**Department of Electronics & Communication Engineering**

**MIT ART DESIGN & TECHNOLOGY UNIVERSITY, PUNE**

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**MIT SCHOOL OF ENGINEERING, PUNE**

**STRUCTURE & SYLLABUS (190 CREDITS)**

**FOR**

# Bachelor of Technology

# Electronics and Communication Engineering

**UNDER FACULTY OF TECHNOLOGY**

**(w.e.f. 2017-2018)**

**UNDER FACULTY OF TECHNOLOGY**

**M. Tech. Mechanical Engineering (Mechatronics)**

**2017-Course**

**Admin**

**SEMESTER III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTMT301 | Integral Calculus and Transform Techniques | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC302 | Electronics Circuit Analysis  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC303 | Signals & Systems | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC304 | Digital Logic Design  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC305 | Network Theory | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC311 | Measuring Instruments & simulation Laboratory | 0 | 0 | 2 | 1 | 40 | 60\*\* | 100 |
| 17BTEC312 | Circuit Analysis & Digital Logic Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC321 | Mini Project –I | 0 | 0 | 4 | 2 | 100 | -- | 100 |
| **Total** | **17** | **3** | **10** | **25** | **380** | **420** | **800** |

**SEMESTER-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTEC401 | Data Structures and Algorithms | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC402 | Control Systems  | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC403 | Analog Communication | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC404 | Computer Organization & Microprocessor  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC405 | Linear Integrated Circuits | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC411 | Analog Communication Laboratory  | 0 | 0 | 2 | 1 | 40 | 60\*\* | 100 |
| 17BTEC412 | Data Structures & Microprocessor Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC421 | Mini Project-II | 0 | 0 | 4 | 2 | 100 | -- | 100 |
| **Total** | **17** | **3** | **10** | **25** | **380** | **420** | **800** |

**SEMESTER-V**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTEC501 | Electrical Machines & Power Electronics | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC502 | Digital Communication System | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC503 | Systems Programming  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC504 | Microcontrollers and Applications  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC505 | Electromagnetics Field Theory | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC511 | Digital Communication Laboratory | 0 | 0 | 2 | 1 | 40 | 60\*\* | 100 |
| 17BTEC512 | System Programming & Microcontrollers Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC521 | Mini Project –III | 0 | 0 | 4 | 2 | 100 | -- | 100 |
| **Total** | **18** | **2** | **10** | **25** | **380** | **420** | **800** |

**SEMESTER-VI**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTEC601 | Information Theory and Coding | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC602 | Digital Signal Processing | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC603 | Embedded Processors  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC604 | Environmental Issues and Disaster Management | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC633 | Elective-I- Machine Learning with Python Programming | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC611 | Embedded Processor Laboratory | 0 | 0 | 2 | 1 | 40 | 60\*\* | 100 |
| 17BTEC612 | DSP & Information Theory and Coding Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC621 | Mini Project-IV | 0 | 0 | 4 | 2 | 100 | -- | 100 |
| **Total** | **19** | **1** | **10** | **25** | **380** | **420** | **800** |

**SEMESTER-VII**

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| --- | --- | --- | --- |
| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTEC701 | Computer Networks  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC702 | VLSI System Design | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC703 | Wave Theory and Antenna  | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC7[31-35] | Elective-II | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 17BTEC7[36-40] | Elective-III | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 17BTEC711 | Computer Networks & VLSI Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC7[12-16] | Elective –II Laboratory | 0 | 0 | 4 | 2 | 40 | 60\*\* | 100 |
| 17BTEC721 | Project Phase-I | 0 | 0 | 4 | 2 | 100 | -- | 100 |
| **Total** | **18** | **1** | **12** | **25** | **380** | **420** | **800** |

**SEMESTER-VIII**

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| **Course Code**  | **Course Name**  | **Hours/week** | **Maximum Marks** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **CA** | **FE** | **Total** |
| 17BTEC8 [31-33] | Elective-IV | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 17BTEC8 [34-39] | Elective-V | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 17BTEC821 | Project Phase-II | 0 | 0 | 20 | 10 | 100 | 200 | 300 |
| **Total** | **6** | **0** | **20** | **16** | **180** | **320** | **500** |

**LIST OF ELECTIVES**

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| **Elective**  | **Course Name** |
|
| Elective-I | 17BTEC631 | Mechatronics |
| 17BTEC632 | Open Electives |
| 17BTEC633 | Machine Learning with Python Programming |
| Elective-II | 17BTEC731 | Digital Image Processing |
| 17BTEC732 | Data science & Applications |
| 17BTEC733 | Software Defined Radio |
| 17BTEC734 | PLC and Automation |
| 17BTEC735 | Open Electives |
| Elective-III | 17BTEC736 | Electronics Product Design |
| 17BTEC737 | Internet of Things |
| 17BTEC738 | Wireless Network |
| 17BTEC739 | Information security |
| 17BTEC740 | Open Electives |
| Elective-IV | 17BTEC831 | Engineering Economics and Management |
| 17BTEC832 | Management for Engineers |
| 17BTEC833 | Business Process Management |
| Elective-V | 17BTEC834 | Mobile Communication |
| 17BTEC835 | Biomedical Signal Processing |
| 17BTEC836 | Microwave & Satellite Communication |
| 17BTEC837 | Audio Video Engineering |
| 17BTEC838 | Soft Computing |
| 17BTEC839 | Open Electives |

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC701** | **Computer Networks** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **4** | **0** | **0** | **40** | **60** | **4** |
| **Prerequisite: Digital Communication, Coding Techniques** |
| **Course Objectives:**1. To introduce the concept, terminologies, and technologies used in computer networking and study functions of different layers in reference models.
2. To explain the basics of connecting devices used and protocols used in each layer.
3. To explain the basics of wired as well as wireless LAN and to introduce the IEEE standards used in Ethernet and wireless LANs.
4. To learn how data delivery is carried out in each layer between source and destination node.
5. To study about various applications and to understand the various network security algorithms.
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**COURSE CONTENT**

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| **Unit I Basics of Networking and Physical Layer (8)** |
| **Basics of Networking:** Uses of Computer Networks, Network Hardware, Network Software, Reference Models**Physical Layer:** Guided and Unguided Transmission media, Switching: Circuit switched networks – Data gram Networks – Virtual circuit networks. |
| **Unit II Data Link Layer (12)** |
| **Data link Control:** Data Link Layer Design Issues, Framing, Flow and error control mechanisms, High Data Link Control.**Media Access:** Random access, controlled access, channelization.**IEEE Standards**: Ethernet, Wireless LAN**Connecting LANS:** Connecting devices - Backbone networks - Virtual LANS  |
| **Unit III Network Layer (10)** |
| **Logical addressing**: IPv4, Classful and Classless addressing, Subnetting, Supernetting, Network address translation, IPv6 addresses. Internet Protocol: IPv4 **Address mapping:** ARP, RARP,BOOTP, DHCP, ICMP, IGMP **Routing Algorithms**: Routing algorithm parameters, Shortest Path Routing, Distance Vector Routing, Link State Routing. |
| **Unit IV Transport Layer (9)** |
| **Transport Layer Protocols:** Process-to-Process delivery - User Datagram Protocol (UDP) – Transmission Control Protocol (TCP).**Congestion Control**: General Principles of Congestion Control, Congestion Prevention Policies, Congestion Control in Virtual-Circuit Subnets and Datagram Subnets.**Quality of Service**: Requirements, Techniques for Achieving Good Quality of Service. |
| **Unit V Application Layer and Network Security (9)** |
| **Application Layer**: Domain Name System (DNS), E-mail, FTP, WWW, HTTP,**Multimedia Network Security**: Cryptography – Symmetric key and Public Key algorithms - Digital signature – Management of Public keys – Communication Security – Authentication Protocols. |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Understand reference models and function of each layer.
2. Explore various protocols and their use in data delivery from source to destination.
3. Design subnetwork and supernetwork based on knowledge of logical addressing.
4. Understand need of congestion control and quality of service along with mechanisms to achieve it.
5. Highlight possible security threats in the network and techniques to deal with it.
 |
| **Text Books** |
| 1. Behrouz A. Foruzan, “Data communication and Networking”, Tata McGraw-Hill, 2006
2. Andrew S. Tannenbaum, “Computer Networks”, Pearson Education, Fourth Edition, 2003
 |
| **References** |

