- Understand the concept of error control coding.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Examine** information sources and channels based on their statistical properties. | **4- Analyze** |
| CO2 | **Apply** Shannon's theorems in information transmission systems | **3-Apply** |
| CO3 | **Demonstrate** applications of source coding and error coding techniques in selected fields of information and communication technology (ICT). | **2-Demonstrate** |
| CO4 | **Design** source coding and error coding techniques to suit prescribed requirements. | **6- Creating** |
| CO5 | Evaluate the performance of various coding techniques over noisy communication channels. | **5-Evaluate** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: Information Theory** | **08Hrs** |
| Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark-off statistical model for information source, Entropy and information rate of mark-off source. | |
| | |
| **MODULE 2: Source Coding** | **08Hrs** |
| Encoding of the source output, properties of codes, Kraft inequality, construction of instantaneous codes, code efficiency and redundancy, Shannon's encoding algorithm, Shannon-Fano Coding, Huffman minimum redundancy code, Extended Huffman coding, Arithmetic Coding. | |
| | |
| **MODULE 3: Information Channels** | **08Hrs** |
| Communication Channels: Channel Models, Channel Matrix, Joint probability Matrix, System Entropies, Mutual Information, Properties of Mutual information, Channel Capacity, Special Channels, Channel Capacity of: Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Continuous Channels: Maximization of entropy Mutual information of continuous noisy channels, Shannon-Hartley law and its implications Joint and Conditional Entropies, Shannon Limit. | |
| **08** | **10Hrs** |
| | |
| Introduction, Examples of error control coding, Methods of controlling errors, types of codes, types of errors, Linear block codes matrix description of, minimum distance consideration Error detection and correction capabilities, single error correcting Block codes, single error correcting Hamming codes Table lookup for decoding using Standard array. | |
| | |
| **Module: Types of coding** | **07Hrs** |
| | |
| Binary cyclic codes Algebraic structure of cyclic codes Encoding using (n-k) bit shift register Syndrome calculation, Error detection and correction Convolution Codes, Time domain approach. Transform domain approach, State Diagram, tree diagram, Trellis diagram. Encoders and Decoders using Viterbi's algorithm for (n,k,l) convolutional codes | |

**TEXT BOOKS:**

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3. Digital and analog communication systems, K.SamShanmugam, JohnWiley India Pvt. Ltd,20011.
4. Digital Communication, Simon Haykin, John Wiley India Pvt. Ltd,2012.
5. Information Theory and Coding, Muralidhar Kulkarni, K.S. Shivaprakasha, Wiley India Pvt. Ltd, 2015, ISBN:978-81-265-5305-1.

**REFERENCES:**


. 7. ITC and Cryptography, Ranjan Bose, TMH, 2 ndedition,2012
8. Digital Communications - Glover and Grant; Pearson Ed. 2nd edition2010.
9. Digital Communications: Fundamentals & Applications, 2nd edition, Sklar, Pearson Education India.
10. Error Control Coding-Fundamentals & Applications, Shulin, Daniel J. Costello, 2ndEdition, Prentice Hall Inc. Eagle wood Cliffs.

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| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3507** | | | | | |
| **TITLE OF THE COURSE** | **MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To introduce the fundamental concept of MEMS & Microsystem and their relevance to current industry/scientific needs
- To introduce and demonstrate processes which are used in MEMS fabrication
- To apply basic sensing principles of chemical/biological systems to develop novel sensors
- To discuss the limitations and challenges in the design and fabrication of micro sensors, sensing modalities to build the desired microsystem
- To introduce students to apply general micromachining principles to build novel devices.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Students will be able to know about the basics of MEMS | **4-Analyze**<br>1-**Remembering** |
| CO2 | Explain about various materials and technology of MEMS | **1-Remembering**<br>2- **Understand** |
| CO3 | Study about micromachining processing and fabrication techniques | **2-Understand**<br>**3-Apply** |
| CO4 | Explore about MEMS sensors and MEMS novel devices | **1-Remembering**<br>**2-Understand** |
| CO5 | Identify problems and suggest suitable MEMS material/ Devices/Process to get the Requisite Solution for a given application. | **3-Apply**<br>**4-Analyze** |
| CO6 | Apply advanced MEMS techniques to solve future engineering problems | **5-Evaluate**<br>**6-Create** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Definition** | **08Hrs** |
| Development- fundamentals of MEMS, Micro fluidics, microelectronics, micro systems-design and fabrication, working principles and applications. Integrated circuit processes, potential of MEMS in industry. | |
| | |
| **MODULE 2:** | **07Hrs** |
| Materials substrates and wafers, silicon substrate- properties of silicon, silicon compounds, silicon piezo resistors. Galium Arsenide, quartz, polymer for MEMS, conductive polymer. Shape memory alloys | |
| | |
| **MODULE 3:** | **08Hrs** |
| Photolithography, photo resist applications, light sources, X-ray lithography, electron beam lithography, ion implantation, thin film deposition, diffusion process, Chemical and physical vapour deposition, bulk and surface machining, LIGA, DRIE, RIE, laser ablation process, Micro sterio lithography for 3D fabrication and nanolithography. | |
| | |
| **MODULE 4:** | **08Hrs** |
| Micro sensors, classification of physical sensors, integrated, intelligent or smart sensors, sensors principle, thermal sensors, electrical sensors, mechanical sensors, chemical and biosensors. | |
| | |
| **MODULE 5:** | **08Hrs** |
| Electromagnetic and thermal micro actuation, mechanical design of micro actuators, micro actuator, micro valves, micro pumps, micro motors. Micro actuator systems: Ink jet printers, micro-mirror TV projectors. Micro-opto-electromechanical systems, metal oxide semiconductor field effect transistor, multi-disciplinary applications. | |
| | |

**TEXT BOOKS:**

. 1. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw Hill, New Delhi, 2002.
2. Nitaigour Premchand Mahalik, Micro Electro Mechanical Systems, Tata McGraw Hill, New Delhi, 2007.
3. Mohamed Gad-El-Hak, The Micro Electro Mechanical SystemsHandbook, CRC Press, New York, 2002.

**REFERENCES:**


. 1. Kalpakjian, Manufacturing Engineering and Technology, 4'edition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.
2. Mark Madou, Fundamentald of Microfabrication, CRC Press, New York, 1997. Maluf.N, An Introduction to Microelectro mechanical Sytems Engineering, Artech House, Boston, 2000.
3. Rai Choudhury, Micro Electro Mechanical Systems and _ Micro-opto-electromechanical systems Technology and Applications, PHI Learning, 2009.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3508** | | | | | |
| **TITLE OF THE COURSE** | **C PROGRAMMING FOR EMBEDDED SYSTEMS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Setting the required background in embedded system concepts
- Understanding the C Programming Language in the context of embedded systems
- Familiarizing the students in advanced topics in 'C' such as Memory management, Pointers, Data structures which are of high relevance in embedded software is considered in depth.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | To understand the technologies and development platforms behind the embedded systems. | **Understand - 2** |
| CO2 | To define and manage Data structures, Functions and Operators based on problem subject domain. | **Remember - 1** |
| CO3 | To apply the method of writing program using Interrupts | **Apply - 3** |
| CO4 | To construct the program logic using the Arrays, Strings, Pointers and Structures. | **Apply -3** |
| CO5 | To understand various debugging techniques required during embedded software development | **Evaluate - 4** |
| CO6 | To understand the technologies and development platforms behind the embedded systems. | **Understand - 2** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction** | **08Hrs** |
| Introduction to the embedded target for the course, various constraints in an embedded device. Your First Embedded Program , The role of Infinite Loop, Build Process : Scatter File(loader/linker script), Scatter File to ElF mapping, make file, using standard and external libraries. | |

| | |
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| | |
| **MODULE 2: Embedded C basics** | **08Hrs** |
| Type Qualifiers: Volatile, Static(how it is compiled??), little endian and big endian, Macros, bitwise operations: set, clear, creating masks, Structure padding, packing & bit fields, Union, size of structures and unions, stack(main stack, ISR stack, thread stack), malloc/memory management using memory pools, thread management: creation, priority, watchdog and idle thread, Pointer to pointer, function pointers, dynamic memory allocation, memory leakage. | |
| | |
| **Module 3: Interrupts** | **08Hrs** |
| Interrupts: Interrupt Vector Table, FIQ, IRQ, Exceptions, watchdog, Reset Interrupt handling, Nesting of Interrupts, context switching(thread to thread, thread to interrupt, interrupt to interrupt: (IRQ to FIQ, IRQ-IRQ), interrupt to exception. | |
| **MODULE 4: Optimization and Pre-Processor directives in C** | **08Hrs** |
| | |
| Optimization: Increasing Code Efficiency, Decreasing Code Size, Reducing Memory Usage, Compiler Optimization and Flags. Pre-Processor directives: File Inclusion, Conditional Compilation, #error & #pragma directive. | |
| | |
| **MODULE 5: Debugging Techniques** | **07Hrs** |
| | |
| During development GDB, Runtime debugging: register dumps, persistent data, stack dump, types of error: stack corruption (magic words on stack boundaries, check stack on thread switching) | |

**TEXT BOOKS:**

1. Programming Embedded Systems in C and C++, Micheal Barr

**REFERENCES:**

. 1. Programming With STM32 Getting Started with the Nucleo Board and CC++, Donald Norris.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **V** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3509** | | | | | |
| **TITLE OF THE COURSE** | **PLC and SCADA** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To understand basic concept of PLC and to describe the hardware components, program scan sequence, the communication of information to the PLC using different languages, internal relay instruction, writing and entering the ladder logic programs.
- To impart knowledge about the working of timers, counters, sequencers, describe the function of selectable timed interrupt, define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays and fault routine files and use of temporary end instruction and the about PLC program flow instructions.
- To Understand the basic concepts and overview of applications of PLC, SCADA and DCS Systems and their interfacing. To understand the basic concept of Industry 4.0
- To develop an Industrial Automation applications using PLC and understand how Internet of Things plays major role in various process in industrial Setup.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Understand** the basic concepts of PLC's and SCADA techniques. | **2-Understand** |
| CO2 | **Apply** the programming concepts to interface peripheral and to **Analyze** and evaluate the automation techniques for industrial applications | **3-Apply**<br>**4-Analyze** |
| CO3 | Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming. | **2-Understand**<br>**6-Create** |
| CO4 | Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module. | **2-Understand** |
| CO5 | Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals. | **2-Understand** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction** | **08Hrs** |
| Definition of Automation, Types &Application of Automation to Industry processors, Basic Concepts of PLC, PLC in industry, Components, I/O Configuration, Introduction to PLC operation, Binary Data Representation, The input and output status files, Sixteen point I/O modules.<br>PLC Hardware:<br>Input modules: Discrete input modules, Discrete AC and DC input & Output Modules: Discrete & solid-state output module switching, relay output modules. PLC memory. | |
| | |
| **MODULE 2: Basics of PLC Programming** | **08Hrs** |
| Processor memory organization, The Program Scan, PLC Programming languages, Bit or Relay Instruction, OSR Instruction, Output latching instructions, Negated output Instruction, Internal Bit type Instruction, Modes of PLC operation interfacing start/stop Push button switch and Motor to PLC.<br>Special programming Instructions: Timer and Counter Instructions: On delay and off delay and retentive timer instructions, PLC Counter up and down instructions, combining counters and timers. | |
| | |
| **MODULE 3: Special programming Instructions** | **08Hrs** |
| Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, PLC Counter up and down instructions, combining counters and timers.<br>Program Control &Data manipulation Instructions: Data handling instructions, Sequencer instructions, Programming sequence output instructions. | |
| **MODULE 4: Case Studies** | **08Hrs** |
| | |
| Temperature control, Valve Sequencing, Conveyor Belt control, Control of a Process, Material Sorting, and Elevator System Problems<br><br>**SCADA & DCS**: Introduction to Supervisory Control and Data Acquisition (SCADA), SCADA Hardware and Software, Introduction to Distributed control system (DCS), DCS Software. | |
| | |
| **MODULE 5: Introduction: Fundamentals of IIOT** | **07Hrs** |
| | |
| The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture. | |

**TEXT BOOKS:**

. 1. Garry Dunning, "Introduction to Programmable Logic Controllers", CENGAGE Learning, 3rd edition, 2006. ISBN- 9-781-4018-8426-0
2. Bolton W., "Industrial Control and Instrumentation", Universities Press, 4th Edition, 2006. ISBN9-780-7506-8112-4.