1. William Stallings, “Data and Computer Communication”, Ninth Edition, Pearson Education (2010)
2. Douglas Comer, “Internetworking with TCP/IP, Volume 1”, Pearson Education India; 6 edition (2015)
3. Behrouz A Forouzan, “Computer Networks: A Top - Down Approach”, McGraw Hill Education; 1 edition (1 July 2017)
4. James F. Kurose, Keith W. Ross, “Computer Networking”, Pearson Education; 6 edition (May 1, 2012)

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC702** | **VLSI System Design**  | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **04** | **00** | **0** | **40** | **60** | **4** |
| **Prerequisite: Digital Electronics, Microcontrollers, Microprocessors, Fundamentals of MOSFET & CMOS Circuits**  |
| **Course Objectives** 1. To make the students aware of the PLD or SoC based prototype design flow, HDL modelling of algorithms or protocols in detail pertaining to development of hardware accelerators.
2. To make the students aware of the present advanced architectures of PLDs and SoC issues to be able to convert given requirements into architecture-precise electronic design specifications.
3. To make students aware of the need to test designed circuits, basic aspects of testing and provide an emphasis on test vector generation, various fault models and combinational and sequential design testing methods.
4. To make students aware of state of art CMOS technology-based circuit design methods and tradeoffs in miniaturization and to analyze various signal integrity parameters like delays, rise time/fall time, fanout, etc.
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**Unit I Digital Circuit Design (12)**

Combinational Circuit Design: CMOS Unit Inverter, NAND, NOR gate design, Complex CMOS Logic Circuit Design, CMOS Transmission Gates (Pass Gates)

Sequential Circuit Design: By Stable Element, SR Latch, Clocked Latch and Flip-Flop Circuits.

Delay: RC Delay Model, Linear Delay Model, Logical Effort. Power: Static, Dynamic, Short Circuit, Power Delay Product.

**Unit II PLDs & System on Chip (SoC)**  **(12)**

PLA, PAL, SPLD, CPLD Architectures, Features, Specifications, Applications. FPGA Architectures, Features, Specifications, Applications, comparison between CPLD and FPGA.

**Logic gates:** Delay through Resistive Interconnect, Delay through Inductive Interconnect, Design-for-Yield. **Combinational Logic Networks:** Combinational Network Delay, Logic and Interconnect Design, Power Optimization. **Sequential Systems and Clocking Disciplines**: Power Optimization. Clock distribution techniques, Clock skew, Clock jitter. Supply and ground bounce, Power distribution techniques. Interconnect routing techniques wire parasitic. Design validation. Off chip connections, I/O architectures.

**Unit III HDL Modeling**  **(12)**

Necessity of CAD tool-based design, Overview of Digital Design with Verilog HDL, Hierarchical Modeling Concepts, Basic Concepts, Modules and Ports, Gate-Level Modeling, Dataflow Modeling, Behavioral Modeling, Tasks and Functions. Writing a test bench in Verilog.

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**Unit IV Fault tolerance and testability (10)**

Need of design for testability (DFT), Types of fault. Fault model, complexity of test set, path sensitizing, Controllability, Observability, Predictability, Testability, Built in Self Test (BIST), Partial and full scan check, Need of boundary scan check, JTAG, TAP Controller.

**Unit V Applications of VLSI design (12)**

Datapath unit design, control unit design, PLD based implementation of combinational and sequential logic design, FSM/ASM, design of port structure, memory, FIFO, queue, ALU, serial data transmission/reception protocol, test pattern generator, CMOS realization of gates, combinatorial logic.

**Course Outcomes:**

**After successful completion of the course, students will be able to**

1. Design CMOS digital VLSI circuits and compute various circuit parameters.
2. Understand PLD architectures and SoC signal integrity issues.
3. Understand software-based approach to design hardware with HDL modelling.
4. Know DFT, testability issues and state of the art methods and standards of testability.
5. Design, Develop and implement PLD based prototypes of various digital sub systems and simulate technology specific CMOS device level circuits.

**Textbooks:**

1. Neil Weste, David Harris, Ayan Banerjee, “CMOS VLSI Design- A Circuit & Systems Perspective”, Pearson, 3rd Edition.
2. Wyan Wolf, “Modern VLSI Design (System on Chip)”, Pearson Publication.
3. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Sunsoft Press.

**Reference books:**

1. Charls Roth, “Digital System Design using VHDL”, Tata McGraw Hill.
2. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill
3. Data Sheets of PLDs.
4. Stephen Brown, Zvonko Vrenesic, Fundamentals of digital logic with VHDL design, Second edition, McGraw Hill Publications.

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC703** | **Wave Theory and Antenna** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **04** | **0** | **0** | **40** | **60** | **4** |
| **Prerequisite: Electromagnetics Field Theory** |
| **Course Objectives:** 1. To study parameters of transmission lines.
2. To understand antenna parameters and radiation.
3. To study antenna arrays and special antennas.
4. To learn Antenna measurements.
5. To understand the mode of propagation of radio waves.
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**COURSE CONTENT**

**Unit I** **Transmission Lines** **(09)**

Types of Transmission Lines, Primary Constants, Loop Inductance, Shunt Capacitance, Loop Resistance, Skin Effect, Transmission Line Equations, Determination of constants, Infinite Line, Secondary Constants, Characteristic Impedance, Propagation Constant, Attenuation and Phase Constants, wavelength, velocity of propagation and Group velocity, open and Short circuited lines: Reflected and Incident waves, Standing waves, Input Impedance, Line with any termination: Input Impedance, Reflection Coefficient, Standing Wave Ratio, Distortionless line, Coaxial cable.

**Unit II Basic Antenna Concepts (09)**

Basic Antenna Parameters, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain, Aperture Concept, Effective Aperture, Effective Height, Maximum effective aperture, FRIIS Transmission Formula, Fields from Oscillating Dipoles, radiation from pulsed centre-fed Dipole Antenna.

**Unit III Antenna Arrays: Point Sources (09)**

Definition of Point Sources, Power Patterns, Arrays of two Isotropic Sources - Different Cases, Principle of Pattern Multiplication, Uniform Linear Arrays - Broadside Arrays. End fire Arrays. EFA with Increased Directivity, BSAs with Non-uniform Amplitude Distributions - General Considerations.

**Unit IV Antennas and Measurements (09)**

Yagi-Uda Array, Half Wave Dipole, Folded Dipole Antenna, Log Periodic Antenna, Thin Linear Antenna, Loop antenna, Helical Antenna, Horn Antenna, Microstrip Antenna, Lens Antenna, Parabolic Reflector Antenna.