**REFERENCES:**


. 1. Krishna Kant, “Computer Based Industrial control”, PHI Publishers, 2nd Edition, 2006. ISBN-9-788-1203-3994-1
2. John W. Webb. Ronald A Reis “Programmable logic controllers” PHI Publishers,5ndEdition,2007, ISBN 9-788-1203-2308-7
3. Industry 4.0 the industrial Internet of Things , Alasdair Gilchrist, 1stedition, Apress Publisher,2017, ISBN-13: 978-1-4842-2046-7

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3601** | | | | | |
| **TITLE OF THE COURSE** | **RF AND MICROWAVE COMMUNICATION** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV | 19EC2404 | ELECTROMAGNATIC WAVES |
| 2 | | | |

**COURSE OBJECTIVES:**

- To familiarize students with the importance of Microwaves in the present scenario.
- To use the concept of Electromagnetic field theory and network analysis to analyze the microwave transmission line and waveguides.
- To make the students learn about microwave passive and active devices, SWR and Impedance Matching
- To design an impedance matching circuit at microwave frequency using transmission lines.
- Make the students to know S-matrix and S-parameters
- To familiarize students with the various network parameters and analyze microwave networks

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Explain** different types of waveguides and their respective modes of propagation. | **2-Understanding** |
| CO2 | **Analyze** typical microwave networks using impedance, admittance, transmission and scattering matrix representations. | **4-Analayze** |
| CO3 | **Design** microwave matching networks using L section, single and double stub and quarter wave transformer. | **6-Create** |
| CO4 | **Explain** working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc. | **2-Understanding** |
| CO5 | Describe and **explain** working of microwave tubes and solid-state devices. | **2-Understanding** |
| CO6 | Perform measurements on microwave devices and networks using power meter and VNA | **6-Create** |
| CO7 | Explain the basics of RF and RF mixers. | **2-Understanding** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction to Rf And Transmission Line Theory** | **08Hrs** |
| Microwave frequencies, Microwave devices and Microwave Systems, Transmission Line Equations and Solutions, Reflection Co-efficient and Transmission Co-efficient, standing wave and standing-wave ratio, Line Impedance and Admittance, Smith Chart and Impedance Matching | |
| | |
| **MODULE 2: Planar Transmission Lines** | **07Hrs** |
| Planer transmission lines such as strip line, micro-strip line, slot line and coplanar waveguides. Characteristics of planar transmission lines. Losses in Micro-strip Lines- Quality Factor Q of Micro-strip Lines: - Properties of materials (Substrate, Conductor, Dielectric and Resistive). Introduction to MIC's:-Technology of hybrid MICs, monolithic MICs, comparison of both MICs. | |
| | |
| **MODULE 3: Microwave Network Characterization And Passive Devices** | **08Hrs** |
| The scattering Matrix – Reciprocity Theorem- Lossless networks and unitary conditions- ABCD parameters- Cascaded networks-Relations between S- Y and ABCD parameters. Properties and s-matrices for typical network such as section of uniform transmission line, 3-port networks (reciprocal and nonreciprocal), T-junctions directional coupler, magic tee, ferrite devices, isolator, circulators. | |
| **MODULE 4: Microwave Devices** | **08Hrs** |
| | |
| Klystron, Multicavity Klystron, Reflex klystron, velocity modulation, transit time, density modulation, beam spreading/ debunching, power output and efficiency, Travelling Wave Tube, Magnetron. Gunn diode and its applications, PIN diode, schottky barrier diodes. (For all the devices: only constructions, operation, definition with explanation and end equations are included. Derivations are excluded). | |
| | |
| **MODULE 5: Rf/Microwave Circuits And Measurements** | **08Hrs** |
| A brief overview of microwave circuits like LNAs, RF mixers. Introduction, tunable detector, Slotted line carriage, VSWR meter, Spectrum Analyzer, Power Measurements, Insertion loss and attenuation measurements, VSWR Measurements, Return loss measurements by reflectometer, Impedance measurement, frequency measurements. | |

| **List of Laboratory/Practical Experiments activities to be conducted (if any) :** |
|---|
| 1. Study of Reflex Klystron Oscillator Mode Characteristics / Gunn diode characteristics. |
| 2. Study of Circulator/Isolator. Extraction of S-Parameters. (Waveguide/stripline component) |
| 3. Study of E-plane, H-plane & Magic Tee. Extraction of S-Parameters. (Waveguide Tees) |
| 4. Study of E-plane, H-plane & Magic Tee. Extraction of S-Parameters. (Waveguide Tees) |

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|---|
| 5. Measurement of Frequency and wavelength measurement using slotted Line Assembly. |
| 6. Plot Radiation Pattern of an Antenna. (Horn/Parabolic) |
| 7. Measurement of Reflection coefficient using Smith chart (Magnitude and phase) |
| 8. Measurement of input impedance of the line using smith chart. |

**TEXT BOOKS:**

. 1. Samuel Y.Liao, "Microwave Devices and Circuits" ,PHI/Pearson Education, Third Edition, 2003.
2. Annapurna Das and Sisir K Das, "Microwave Engineering", Tata McGraw Hill, Second Edition, 2009.
3. Ali A Behagi, "RF and Microwave Circuit Design: A Design Approach using (ADS)", ISBN-13: 978-0996446617

**REFERENCES:**

. 1. David M Pozar, "Microwave Engineering", John Wiley & Sons, Inc., Fourth Edition, 2011.
2. John D Ryder, "Networks, Lines and Fields", PHI, Second Edition, 2002