Antenna Measurements: Phase Measurement, Directivity, Measurement of Gain, Polarization

**Unit V Propagation of Radio Waves (09)**

Fundamentals of Electromagnetic Waves, Modes of propagation, Structure of atmosphere and ionosphere, Ground wave propagation, Sky Wave propagation, Tropospheric Scatter propagation, Virtual height, Critical frequency, Maximum usable frequency. Skip distance, Fading, Multi hop propagation, Ionospheric variations, Space Wave propagation.

**Course Outcomes:**

**After Successful completion of the course, Students will be able to**

1. Understand the various parameters of Electrostatics transmission line parameters.
2. Design the wave equation and solve it for uniform plane wave
3. Analyze the given wire antenna radiation characteristics
4. Identify the suitable antenna for a given communication system.

**TEXT BOOKS:**

1. John D Kraus, “Antennas for all Applications”, 3rd Edition, Mc Graw Hill, 2005.
2. Edward C. Jordan and Keith G. Balmain” Electromagnetic Waves and Radiating Systems” Prentice Hall of India, 2006.
3. Constantine A. Balanis “Antenna Theory Analysis and Design”, Wiley Student Edition, 2006

**REFERENCES BOOKS:**

1. R.E.Collin, “Antennas and Radiowave Propagation”, Mc Graw Hill 1985.
2. Rajeswari Chatterjee, “Antenna Theory and Practice” Revised Second Edition New Age International Publishers, 2006.
3. Robert S.Elliott “Antenna Theory and Design” Wiley Student Edition, 2006.
4. H.Sizun “Radio Wave Propagation for Telecommunication Applications”, First Indian Reprint,Springer Publications, 2007.
5. George Kennedy, Bernard Davis, “Electronic Communication Systems” Tata McGraw Hill Education Pvt. Ltd., Fourth Edition

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC731** | **Elective-II: Digital Image Processing** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Signals and Systems** |
| **Course Objectives:** 1. To understand the fundamental concepts of Digital Image Processing.
2. To learn basic image processing operations.
3. To study image Morphology, Segmentation and Representation.
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**COURSE CONTENT**

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| **Unit I Digital Image Fundamentals (9)** |
| Human visual system, Image Sensing and Acquisition, Sampling & Quantization, Basic Relationships between Pixels, Representing digital images, Spatial & Intensity Resolution, Image file formats, Basic relationships between pixels, Neighbours of a Pixel, Distance Measures, Basics on Intensity Transformation Functions, Image Negatives, Histogram Processing, Equalization. Image Enhancement Techniques. |
| **Unit II Filtering in Spatial and Frequency Domain (9)** |
| Spatial Domain Filtering: Mechanics, Spatial Correlation and Convolution, Vector Representation, Filter Mask, Smoothing Spatial Filters, Nonlinear Filters, Sharpening Filters Frequency domain Filtering: Preliminary Concepts, Sampling, Discrete Fourier Transform of one variable, Extension to functions of two variables, 2D Discrete Fourier Transform, Image Smoothing and Sharpening using in frequency domain filters.  |
| **Unit III Image Compression (9)** |
| Coding Redundancy, Spatial and Temporal redundancy, Measuring Image Information, Fidelity criteria, Image Compression Models, Image compression standards, Huffman coding, Arithmetic coding, Run-Length coding, Bit-plane coding, Block Transform coding, Predictive coding, Fundamentals of JPEG, MPEG, Introduction to DCT, DFT and DWT. |
| **Unit IV Morphological Image Processing and Image Segmentation (9)** |
| Morphological Operations: Erosion, Dilation, Duality, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction, Skeletons.Image Segmentation: Point, Line and Edge Detection, Marr-Hildreth Edge Detector, Canny Edge Detector, Edge linking and Boundary Detection, Hough Transform, Region Growing, Region Splitting and Merging. |
| **Unit V Image Representation and Description (9)** |
| Representation – Boundary Following, Chain codes, Polygonal approximation, Signatures, Boundary Segments, and Skeletons.Boundary Descriptors – Shape numbers, Fourier Descriptors, Statistical moments. Regional Descriptors – Topological, Texture.Applications: Medical application, Pattern Recognition, Biometric Authentication.  |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Develop principles and techniques of Digital Image Processing.
2. Apply image enhancement and restoration techniques.
3. Use Image compression, segmentation and representation techniques.
 |
| **Text Books:**  |
| 1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Third Edition,

Pearson Prentice Hall.1. S Sridhar, “Digital Image Processing”, Oxford University Press.
 |
| **References:**  |
| 1. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, “Digital Image Processing Using MATLAB”, Second Edition, - Tata McGraw Hill Publication.
2. S Jayaraman, S Esakkirajan, T Veerakumar, “Digital Image Processing”, Tata McGraw, Hill Publication.
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC732** | **Elective – II Data Science and Application** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Random processes, Statistical analysis, Basic knowledge of Python programming, Machine Learning** |
| **Course Objectives:**1. To understand basic concepts of Data Science and the Data Science Process. 2. To study Data Visualization techniques.3. To understand the different data science libraries and Machine Learning libraries with their practical application / implementation using Python. |

**Unit I An Introduction to Data Science (10)**

Definition, working, benefits and uses of Data Science, Facets of Data: Structured Data, Unstructured Data, Natural Language, Machine-generated data, Data Science Tools, Open Source Tools, Data Science Workflow: Acquiring Data, Data Munging, Modelling & Evaluation, Representation & Interaction, Data Science: An Interactive Process, Business Intelligence Vs Data Science, Role of data scientist in Big data ecosystem

**Unit II The Data Science Process (10)**

Overview of the Data Science Process, The Data Science Process: Setting the research goal, Retrieving data, Data preparation, Data exploration, Data modelling or model building, Presentation and Automation, Defining research goals and creating a project charter, Retrieving data, Cleansing, Integrating, and Transforming data, Exploratory Data Analysis, Build the models, Presenting findings and building applications on top of them

**Unit III Handling Large Data on a Single Computer (9)**

Problems faced in handling large data, General Techniques for handling large data, General programming steps for handling large volume of data, Case Studies: Predicting malicious URLs, Building a recommender system inside a data base

**Unit IV Data Visualization (8)**

Data Visualization Basics, Techniques, Types, Applications, Different Tools used for data visualization, Data Visualization using matplotlib & Tableau, Data Journalism, Interactive dashboards

**Unit V Python Libraries for Data Science (8)**

Data Mining Libraries: Scrapy, BeautifulSoup; Data Processing & Modelling Libraries: NumPy, SciPy, Pandas, SciKit-Learn, TensorFlow; Data Visualization: Matplotlib, Seaborn, Bokeh, Introduction to Natural Language Processing (NLP)

**Text Books:**

1. Davy Cielen Arno D. B. Meysman Mohamed Ali, “Introducing Data Science”, Manning Publications Co.
2. Joel Grus, “Data Science from Scratch”, O’Reilly Publication
3. Joel Grus, “Data Science from Scratch first Principle in python”, Shroff Publishers

**Reference Books:**

1. Rachel Schutt and Cathy, “Doing Data Science”, O’Neil, O’Reilly
2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly
3. Annalyn Ng and Kenneth Soo, “Numsense! Data Science for the Layman: No Math Added”, Kindle Edition

**Course Outcomes**

**After completion of the course the students will be able to**

1. Explore the fundamental concepts of Data Science
2. Demonstrate knowledge of exploratory data analysis data analysis techniques
3. Develop in depth understanding data visualization techniques and related tools
4. Implement applications using Python libraries

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC733** | **Elective – II Software Defined Radio** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **4** |
| **Prerequisite: Basic knowledge of Digital Communication, Wireless Communication**  |
| **Course Objectives:**1. To understand basics & concept of Modern Radio Communication System and how they can be reconfigured. 2. To understand GNU Radio with how SDR platform provides easy access to wireless network system. 3. To enable students to understand the concept of Cognitive Radio and Spectrum sharing. |

**Unit I Introduction to Software Defined Radio (SDR) with RF Implementation (10)**

What is Software Defined Radio (SDR)? The need of it , Characteristics and benefits of software radio- Design Principles of Software Radio, Software/Hardware platform, GNU radio -What is GNU radio, GNU Radio Architecture, Hardware Block of GNU,GNU software RF Implementation issues- The Purpose of RF Front – End, Dynamic Range- The Principal Challenge of Receiver Design – RF Receiver Front- End Topologies- Enhanced Flexibility of the RF Chain with Software Radios- Importance of the Components to Overall Performance- Transmitter Architectures and Their Issues- Noise and Distortion in the RF Chain, ADC and DAC Distortion.