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3602** | | | | | |
| **TITLE OF THE COURSE** | **NETWORKING AND COMMUNICATION** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | V | 19EC3501 | ANALOG AND DIGITAL COMMUNICATION |
| 2 | | | |

**COURSE OBJECTIVES :**

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks.
- To learn the functions of network layer and the various routing protocols.
- To familiarize the functions and protocols of the Transport layer.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Independently **understand** basic computer network technology. | **2-Understanding** |
| CO2 | Understand and **explain** Data Communications System and its components. | **2-Understanding** |
| CO3 | **Identify** the different types of network topologies and protocols. | **3-Apply** |
| CO4 | Enumerate the layers of the OSI model and TCP/IP. Explain the functions of each layer. | **2-Understanding** |
| CO5 | Understand and building the skills of subnetting and routing mechanisms. | **3-Apply**<br>**6-Create** |
| CO6 | Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation. | **1-Remember**<br>**6-Create** |

**COURSE CONTENT:**

**MODULE 1: Introduction** **08Hrs**

Data communications (Components, Data Representation, and Dataflow), Networks (Distributed Processing, Network Criteria, Physical Structures, Network Models, and Categories of Networks), Reference Models: OSI, TCP/IP
Physical Layer: Transmission media: Magnetic Media, Twisted pair, Base band Coaxial Cable, Fiber optics, Wireless Transmission: Electromagnetic Spectrum, Radio Transmission, Microwave Transmission

**MODULE 2: Data Link Layer** **07Hrs**

**Data link layer:** Design issues: framing, error detection and correction, Elementary Data link Protocols: Stop and wait, Sliding Window protocols: Go-back-N, Selective Repeat,

**Medium Access sub layer:** Channel allocation methods, Multiple Access protocols: ALOHA,
CSMA, Ethernet and Wireless LAN.

**MODULE 3: Network Layer** **08Hrs**

Network Layer design issues, Virtual circuit and Datagram subnets, Routing algorithms: Shortest path routing, Flooding, Distance vector routing, Hierarchical routing, Broad cast and Multi cast routing, Congestion Control: Congestion prevention policies.
The Network layer in the internet: The IP Protocol, IP Addresses, and Internet Control Protocols, IPv6.

**MODULE 4: Transport Layer** **08Hrs**

**List of Laboratory/Practical Experiments activities to be conducted (if any) :**

Part-A:Software
MATLAB /MATHEMATICA/SONNET/MAGICAD/HFSS

1. Simulate three nodes point-to-point networks with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped.
2. Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4. Write a program for error detecting code using CRC-CCITT (16- bits).
5. Write a program to find the shortest path between vertices using Dijkstra algorithm.
6. Write a program for a HDLC frame to perform the following.
   Bit Stuffing
   Character Stuffing
7. Implementation of Stop and Wait protocol, Sliding Window Protocol.

| |
|---|
| 8. Write a program for simple RSA algorithm to encrypt and decrypt the data. |
| 9. Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present. Implement the above program using as message queues or FIFOs as IPC channels. |
| 10. Implement and study the performance of CDMA. |
| Transport Services, Elements of Transport Protocols: Addressing, Connection establishment, Connection Release, Flow control and Buffering, Internet Transport Protocols: UDP and TCP.<br>Session layer: Dialog Control and Synchronization. |
| |
| **MODULE 5: Application Layer** **08Hrs** |
| **Presentation Layer:** Translation, Encryption and Compression Domain Name System, Electronic Mail, World Wide Web, Hyper Text Transfer Protocol,<br><br>**Network Security:** Cryptography, Symmetric key algorithms, Public key algorithms, Digital signatures |

**TEXT BOOKS:**


. 1. Data Communications and Networking – Behrouz A. Forouzan, Fourth Edition TMH, 2006.
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education.


**REFERENCES:**


. 1. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson


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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3603** | | | | | |
| **TITLE OF THE COURSE** | **POWER ELECTRONICS** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **2** | **-** | **52** | **4** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- Study the semiconductors devices as switches suitable for power circuits.
- Select and design the converters for various forms of power conversions.
- Understand the operations of various motor drives
- Design and implement the control circuits for various power electronics Applications
- Understanding power electronic circuits for EV applications

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | **Compare** the different semiconductors devices as switches suitable for power circuits. | **2-Understanding**<br>**4-Analyze**<br>**5-Evaluate** |
| CO2 | Selection and design of suitable converters for various forms of power conversions. | **1-Remember**<br>**4-Analyze** |
| CO3 | **Analyse** various drive circuits suitable for different motors. | **4-Analyze** |
| CO4 | **Design** and implementation of control circuits for EV applications | **6-Create** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction to Power Electronics** | **08Hrs** |
| INTRODUCTION: Need for power electronics, power semiconductor devices, Types of power electronic circuits. Power BJTs, switching characteristics, Power MOSFET Switching characteristics, Power IGBTs, switching characteristics, gate and base drives. | |
| | |
| **MODULE 2: Thyristors** | **08Hrs** |

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|---|---|
| Introduction, VI characteristics, two transistor models, switching characteristics, di/dt and dv/dt protection, thyristor types, series and parallel operation of thyristors, thyristor firing circuits.<br>COMMUTATION TECHNIQUES: Natural commutation, Forced commutation: self-commutation, impulse commutation, resonant pulse commutation and complementary commutation. | |
| | |
| **MODULE 3: Controlled Rectifiers And Controllers** | **08Hrs** |
| Introduction, Principle of phase controlled converter, Operation of single-phase semi converters, full converters and dual converters with parameter analysis. Principle of Three phase half wave converter.<br>AC VOLTAGE CONTROLLERS: Introduction, principle of ON-OFF and phase control, Operation of single phase, Bi-directional controllers with resistive and inductive loads. Single phase Cyclo converters. | |
| | |
| **MODULE 4: DC Choppers** | **07Hrs** |
| | |
| Introduction, principle of step-down operation, step-down chopper with RL loads, Principle of step-up operation, step-up chopper with Resistive load, performance parameters, Chopper classification (Class A to Class E). | |
| | |
| **MODULE 5: DC Drives and Inverters** | **08Hrs** |
| | |
| DC DRIVES: Introduction, Basic Characteristics of DC Motors, Operating modes, Single phase Drives. Stepper motor characteristics, Permanent Magnet stepper motors (bipolar and unipolar motor drive sequence), Stepper Motor Drives<br><br>INVERTERS: Introduction, principle of operation, performance parameters, single phase bridge inverters, three phase inverters, voltage control of single phase inverters, current source inverter, variable DC link inverter,<br>Introduction to Hybrid Electric Vehicles, Basics of Conventional Vehicles. Hybrid Electric Drive-trains and Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. | |

**TEXT BOOKS:**

. 1. Power Electronics - M. H. Rashid, Prentice Hall of India Pvt. Ltd., (Pearson (Singapore–Asia)) New Delhi, 2002.
2. Modern Power Electronics – P.C. Sen, 2nd Edition S.Chand, 2000.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2004

**REFERENCES:**


. 1. Power Electronics- M. D. Sing and Khanchandani K. B., Tata McGraw Hill Publishing Company Limited, Reprint 2001.
2. Power Electronics - Cyril W.Lander, 3rd Edition, McGraw Hill, 1993.
3. Power Electronics, Converters, Applications and Design – Ned Mohan, Undeland, Riobbins
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011
5. Power Electronics Lab Manual, SOE DSU , 2018

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3604** | | | | | |
| **TITLE OF THE COURSE** | **Analog VLSI Design** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | V | 20EC3503 | CMOS VLSI DESIGN |
| 2 | | | |

**COURSE OBJECTIVES:**

- Analyse small signal and large signal model of MOSFETS
- Analyse characteristics of single-stage amplifiers and differential amplifiers.
- Understand and Analyse Op-Amp parameters.
- Study Analog Comparators.
- Infer VCO and PLL Characteristics.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Acquire knowledge about physics involved in modelling of semiconductor device. | **3-Apply** |
| CO2 | To study key analog circuits for signal processing, conditioning and detection in system. | 1. Understand |
| CO3 | Apply knowledge of mathematics, science, and engineering to design and analysis of analog integrated circuits. | **3-Apply** |
| CO4 | Identify, formulates, and solves engineering problems in the area of analog integrated circuits. | **3-Apply 4-Analyze** |
| CO5 | Use the techniques, skills, and modern programming tools, necessary for engineering practice. | **3-Apply** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: CMOS Device Modelling** | **10Hrs** |
| 11. CMOS Device Modelling: MOS large Signal Model, Small Signal Model. Analog | |

| | |
|---|---|
| CMOS Subcircuits: MOS Switch, MOS Diode, Current Sinks and Sources, Current Mirrors, Basic Current Mirror, Cascode Current Mirror. | |
| | |
| **MODULE 2: Single Stage Amplifiers:** | **10Hrs** |
| Common Source with Resistive load, Diode connected Load, Current Source load, Triode Load, Source degradation, Source follower, Common Gate | |
| | |
| **MODULE 3: Differential Amplifiers and Operational Amplifiers** | **10Hrs** |
| **Differential Amplifiers and Operational Amplifiers:** Single Ended Differential operation, Basic differential Pair, Common Mode Response, Differential Pair with MOS Load.<br><br>**OP- AMPS:** General Consideration and Performance Parameters, One/Single Stage OP-AMP, Two stage Op-amp, Gain Boosting, Slew Rate and Power Supply Rejection Ratio | |
| | |
| **MODULE 4: Other Analog Circuits:** | **09Hrs** |
| Comparators, Characterization of a Comparator, Two Stage Open Loop Comparator, Voltage Controlled Oscillator, Basic PLL Topology | |
| | |
| | |

**TEXT BOOKS:**

. 1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 3rd Edition, 2002, Tata McGrawHill

**REFERENCES:**

. 1. CMOS Analog Circuit Design, Phillip E Allen, Douglas R Holberg, 2rd Edition, 2006, Oxford University Press.
2. Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, John Wiley & Sons, 5th edition, 2009
3. Analog Integrated Circuit Design, Carusone, Johns, and Martin, 2nd edition, John Wiley, 2012.
4. Analog Design for CMOS VLSI Systems, Franco Maloberti, Kluwer Academic Publishers, 2001

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| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3605** | | | | | |
| **TITLE OF THE COURSE** | **Wireless and Mobile Communication** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | | | |
| 2 | | | |

**COURSE OBJECTIVES:**

- To understand the concepts and techniques of mobile radio communication
- fundamentals like reflection, diffraction, scattering and fading.
- The course provides the basic foundation of mobile communication. This course covers aspects like working principles, types, modulation methods, channeling and applications.
- To understand equalization techniques and the analysis of same to improve the signal strength
- To analyze the modulation and multiple access techniques to increase the channel efficiency
- To understand cellular design concepts and apply them in wireless communication
- To understand the short distance communication and the concept of 5G wireless communication and analyses the pros and cons of technology.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Understand the concepts and techniques of mobile radio communication fundamentals like reflection, diffraction, scattering and fading | **2-Understand** |
| CO2 | Understand working principles, types, modulation methods, channeling and applications. | **1-Remember**<br>**2 Understand** |
| CO3 | Understand equalization techniques and the analysis of the same to improve the signal strength | **2-Understand**<br>**4- Analyze** |
| CO4 | Analyse the modulation and multiple access techniques to increase the channel efficiency | **4- Analyze**<br>**5 -Evaluate** |

| | | |
|---|---|---|
| CO5 | Understand cellular design concepts and apply them in wireless communication | **2 Understand 3- Apply** |
| CO6 | Understand the short distance communication and the concept of 5G wireless communication and analyses the pros and cons of technology | **2 – Understand 4 - Analyze** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1:** | **08Hrs** |
| Evolution of mobile radio communication fundamentals, General Model of Wireless Communication Link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing. | |
| | |
| **MODULE 2:** | **08Hrs** |
| Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques, Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation. | |
| | |
| **MODULE 3:** | **08Hrs** |
| Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms; Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, SC-FDMA, IDMA Schemes and Hybrid Method of Multiple Access Schemes, RAKE Receiver; Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes. | |
| **MODULE 4:** | **08Hrs** |
| | |
| GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA Based Standards: IS 95 to CDMA 2000, Wireless Local Loop, IMT 2000 and UMTS, Long Term Evolution (LTE), Mobile Satellite Communication. | |
| | |
| **MODULE 5:** | **07Hrs** |
| | |
| Introduction to Mobile Adhoc Networks, Bluetooth, Wi-Fi Standards, WiMax Standards, Li-Fi Communication, Ultra-Wideband Communication, Mobile data networks, Wireless Standards IMT 2000, Introduction to 5G concept | |

**TEXT BOOKS:**

. 1. T.S. Rappaport, "Wireless Communication-Principles and practice", Pearson Publications, Second Edition.
2. Upena Dalal, "Wireless Communication and Networks", Oxford Press Publications.