**Unit II Architecture of SDR (9)**

Essential functions of the software radio, Architecture of SDR: Open Architecture, Software Communication Architecture, Transmitter Receiver Homodyne/heterodyne architecture, RF front End, ADC, DAC, Noise considerations, Distortions in ADC and DAC, Role of FPGA/GPU in SDR, Applications of FPGA in SDR, Trade –offs in using DSP, FPGA and ASIC, Power Management Issues in DSP, ASIC, FPGA

**Unit III Next Generation Network (9)**

Transmission techniques and multiple access schemes for next generation wireless mobile communication system: multicarrier communications, Orthogonal Frequency Division Multiplexing (OFDM), Multiple Input Multiple Output OFDM (MIMO – OFDM), OFDMA, Wireless Networking Techniques: Cellular Network, Wireless Local Area Networks (WLAN), Mobile ad hoc Networks.

**Unit IV Introduction to Cognitive Radio (CR) (9)**

Cognitive Radio Architecture, Dynamic Access Spectrum, Spectrum Efficiency, Spectrum Efficiency gain in SDR and CR, Spectrum Usage, SDR as a platform for CR, OFDM as PHY layer, OFDM Modulator & Demodulator, OFDM Bandwidth, Benefits of OFDM in CR, Spectrum Sensing in CR, CR Network

Cognitive Techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

**Unit V SDR Applications (8)**

Application of SDR in Advance Communication System-Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability.

Case Study: Public Safety Cognitive Radio (PSCR): Architecture & Modes of PSCR, Embedded PCSR using GNU radio

**Text Books:**

1. Jeffrey. H. Reed ,Software Radio : A Modern Approach to Radio Engineering, Pearson LPE
2. Markus Dillinge, KambizMadani, Nancy Alonistioti, Software Defined Radio: Architectures , Systems and Functions ,Wiley
3. Ramjee Prasad, “5G: 2020 and beyond” River publishers, Denmark, 2014

**Reference Books:**

1. Tony .J. Rouphael, RF and DSP for SDR, Elsevier Newness Press ,2008
2. Dr. Taj Struman, Evaluation of SDR –Main Document
3. SDR –Handbook, 8th Edition , PENTEK
4. Bruce a. Fette, Cognitive Radio Technology, Newness, Elsevier

**Course Outcomes**

**After completion of the course the students will be able to**

1. Describe the basics of the software defined radios
2. Compare SDR with traditional Hardware Radio HDR
3. Work on open projects and explore their capability to build their own communication System.

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC734** | **Elective II PLC and Automation** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite:** Logic gates operations, Boolean algebra, Relay logic |
| **Course Objectives:**1. To understand the generic architecture and constituent components of a Programmable Logic Controller.
2. To develop a software program using modern engineering tools and technique for PLC.
3. Student will gain the ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC & SCADA approach.
4. To get an over view of technology of advanced topics such as SCADA, DCS Systems, Digital Controller, CNC Machines.
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**COURSE CONTENT**

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| **Unit I Introduction to PLC & Interfacing of PLC with I/O devices (9)** Role of automation in Industries, benefits of automation, Necessity of PLC, types – fixed/modular/dedicated, Architecture of PLC, PLC Input and output modules (along with Interfaces), comparison of various PLCs manufactured by Allen Bradley, Siemens, ABB, Mitsubishi, GE, Fanuc and Schneider. Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices Sensors-temperature, pressure, flow, level Actuators-Electrical, pneumatic, hydraulic Encoders-Incremental, Limit switches, proximity sensors Control Elements, Mechanical, Electrical, Fluid valves**Unit II PLC programming (9)** PLC programming languages, Ladder diagram: of logic gates, multiplexer, Ladder diagram for different logical conditions or logical equations or truth table. Timers: types of timer, Characteristics, Function of timer in PLC, Classification of a PLC timer, Ladder diagram using timer, PLC counter, Ladder diagram using counter, latch instruction MCR (master control relay) and control zones Developing ladder logic for Sequencing of motors, ON/OFF Tank level control, ON/OFF temperature control elevator, bottle filling plant, car parking, traffic light controller. |
| **Unit III Controller and Applications of PLC (9)**PID working principles, Integral and Derivative (PID), PID modules, PID tuning, tuning methods including “Adjust and observe” method, Cascade PID control. PAC (Programmable automation controller) Solenoids, Relays and Contactors, Motors Controls: DC motor controller, Variable speed (Variable Frequency) AC motor Drive, BLDC Motor, Stepper Motor, Servo Motor, Pneumatic and hydraulic actuators. PLC Applications in developing systems- Tank level controller using analog signals, temperature controller using RTD. |
| **Unit IV Industrial Automation & Control (9)**Process control principles, Analog control, Digital control, Types of Automation; Architecture of Industrial Automation Systems. Basic Concept, History and Hierarchy of DCS, Functions of each level, Architecture of SCADA , MTU- functions of MTU, RTU- Functions of RTU, Working of SCADA, Comparison, suitability of PLC, DCS and SCADA, SCADA system in critical infrastructure: Thermal power plant, Irrigation and Cement factory, Petroleum Refining Process, Conventional electric power generation, Water Purification System. **Unit V Automation with CNC Machines (9)** Introduction of CNC(**Computer Numeric Control**) Machines: Basics and need of CNC machines, NC, CNC and DNC (Direct NC) systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Industrial Communication: Devicenet, Interbus , Device network: Foundation Field bus -H 1, HART, CAN, PROFIBUS-PA, Control network: ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP. Application of IoT in Industrial Automation  |

**Industrial Visit:** Site visit to any SCADA and PLC or CNC based automation industry.

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| **Course Outcomes: After successful completion of the course, students will be able to** |
| 1. Develop and explain the working of PLC with input and output interfacing devices.2. Execute, debug and test the programs developed for digital and analog operations for simple industrial applications.3. Implement the Engineering Automation using PLC & SCADA approach in different infrastructure.4. Observe development of various industrial applications using technology of advanced topics such as SCADA, DCS Systems, Digital Controller, CNC Machines. |
| **Text Books:**  |
| 1.Curtis Johnson, ―Process Control Instrumentation Technology‖; 8th Edition, Pearson Education. 2. MadhuchhandaMitra, SamarjitSen Gupta, ―Programmable Logic controllers and Industrial Automation‖; Penram International Publishing India Pvt. Ltd. 3. Krishna Kant, “Computer Based Industrial Control”, PHI  |
| **Reference Books:** |
| 1. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication. 2. John W. Webb, Ronold A Reis, ―Programmable Logic Controllers, Principles and Applications‖; 5th Edition, Prentice Hall of India Pvt. Ltd. 3. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition 4. Pollack. Herman, W & Robinson., T. ―Computer Numerical Control, Prentice Hall. NJ. Pabla, B.S. & Adithan, M. ―CNC Machines‖, New Age Publishers, New Delhi  |

5. Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC736** | **Elective – III Electronic Product Design** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **1** | **0** | **40** | **60** | **4** |
| **Prerequisite: PCB Designing & Mini Projects** |
| **Course Objectives:** 1. To study different stages of product design and development.
2. To learn the different design methods of hardware and software testing.
3. To learn the methods of PCB design and different tools used for it.
4. To explain the importance of debugging & testing in product design cycle.
5. To understand the processes of documentation.
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**COURSE CONTENT**

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| **Unit I Introduction to Product Design and Development (9)** |
| An overview of product development & product assessment, Market survey, Product Specifications, Prototypes, Pilot Production Batch, Screening test, Environmental effects on reliability, Redundancy, Failsafe system, Industrial design, cognition, ergonomics, Packaging and storage, Estimating power supply requirement, design for manufacture, assembly and disassembly, wiring, temperature, vibration and shock, Safety considerations, noise, energy coupling, grounding, filtering and shielding. |
| **Unit II Hardware Design & Testing Methods (9)** |
| Design process, Identifying the requirements, Industrial Information, formulating specifications, design specifications, System partitioning, Functional design, architectural design, Thermal Design, Industrial Mini PCI Connector- R15 MPCIE, M2 Connectors, Prototyping, Performance and Efficiency measures. Formulating a test plan, writing specifications, Test procedure and test cases, Egoless design, design reviews. Module debug and test: black box test. Logic analyzer, Spectrum analyzer, Network analyzer, Oscilloscope, Monte Carlo analysis. Hardware Documentation.  |
| **Unit III Software Design & Testing Methods (9)** |
| Introduction Phases of software design & Goals of software design, Methods of program flow representation, Types of Software, Software metrics, Software bugs and testing. User interface, Embedded, Real time software. Assembler, Compilers, Simulators, Emulators. Software Documentation. |
| **Unit IV PCB Design (9)** |
| Fundamental Definitions, Standards. Routing Topology Configurations, Layer Stack up, Sketch, Grounding Methodologies, Aspect Ratio, Image Planes, Functional Partitioning, Critical frequencies, Bypassing and decoupling. Design techniques for ESD Protection, Guard Band implementation. Multilayer boards, Component assembly & testing of assembled PCB, Bare board testing. Component assembly techniques, Automation & computers in PCB design, Computer aided design, Design automation, Visualization, Soldering techniques, Study of packages for discrete devices & ICs. |
| **Unit V Product Debugging and Testing (9)**  |
| Steps of Debugging, Techniques for troubleshooting, characterization, passive components, active components, active devices, operational amplifier, Analog-Digital Conversion, Digital Components, Inspection and test of components, Environmental testing for product, Simulation, Prototyping and testing, Integration, validation and verification. Electromagnetic compatibility (EMC) with respect to compliance. |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Understand various stages of hardware, software and PCB design.
2. Apply the process of product test & design.
3. Implement the process of documentation.
 |
| **Text Books:**  |
| 1. Kim Fowler,” Electronic Instrument Design” Oxford university press.
2. Robert J. Herrick, “Printed Circuit board design Techniques for EMC Compliance”, Second edition, IEEE press.
3. Electronic Product Design, R.G.Kaduskar, V.B.Baru, Wiley India
 |
| **References:**  |
| 1. James K. Peckol, “Embedded Systems – A Contemporary Design Tool”, Wiley Publication
2. J C Whitakar,” The Electronics Handbook”, CRC press
3. Tim Williams, “EMC for Product Designers”, Elsevier, Fourth edition 2007
4. Handbook of Printed Circuit manufacturing Raymond H. Clark (Van Nostrand Reinhold Company, New York)
5. Pressman , “Software Engineering - A Practitioner's Approach”Printed Circuit Board design and technology.
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| **Elective – III Electronic Product Design (Tutorial Assignments)****The main objective of this tutorial is to focus on the outcomes defined in the theory****Syllabus by solving the following assignment based on paper/hardware/software work.****Perform any 8 tutorials** |
| 1. Introduction to Electronics Product Designs
2. Reading Electronics Components and Data Sheet
3. To study Mechanical aspects of product design
4. Analyzing Electronic circuit design
5. Understanding the fundamental of Simulations at high speed
6. Introduction to PCB designs
7. Study of single layer board designs
8. EDA Libraries understanding and implementation
9. Design Rule Checking
10. To study CAD-CAM interface
11. Learning to design Double sided boards
12. PCB Fabrication understanding
13. Study of mini PCI connectors and its real time applications
14. Study of development of HIS to PCI and its different versions
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC737** | **Elective – III Internet of Things** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **1** | **0** | **40** | **60** | **4** |
| **Prerequisite: Communication, Microprocessor and Microcontroller, Computer Network** |
| **Course Objectives:**1. To understand concept, terminologies and technologies related to Internet of things.
2. To Describe architecture, Design, underlying technologies, platforms and cloud interface
 |

**COURSE CONTENT**

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| **Unit I INTRODUCTION TO INTERNET OF THINGS (9)** |
| Internet of Things: Definitions and Characteristics of IoT, IoT Architecture, Basic Nodal Capabilities, Physical Design of IoT: IoT Protocols, Logical Design of IoT: Functional block, communication Model, Communication API’s, IoT Enabling Technologies: WSN, Cloud Computing, Big Data Analytics, communication Protocols, Embedded systems, IoT levels and Deployment Templates: Level 1 to Level 6. |
| **Unit II IoT NETWORK ARCHITECTURE AND DESIGN (10)** |
| The one M2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, A Simplified IoT Architecture, IoT protocol stack, The Core IoT Functional Stack, IoT Data Management and Compute Stack: Fog Computing, Edge Computing, The Hierarchy of Edge, Fog, and Cloud IoT and M2M: Introduction to M2M, Difference between IoT and M2M, SDN and NFV for IoT. |
| **Unit III SMART OBJECTS: THE “THINGS” IN IoT (9)** |
| Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects: Communications Criteria, IoT Access Technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, LoRaWAN. |
| **Unit IV ADDRESSING TECHNIQUES FOR THE IoT (10)** |
| Address Capabilities, IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6, Mobile IPV6 technologies for the IoT: Protocol Details, IPv6 over low-power WPAN (6LoWPAN).**IoT PLATFORMS**Exemplary Devices: Raspberry Pi, Raspberry Pi Interfaces, Other IoT Devices:Beagle Bone Black, ARDUINO. |
| **Unit V IoT PHYSICAL SERVERS AND CLOUD OFFEREINGS (9)** |
| Introduction to cloud storage models and communication API’s, WAMP-AutoBahn for IoT, Python web application framework, Designing a RESTful web API, AMAZON web services for IoT, IoT case studies: Home Automation, Smart Cities, Smart Grid. |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Explain the concept of Internet of Things.
2. Describe architecture and design of IoT.
3. Explore the underlying Technologies.
4. Use the platforms in IoT.
5. Design cloud interface to IoT.
 |
| **Text Books** |
| 1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
 |
| **References** |

1. “The Internet of Things, Key Olivier, Willy Publication 2nd Edition
2. “The Internet of Things Connecting Objects to the Web”, Hakima Chaouchi, Willy Publications
3. “IoT Fundamentals: Networking, Technologies, Protocols and Use Cases for Internet of Things”, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Cisco Press

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC738** |  **Elective-III Wireless Network** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **1** | **0** | **40** | **60** | **4** |
| **Prerequisite: Basic Network Theorems** |
| **Course Objectives:** 1. To understand the concept about Wireless networks, protocol stack and standards.
2. To understand and analyze the network layer solutions for Wireless networks.
3. To study about fundamentals of 3G Services, its protocols and applications.
4. To learn about evolution of 4G Networks, its architecture and applications.
 |

**Unit I Introduction to Wireless Network (9)**
Introduction, Overview of wireless network architectures including cellular networks, local area networks, multi-hop wireless networks such as ad hoc networks, mesh networks, and sensor networks. Mobile Communications Fundamentals, Mobile Data, WiFi, Bluetooth, Cable Systems, Wireless Migration Options.

**Unit II Single-node and multi-node Network Architecture (8)**

Hardware components, Energy management of sensor nodes, Examples of sensor nodes, Sensor network scenarios - single hop and multi hop, network, multiple sink/sources, Optimization goals and figures of merit, Design principles for sensor networks

**Unit III Wireless LAN (10)**

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, WPAN – IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, IEEE 802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX.

**Unit IV WIRELESS WIDE AREA NETWORK (9)**

Overview of UMTS Terrestrial Radio access network-UMTS Core network Architecture: 3GPP Architecture, User equipment, 3G-MSC, 3G SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS / DHCP-High speed Downlink packet access (HSDPA) - LTE network architecture and protocol.

**Unit V 4G NETWORKS (8)**

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies:

Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Acquainted with the latest 3G/4G networks and its architecture.
2. Ability to select the suitable network depending on the availability and requirement.
3. Design and implement wireless network environment for any application using latest wireless protocols and standards.
 |

**Text Books:**

1. Jochen Schiller,” Mobile Communications”, Second Edition, Pearson Education 2012.
2. Vijay Garg, “Wireless Communications and networking”, First Edition, Elsevier 2007.
3. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband”, Second Edition, Academic Press, 2008.

**Reference Books:**

1. Anurag Kumar, D.Manjunath, Joy kuri, “Wireless Networking”, First Edition, Elsevier 2011.
2. Simon Haykin , Michael Moher, David Koilpillai, “Modern Wireless Communications”, First Edition, Pearson Education 2013
3. Holger Karl, Andreas Willig, John, Protocols and architectures for wireless sensor networks,Wiley
4. KazemSohraby, Daniel Minoli, TaiebZnati, John, Wireless sensor networks, Technology, protocols, and applications, Wiley
5. Edgar H. Callaway, Wireless Sensor Networks, Architectures and Protocols, CRC Press

**List of Tutorials**

1. Study of different LAN components.
2. Study of Mobile Communications Fundamentals.
3. Study of Single-node Network Architecture.
4. Study of multi-node Network Architecture
5. Study of wireless LANs (Wi-Fi, Bluetooth, ZigBee).
6. Study of WIMAX and its spectrum allocation.
7. Study of 3GPP architecture.
8. Study of LTE network architecture and protocol.
9. Study of OFDM-MIMO system.
10. Study of cognitive radio.

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC739** | **Elective-III Information Security** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **1** | **0** | **40** | **60** | **4** |
| **Prerequisite: Basic Network Theorems** |
| **Course Objectives:** 1. To understand the basics principle, model and basic approaches in information security. 2. To have the knowledge of Encryption methods, cryptography concepts, and authentication functions.3. To study the threats and security issues at network level and system level.  |

**COURSE CONTENT**

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| **Unit I Introduction to Information security (9)** |
| The OSI Security Architecture, Security Attacks, Services and Mechanism, A Model for Network Security, mathematical tools of cryptography, Cryptography techniques, Authentication access control, Digital signature, Certificates & standards.  |
| **Unit II Data Encryption Techniques (9)** |
| Encryption Methods: Symmetric, Asymmetric, Cryptography, Substitution Ciphers.Transposition Ciphers, Stenography applications and limitations, Block Ciphers and methods of operations, Block Cipher Design Principles, AES Structure, MultipleEncryption and Triple-DES |
| **Unit III Public key cryptography and authentication functions (9)** |
| Principles of Public-Key Cryptosystems, RSA Algorithm, Other Public keyCryptosystems - Diffie-Hellman Key Exchange. Authentication methods, Message Digest, Kerberos, X.509 Authentication service.Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol.  |
| **Unit IV Network security (9)** |
| Authentication Applications - Kerberos, Authentication Service, Electronic Mail Security - Pretty Good Privacy, S/MIMEIP Security – IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating security Payload,WEB Security - Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction. |
| **Unit V System Security: (9)** |
| Intruders - Intruders, Intruder detection, Password Management, Malicious Software - Viruses and Related Threats, Virus Countermeasures, Firewall - Firewall Design principles, Trusted systems. |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Explain the model of network security and basics of cryptography.
2. Illustrate various data encryption techniques and authentication methods.
3. Explain the use of Cryptographic algorithms to ensure data protection.
4. Analyze the security issues designed to provide network and System security .
 |
| **Text Books:**  |
| 1. Williams Stallings – Cryptography and Network Security Principles and PracticesPearson Education (LPE), 6th Edition and 4th Edition( For Unit 6)
2. Cryptography & Network Security B.A. Forouzan McGrawHill
3. Michael E Whitman and Herbert J Mattord, ―Principles of Information Security, Vikas Publishing House, New Delhi, 2003
 |
| **References Books:**  |
| 1. Eric Cole, Dr. Ronald Kurtz and James W. Conley, Network Security Bible, Wiley Publishers
2. Atul Kahate. “Cryptography and Network Security.” Tata McGraw-Hill Education, NPTEL : Prof. D. Mukhopadhyay, Cryptography and Network Security
3. Micki Krause, Harold F. Tipton, ― Handbook of Information Security Management, Vol 1-3 CRCPress LLC, 2004.
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC711** | **Computer Networks & VLSI Laboratory** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **40** | **60** | **2** |
| **Prerequisite: C/C++ programming, Network simulation software** |
| **Course Objectives:**1. To study fundamentals of computer networks and to implement local area network.
2. To configure server to perform various roles as web server, DHCP and DNS server.
3. To simulate routing and security algorithms using suitable network simulation tool/ programming language.
4. To learn methods and tools for modelling, simulation and implementation of PLD based prototypes of digital systems.
5. To study CMOS technology specific layout for circuits to investigate performance parameters.
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**COURSE CONTENT**

**Part A: List of Experiments: Computer Networks**

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| 1 | Implementation of Local Area Network and share file/folder. Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool. |
| 2 | Write a program to simulate automatic repeat request mechanism. |
| 3 | Study of wireless LANs and simulate the same using simulation tool. |
| 4 | Study of IP Addresses subnetting and CIDR. |
| 5 | Configuration of router & use of routing algorithm to communicate between LAN’s. |
| 6 | Study of IP Address Classes and Dynamic Host Configuration Protocol (DHCP) |
| 7 | Installation and configuration of Web server and Domain Name System server. |
| 8 | Write a program for Encryption and Decryption |