**REFERENCES:**

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1. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press.
2. S. Haykin & M. Moher, “Modern wireless communication”, Pearson, 2005.
3. T L Singal, “Wireless Communications”, McGraw Hill Publications

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3606** | | | | | |
| **TITLE OF THE COURSE** | **EMBEDDED SYSTEMS DESIGN** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV | 20EC2403 | MICROCONTROLLERS |
| 2 | | | |

**COURSE OBJECTIVES:**

- To introduce the fundamentals of embedded processor modeling.
- To understand the hardware components involved in embedded system design.
- To discuss on the software aspects required in developing an embedded system.
- To involve in Discussions/ Practices/Exercises onto revising & familiarizing the concepts acquired with applications for improved employability skills.

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction To Embedded Systems** | **08Hrs** |
| Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock-Software Development tools-IDE, assembler, compiler, linker, simulator, debugger, In circuit emulator, Target Hardware Debugging, need for Hardware-Software Partitioning, Co-Design. | |
| | |
| **MODULE 2: Embedded Hardware and System Components** | **08Hrs** |
| Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Core of an Embedded System including all types of processor/controllers, Memory, Sensors, Actuators, LED, Opto-coupler, Relay, Piezo buzzer, Push button switch, Communication Interface, Embedded firmware. | |
| | |
| **MODULE 3: Embedded Software** | **08Hrs** |
| Embedded Systems programming in C – Binding & Running Embedded C program in IDE, Dissecting the program, Building the hardware, Basic techniques for reading & writing from I/O port pins, Examples fo r switches, LED Interfacing using Embedded C. Firmware : Firmware and Bootloader, Example: Sandstone | |
| | |
| **MODULE 4: Embedded Operating Systems (Seos)** | **07Hrs** |
| | |
| Basic OS Concepts: Process Management, Memory Management, I/O and File Management. | |

| | |
|---|---|
| Basics of sEOS, Timer Design consideration using sEOS, Multi-state system design. | |
| | |
| **MODULE 5: Embedded Systems Applications** | **08Hrs** |
| | |
| Case study – Intruder alarm system. HyperTerminal based control-packet based control for LED interfacing, Discussions on Design, Development & Product Manufacturing Processes' of embedded Products like Digital Camera /Adaptive Cruise control in a Car /Mobile Phone / Automated Robonoid Implementation of Traffic light sequencing using on chip UART for RS-232 communication- memory requirements. | |

**COURSE OUTCOMES:**

| CO No. | Outcomes | Bloom's Taxonomy Level |
|---|---|---|
| CO1 | To identify various functional and structural modules within an embedded processor. | **Identify -1** |
| CO2 | Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems. | **Describe - 2** |
| CO3 | To demonstrate automated process with improved design strategies. | **Demonstrate - 2** |
| CO4 | To Understand the implementation of operating systems for Embedded applications. | **Understand -2** |
| CO5 | Analyze various examples of embedded systems. | **Analyze - 4** |

**TEXT BOOKS:**

. 1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009.
2. Andrew N. Sloss, Dominic Symes,Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier, 2004

**REFERENCES:**


1. Tammy Noergaard, "Embedded system architecture", Elsevier.
2. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme.
3. Peckol, "Embedded system Design", JohnWiley &Sons.
4. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson.
5. Jonathan W.Valvano,"Embedded Microcomputer Systems, Real Time Interfacing", Cengage Learning.
6. Jivan S. Parab, Vinod G. Shelake, Rajanish K.Kamot, and Gourish M.Naik, "Exploring C for Microcontrollers- A Hands on Approach", Springer, 2007.
7. Michael J. Pont, "Embedded C", Addison Wesley.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3607** | | | | | |
| **TITLE OF THE COURSE** | **Digital IC Design** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | **0** | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | V | 20EC2302 | Analog Circuits |
| 2 | | | |

**COURSE OBJECTIVES:**

- Analyse small signal and large signal model of MOSFETS
- Analyse characteristics of single-stage amplifiers and differential amplifiers.
- Understand and Analyse Op-Amp parameters.
- Study Analog Comparators.
- Infer VCO and PLL Characteristics.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | To impart the knowledge about various VLSI digital design flow | **2-Understand** |
| CO2 | Acquire knowledge about timing issues in digital circuits. | **3-Apply** |
| CO3 | Acquire knowledge about RAM, ROM and High-Performance Subsystem Memories | **3-Apply** |
| CO4 | Solve engineering problems for feasible and optimal solutions in the core area of CMOS Digital ICs. | **3-Apply** |
| CO5 | Apply the CMOS Digital IC concepts for usage of modern CAD tools and their Limitations. | **3-Apply** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE: Implementation Strategies For Digital Ics** | **08Hrs** |
| Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design, Methodology Standard Cell, Compiled Cells, | |

| | |
|---|---|
| Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays. | |
| | |
| **MODULE 2: Timing Issues In Digital Circuits** | **08Hrs** |
| Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking, Self-Timed Circuit Design, Self-Timed Logic - An Asynchronous Technique , Completion-Signal Generation, Self-Timed Signaling, Practical Examples of Self-Timed Logic, Synchronizers and Arbiters, Synchronizers—Concept and Implementation, Arbiters, Metastability | |
| | |
| **MODULE 3: Designing Arithmetic Building Blocks** | **08Hrs** |
| Introduction, Datapaths in Digital Processor Architectures, The Adder, The Binary Adder: Definitions, The Full Adder: Circuit Design Considerations, The Binary Adder: Logic Design Considerations, The Multiplier: Definitions, Partial-Product Generation, Partial Product Accumulation, Final Addition, Multiplier Summary, The Shifter Barrel Shifter, Logarithmic Shifter. | |
| | |
| **MODULE 4: Designing Memory and Array Structures** | **07Hrs** |
| | |
| Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile, Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References Drivers/Buffers, Timing and Control, Memory Reliability and Yield, Signal-To-Noise Ratio, Memory yield. | |
| | |

**TEXT BOOKS:**

. 1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 3rd Edition, 2002, Tata McGrawHill

**REFERENCES:**

. 1. CMOS Analog Circuit Design, Phillip E Allen, Douglas R Holberg, 2rd Edition, 2006, Oxford University Press.
2. Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, John Wiley & Sons, 5th edition, 2009
3. Analog Integrated Circuit Design, Carusone, Johns, and Martin, 2nd edition, John Wiley, 2012
4. Analog Design for CMOS VLSI Systems, Franco Maloberti, Kluwer Academic Publishers, 2001

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| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3608** | | | | | |
| **TITLE OF THE COURSE** | **DIGITAL IMAGE PROCESSING** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | V | 20EC3504 | DGITAL SIGNAL PROCESSING |
| 2 | | | |

**COURSE OBJECTIVES:**

- To understand the basics of Image Processing and color image processing.
- To appreciate the usage of image transforms in image processing
- To learn various image processing techniques like image enhancement, restoration.
- To know segmentation, image compression and basics of watermarking.

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Analyze basics of image and full color image processing techniques. | **4-Analyze** |
| CO2 | Appreciate image manipulations and different digital image processing techniques in various fields and apply the various image transforms used in image processing. | **3-Apply** |
| CO3 | Perform basic operations like – Enhancement, Image transform and restoration techniques on image. | **6-Create** |
| CO4 | Make use of image segmentation, compression for various applications. | **3-Apply** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Digital Image Fundamentals** | **08Hrs** |
| What is Digital Image Processing? Fundamental Steps in Digital Image Processing, Components of an Image processing system, elements of Visual Perception, Image sensing | |

| | |
|---|---|
| and acquisition, Image sampling and quantization, basic relationships between pixels. An introduction to mathematical tools in digital image processing.<br>Color Fundamentals: Color Models, Pseudo color Image Processing, basics of full color image processing, color transformations. | |
| | |
| **MODULE 2: Image Transforms** | **08Hrs** |
| Two-dimensional orthogonal & unitary transforms, properties of unitary transforms, two dimensional discrete Fourier transform, Discrete cosine transform, sine transform, Hadamard transform, Haar transform, Problems. | |
| | |
| **MODULE 3: Image Enhancement** | **08Hrs** |
| Image Enhancement in Spatial domain, Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering.<br>Image enhancement in the Frequency Domain filters, Smoothing Frequency Domain filters, Sharpening Frequency Domain filters, homomorphic filtering. | |
| | |
| **MODULE 4: Image Restoration** | **07Hrs** |
| | |
| A Model of the Image Degradation/Restoration Process, Noise models, Restoration in the presence of noise, Linear Position-Invariant Degradations, Inverse filtering, Minimum Mean Square Error (Wiener) Filter, Constrained Least squares filtering. | |
| | |
| **MODULE 5: Image Segmentation And Compression** | **08Hrs** |
| | |
| Fundamentals, point, Line and Edge detection, Thresholding, Region based Segmentation.<br>Fundamentals, Image Compression Models, Error Free Compression, Lossy and lossless Compression, Image compression using DCT and DWT.<br>Application of image processing technique using opencv/Python/Matlab/Scilab. | |

**TEXT BOOKS:**


1. Digital Image Processing" Rafel C.Gonzalez and Richard E.Woods, Pearson Education, 3rd edition 2011.
2. Fundamentals of Digital Image Processing", Anil K. Jain, 2003, Pearson Education


**REFERENCES:**


. 1. "Digital Image Processing" S.Jayaraman S.Esakirajan T.Veerakaumar Mc Graw Hill publishers, 2009
2. "Digital Image Processing", S.Sridharoxford publishers, 2011
3. "Digital Image Processing and Analysis" Chanda & Majumdar, 2003, PHI
4. "Digital Image Processing" Vipula Singh, , Elsevier Publications


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| **SEMESTER** | **VI** |
| **YEAR** | **III** |
| **COURSE CODE** | **21EC3609** |

| TITLE OF THE COURSE | REAL TIME EMBEDDED SYSTEMS | | | | | |
|---|---|---|---|---|---|---|
| SCHEME OF Instruction | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| Perquisite Courses (if any) | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV | 19EC2403 | MICROCONTROLLERS |
| 2 | | | |

**COURSE OBJECTIVES:**

- To acquire knowledge about concepts related to OS such as Scheduling techniques, threads, inter-thread communications, memory management.
- To understand the architecture and programming model of STM 32 microcontroller.
- To gain knowledge on UML and resource modelling
- To study about Free RTOS and incorporate in projects