**Part B: List of Experiments: VLSI System Design**

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| ***a.*** | ***To write Verilog program, simulate with test bench, synthesis, implement on PLD. Comment on, % utilization of the device, dynamic power dissipation, timing report*** |
| 1 | 4-bit ALU for add, subtract, AND, NAND, XOR, XNOR, OR, & ALU pass. |
| 2 | Universal shift register with mode selection input for SISO, SIPO, PISO, & PIPO modes. |
| 3 | UART interface. |
| 4 | Lift/traffic light controller. |
| 5 | RAM/FIFO. |
| 6 | LCD / K/B interface. |
| 7 | Any small system using data path unit and control unit |
| ***b.*** | ***To prepare CMOS layout in selected technology, simulate with and without capacitive load, comment on rise, fall time and dynamic power consumption.*** |
| 8 | CMOS Inverter, NAND, NOR gate. |
| 9 | CMOS Half Adder, 2:1 multiplexer using logic gates and transmission gates |
| 10 | CMOS SR Latch, Flipflop |

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| **Course Outcomes:** |
| **After successful completion of the course, students will be able to** |
| 1. Share files/folder/printer in a local area network and design and implement subnetwork.
2. Simulate wired, wireless networks and measure the performance of routing algorithms & Generate different types of test signals using suitable simulation tool
3. Calibrate and monitor a variety of electronic instruments.
4. Model combinational, sequential and FSM/ASM circuits through software design approach and implement on target technology of PLDs and able to design complex test vector in state-of-the-art test environments and verify the functionality of the system.
5. Prepare CMOS layout design for given circuitry and compute various circuit parameters.
 |
| **Text Books:**  |
| 1. Behrouz A. Foruzan, “Data communication and Networking”, Tata McGraw-Hill, 2006
2. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Sunsoft Press.
3. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill
 |
| **References:** |
| 1. [Jordan Krause](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Jordan+Krause&search-alias=stripbooks), “Mastering Windows Server 2016”, Packt Publishing Limited (28 October 2016)
 |
| 1. Douglas Comer, “Internetworking with TCP/IP, Volume 1”, Pearson Education India; 6 edition (2015)
2. PLDs data sheets
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC712** | **Elective –II: Digital Image Processing Laboratory** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **40** | **60** | **2** |
| **Prerequisite: Basic Programming skills** |
| **Course Objectives:** 1. To implement basic operations on images.
2. To write programs for filtering and compression of images.
3. To perform morphological operation on images.
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**COURSE CONTENT**

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| 1. Carry out basic operations on images.
2. To perform image filtering in spatial domain.
3. To perform image filtering in frequency domain.
4. To perform image compression.
5. To perform histogram equalization.
6. To perform image restoration.
7. To perform edge detection on image.
8. To perform opening and closing on an image.
9. To perform erosion and dilation on an image.
10. To obtain boundary / regional descriptors of an image.
11. To perform DCT/IDCT computation.
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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Analyze and implement basic image processing techniques for solving real problems.
2. Evaluate the techniques for image Compression, enhancement and restoration
3. Have hands-on experience in using software tools for processing digital images.
 |
| **Text Books:**  |
| 1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Prentice Hall.
2. S Sridhar, “Digital Image Processing”, Oxford University Press.
 |
| **References:**  |
| 1. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, “Digital Image Processing Using MATLAB”, Second Edition, - Tata McGraw Hill Publication.
2. S Jayaraman, S Esakkirajan, T Veerakumar, “Digital Image Processing”, Tata McGraw, Hill Publication.
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC713** | **Elective –II: Data Science and Application Laboratory** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **40** | **60** | **2** |
| **Prerequisite: Basic knowledge of Python programming, Machine Learning**  |
| **Course Objectives:**1. To understand basic concepts of Data Science and the Data Science Process. 2. To understand the different data science libraries and Machine Learning libraries with their practical application / implementation using Python |

**List of Experiments (Perform any Eight)**

1. Write down a Python Code for Cleaning Data, Checking Missing Vales, Dealing with Missing values
2. Write down a Python Code to generate & visualize simple line & bar graphs using matplotlib. Give the Name to the graphs, give names to axis & fill different colours in the background and in the bars
3. Write down a Python Code to demonstrate: Basic array characteristics, Array Creation Techniques, Basic Operations on Single Array
4. Write down a Python Code for Crawling to the website
5. Write down a Python Code using TensorFlow to multiply two constants & print the result
6. Write down a Python Code to start up an interactive Session, run the result and close the Session automatically again after printing the output using TensorFlow
7. Write down a Python Code for experiment number 1 using Seaborn
8. Write down a Python Code for turning your data into a visualization using Bokeh.
9. Write down a Python Code Multivariate Interpolation using SciPy

**Text Books:**

1. Davy Cielen Arno D. B. Meysman Mohamed Ali, “Introducing Data Science”, Manning Publications Co.
2. Joel Grus, “Data Science from Scratch”, O’Reilly Publication
3. Joel Grus, “Data Science from Scratch first Principle in python”, Shroff Publishers

**Reference Books:**

1. Rachel Schutt and Cathy, “Doing Data Science”, O’Neil, O’Reilly
2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly
3. Annalyn Ng and Kenneth Soo, “Numsense! Data Science for the Layman: No Math Added”, Kindle Edition

**Course Outcomes**

**After completion of the course the students will be able to**

1. Explore the fundamental concepts of Data Science
2. Demonstrate knowledge of exploratory data analysis data analysis techniques
3. Develop in depth understanding data visualization techniques and related tools
4. Implement applications using Python libraries

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC714** | **Elective –II: Software Defined Radio Laboratory** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **40** | **60** | **2** |
| **Prerequisite: Basic knowledge of Digital Communication, Wireless Communication** |
| **Course Objectives:**The objective of the subject is to understand basics & concept of Modern Radio Communication System and how they can be reconfigured. Also, to understand GNU Radio. with how SDR platform provides easy access to wireless network system. It will also enable students to understand the concept of Cognitive Radio and Spectrum sharing |

**List of Experiments (Perform any Ten)**

1. Study of GNU Radio
2. Study of Software Defined Radio Systems
3. Implementation of AM using SDR
4. Implementation of FM using SDR with application such as transfer of files
5. Implementation of M-PSK transmitter using SDR
6. Implementation of M-PSK receiver using SDR
7. Implementation of M-QAM transmitter using SDR
8. Implementation of M-QAM receiver using SDR
9. Implementation of Transmission of files on Wireless media using SDR
10. Implementation of OFDM using SDR
11. Implementation of Cognitive radio using SDR

**Text Books:**

1. Jeffrey. H. Reed , Software Radio : A Modern Approach to Radio Engineering, Pearson LPE
2. Markus Dillinge, KambizMadani, Nancy Alonistioti, Software Defined Radio: Architectures , Systems and Functions ,Wiley
3. Ramjee Prasad, “5G: 2020 and beyond” River publishers, Denmark, 2014

**Reference Books:**

1. Tony .J. Rouphael, RF and DSP for SDR, Elsevier Newness Press ,2008
2. Dr.TajStruman,Evaluation of SDR –Main Document
3. SDR –Handbook, 8th Edition , PENTEK
4. Bruce a. Fette, Cognitive Radio Technology, Newness, Elsevier

**Course Outcomes**

**After completion of the course the students will be able to**

1. Describe the basics of the software defined radios
2. Compare SDR with traditional Hardware Radio HDR
3. Work on open projects and explore their capability to build their own communication System.