**COURSE OUTCOMES:**

| CO No. | Outcomes | Bloom's Taxonomy Level |
|---|---|---|
| CO1 | Describe the fundamental concepts of RTOS | **4-Analyze** |
| CO2 | Describe STM 32 processor architecture and Programming model | **1-Remembering 2-Analyze** |
| CO3 | Analyze different scheduling and multitasking approaches | **4-Analyze** |
| CO4 | Develop programs for real time services, firmware and RTOS. | **1-Remembering 2-Analyze** |

| **COURSE CONTENT:** | |
|---|---|
| | |
| **MODULE 1: Introduction To Real Time Systems** | **08Hrs** |
| Introduction to Embedded Systems, Real time Embedded Systems, characteristics, Hard and Soft Real-Time Embedded Systems, Examples, Cross platform development process, Hardware architecture, Software development, build target images, Memory mapping, integrated testing on target, system production. | |
| | |
| **MODULE 2: ARM for Real Time Systems** | **07Hrs** |
| ARM STM32, Architecture, Memory organization, Process instructions, General Purpose Input Output pin hardware, Interrupts, External & Software Interrupts, Timers, Case Study | |
| | |
| **MODULE 3: Software Architecture for Real Time Embedded Systems** | **08Hrs** |

| | |
|---|---|
| Real time tasks, Periodic and Aperiodic tasks, Task specification, Clock driven scheduling, Round Robin Architecture, Priority driven scheduling algorithms, Round Robin Architecture with interrupts, Queue based architecture, Case study. | |
| | |
| **MODULE 4: Real Time Operating Systems** | **08Hrs** |
| | |
| Operating system basics, Tasks, Process, Threads, Process Management, Memory Management, Multitasking, Real time scheduling, non-Pre-emptive Scheduling, Pre-emptive scheduling, Inter-task Communication, Resource sharing, Introduction to OSEK standards OS, Architecture of OSEK OS. | |
| | |
| **MODULE 5: Embedded System Design with Freertos** | **08Hrs** |
| | |
| Fundamental of UML, Structural modelling: UML, class diagram & class modelling, object diagram, Real time UML, General resource modelling, Resource modelling, concurrency modelling, Getting started with Free RTOS – Task Management, Queue Management, Interrupt & Resource Management. Incorporating Free RTOS in projects. | |

**TEXT BOOKS:**

. 1. Jiacun Wang, Real Time Embedded Systems, Wiley Publications, 2017.
2. Xiaocong Fan, Real Time Embedded Systems: Design Principles & Engineering Practices, Elsevier, 2014.
3. Shibu K V, Introduction to Embedded Systems, McGraw Hill Education(India) Private Limited, 2017.
4. Lemieux Joseph. Programming in the OSEK/VDX Environment, R & D.(2001)

**REFERENCES:**

1. Jim Cooling, Real Time Operating Systems: Book 2 - The practice -Using STM Cube, FreeRTOS and the STM32F4 Discovery boards, Lindentree Associates Publications 2017.
2. Donald Norris, Programming with STM32: Getting started with Nucleo board and C/C++, McGraw Hill Education Publications, 2018.

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|---|---|---|---|---|---|---|
| **SEMESTER** | **VI** | | | | | |
| **YEAR** | **III** | | | | | |
| **COURSE CODE** | **21EC3610** | | | | | |
| **TITLE OF THE COURSE** | **Industrial Internet of things (IIoT)** | | | | | |
| **SCHEME OF Instruction** | Lecture Hours | Tutorial Hours | Practical Hours | Seminar/Projects Hours | Total Hours | Credits |
| | **3** | | **-** | **-** | **39** | **3** |

| **Perquisite Courses (if any)** | | | |
|---|---|---|---|
| # | Sem/Year | Course Code | Title of the Course |
| 1 | IV/III | 19ECxxx | **PLC and SCADA** |
| 2 | | | |

**COURSE OBJECTIVES:**

- To introduce the fundamental concept Industry 4.0 and IoT
- 2. To introduce and demonstrate role of sensors and actuators in industries
- 3. To apply basic knowledge of data analytics to analyses data obtained from machines
- 4. To understand Role of AR and VR
- 5. To introduce students to what role IIoT will play in healthcare, power plant industries as case study

**COURSE OUTCOMES:**

| **CO No.** | **Outcomes** | **Bloom's Taxonomy Level** |
|---|---|---|
| CO1 | Students will able know the basic of 4$^{th}$ industrial Revolution | **1-Remembering** |
| CO2 | Explain about Sensors and Actuators | **1-Remembering**<br>**2-Understanding** |
| CO3 | Explore Various Technologies used in Industrial IoT | **2-Understanding**<br>**3-Applying** |
| CO4 | Analyzing the data obtained from the machines and host them in cloud | **1-Remembering**<br>**2-Understanding** |
| CO5 | IIoT links the automation system with enterprise, planning and product lifecycle. | **3-Applying**<br>**4-Analyzing** |
| CO6 | Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits | **5-Evaluate**<br>**6-Create** |

| COURSE CONTENT: | |
|---|---|
| | |
| **MODULE 1: Introduction** | **08Hrs** |
| Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories | |
| | |
| **MODULE 2: IIoT Technologies** | **08Hrs** |
| Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems. Industrial Sensing & Actuation. | |
| | |
| **MODULE 3: IIoT Communication** | **08Hrs** |
| IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II. Industrial IoT-Layers: IIoT Sensing, IIoT Processing. Communication-Part I. Industrial IoT- Layers: IIoT Communication, IIoT Networking-Part I, Part II, Part III. | |
| | |
| **MODULE 4: IIoT Analytics** | **08Hrs** |
| | |
| Introduction, Machine Learning and Data Science in Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Machine Learning and Data Science - R and Julia Programming, Data Management with Hadoop Data Center Networks, Industrial IoT Security and Fog Computing - Fog Computing in IIoT, Industrial IoT- Application Domains. | |
| | |
| **MODULE 5: Application Domains** | **07Hrs** |
| | |
| Healthcare, Power Plants Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies | |

**TEXT BOOKS:**

. 1. Introduction to industrial internet of things and industry 4.0 by Sudip Misra, Chandan Roy, Anandarup Mukarjee, 1st edition , CRC Press publisher,2021, ISBN 9781003020905

**REFERENCES:**


1. Industry 4.0 the industrial Internet of Things , Alasdair Gilchrist, 1st edition, Apress Publisher,2017, ISBN-13: 978-1-4842-2046-7
2. Industry 4.0: Managing The Digital Transformation, Alp Ustundag, EmreCevikcan, 1st edition, Springer, 2018, ISBN 978-3-319-57869-9.

3. Designing the Industry - Internet of things connecting the physical, digital and virtual worlds, OvidiuVermesan and Peer Friess,1st edition, Rivers Publishers, 2016, ISBN 978-87-93379-81-7

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