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC715** | **PLC and Automation Laboratory** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **40** | **60** | **2** |
| **Prerequisite:** Logic gates operations, Boolean algebra, Relay logic |
| **Course Objectives:**1. To understand the generic architecture and constituent components of a Programmable Logic Controller.
2. To develop a software program using modern engineering tools and technique for PLC.
3. Student will gain the ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC & SCADA approach.
4. To get an over view of technology of advanced topics such as SCADA, DCS Systems, Digital Controller, CNC Machines.
 |

**COURSE CONTENT**

**List of Experiments:** Minimum 05 experiments should be conducted from each Group A & Group B.

Group A. Programmable Logic Controller Experiments

1. Interfacing of lamp and button with PLC for ON and OFF operation. Verify all logic
2. gates.
3. Set / Reset operation: one push button for ON and other push button for OFF operation.
4. Delayed operation of lamp by using push button.
5. UP/DOWN counter with RESET instruction.
6. Combination of counter and timer for lamp ON/OFF operation.
7. PLC based thermal ON/OFF control.
8. Interfacing of Encoder with PLC
9. PLC based speed, position, flow, level, pressure measurement system.
10. Speed control of ac servo motor using programmable logic controller
11. Lift control system using plc

Group B. SCADA Experiments

1. PLC interfaced with SCADA and status read/command transfer operation.
2. Parameter reading of PLC in SCADA.
3. Alarm annunciation using SCADA.
4. Reporting and trending in SCADA system.
5. Tank level control by using SCADA.
6. Temperature monitoring by using SCADA.
7. Speed control of Machine by using SCADA.
8. Pressure control by using SCADA.

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| **Text Books:**  |
| 1.Curtis Johnson, ―Process Control Instrumentation Technology‖; 8th Edition, Pearson Education. 2. MadhuchhandaMitra, SamarjitSen Gupta, ―Programmable Logic controllers and Industrial Automation‖; Penram International Publishing India Pvt. Ltd. 3. Krishna Kant, “Computer Based Industrial Control”, PHI  |
| **References:** |
| 1.Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication. 2.John W. Webb, Ronold A Reis, ―Programmable Logic Controllers, Principles and Applications‖; 5th Edition, Prentice Hall of India Pvt. Ltd. 3. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition 4. Pollack. Herman, W & Robinson., T. ―Computer Numerical Control, Prentice Hall. NJ. Pabla, B.S. &Adithan, M. ―CNC Machines‖, New Age Publishers, New Delhi  |

5. Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC721** | **Project Phase I** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **4** | **100** | **00** | **2** |
| **Course Objectives:**1. To study techno-commercial specifications.
2. To study optimized system design aspects.
3. To study hardware and software development aspects.
 |
| **Project Group**Minimum 3 students maximum 4 students in consultation with project guide**Domain identification** Electronic communication, measurement and control, signal processing, devices & circuits, analog electronics, digital design, mixed signal circuit/system design, computer networking and security, VLSI and embedded systems, Microcontroller based systems, Artificial intelligence, machine learning, IoT based solutions, wireless sensor networks and nodes, etc. **Scope of the final year UG project work-**Application/system/prototype/product development for,1. Providing solutions for betterment of the society
2. Addressing industry/ Agriculture issues
3. Domain area requirements
4. Performance improvement
5. Technological advancements

**Project Phase-I (Design & Development) stages**1. Group formation
2. Finalization of the work area and broad problem definition
3. Literature review – standard papers, white papers and application notes.
4. Title finalization
5. Problem statement with specifications
6. Synopsis submission
7. Finalization of the modelling tool, platform and language (Selection criterions)
8. Block diagram and block wise design (paper design)
9. Interfacing diagram and software design steps-algorithm/flowcharts
10. Continuous assessment after two weeks by panel members

**Documentation**1. Project Diary (Available in the department)
2. Synopsis
3. Interfacing diagrams, rough calculation notebook
4. Reviewed papers, data sheets of microcontroller and other components and sensors
5. Continuous assessment sheet

In project phase-I, literature survey, system design, circuit design, selection of appropriate EDA tool and design and development steps must be completed. Project design and development should incorporate hardware and software design steps. At the end of the semester design and development phases must be completed. **End semester submission after presentation in front of panel members****Course Outcomes:****On successful completion of the course students will be able to:**1. Learn conversion of information about the system in to technical and commercial specifications.
2. Understand optimized design aspects pertaining to intended performance of the system.
3. Develop understanding about hardware and software co-design/simulation aspect.
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC831** | **Engineering Economics and Management**  | **HSC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basics of Mathematics and Statistics.** |
| **Course Objectives:**1. To apply economic analysis in the formulation of business policies.
2. To use reasoning of economics & finance to business problems.
3. To equip the students with financial analysis of the project.
4. Understand needs, functions, roles, scope and evolution of Management.
5. To acquire skill of decision making, Organizing, Staffing, Directing and Controlling.
 |

**COURSE CONTENT**

**Unit I Introduction to Engineering Economics (12)**

Engineering economics- Features, scope and importance, Engineering efficiency and economic efficiency, Elements of cost – Marginal cost Marginal revenue, sunk cost, Opportunity cost, replacement cost, recurring cost, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

**Unit II Theories of Economics (8)**

Demand and Supply, Elasticity of demand, Market equilibrium for price determination, Forms of Market, Break Even Analysis, Inflation and deflation, Tax effect analysis, National Income Accounting, government budget, circular flow in economy, Case studies Exchange rate, Balance of Payment (BOP), Case studies.

**Unit III Investment Decisions (7)**

Investment Analysis – Risk and Return evaluation of investment decisions, Average Rate of Return (ARR) method, Payback Period method, Net Present Value (NPV) method, Internal Rate of Return (IRR) method, Elements of cost, Practical problems. Meaning of Cash Flow Statement, Objectives of Cash Flow Statement, Uses of Cash Flow Statement

**Unit IV Introduction to Management (11)**

Meaning, Nature, Functions and Importance of Management. Functions of Management – Planning (Meaning, Importance and levels, forecasting and decision making), Organizing (Elements of organizing, Types of organizations, Delegation of authority and Decentralization), Staffing (meaning and importance, communication, direction, motivation and leadership), Controlling (Need, Nature, importance, Process & Techniques).

**Unit V Recent Trends in Management (7)**

-Social Responsibility of Management – Environment Friendly Management (Case Study).

-Resistance to change and Change Management (Case Study).

-Crisis Management (Case Study).

-Total Quality Management (Case Study).

-International Management and role of international manager (Case Study).

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. 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.
2. 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.
 |
| **Text Books:** |
| 1. Principles of Economics - P.N. Chopra (Kalyani Publishers).
2. Engineering Economics - Panneer Selvam, R, (Prentice Hall of India Ltd, New Delhi, 2001).
3. Principles and Practices of Management by L.M.Prasad.
 |
| **References:** |
| 1. Modern Economic Theory – K.K. Dewett (S.Chand).
2. Engineering Economics - Chan S. Park, (Prentice Hall, Inc).
3. Principles of Management by Tripathy and Reddy
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC832** |  **Management for Engineers** | **HSC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basic Problem-solving and decision-making skills, Analytical skills** |
| **Course Objectives:** 1. To help the students gain understanding of the functions and responsibilities of managers.
2. To enable them to analyze and understand the environment of the organization.
3. To help the students to develop cognizance of the importance of management principles.
4. To have managers prepared for leading people with different behavioral traits.
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**COURSE CONTENT**

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| **Unit I Basic concepts of management (9)** |
| Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach. |
| **Unit II Planning and Decision Making: (10)** |
| General Framework for Planning - Planning Process, Types of Plans, Management by Objectives; Development of Business Strategy. Decision making and Problem Solving - Programmed and Non-Programmed Decisions, Steps in Problem Solving and Decision Making; Bounded Rationality and Influences on Decision Making; Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work. |
| **Unit III Organization and HRM (10)** |
| Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change, Human Resource Management & Business Strategy: Talent Management, Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal. |
| **Unit IV Leading and Motivation (9)**Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leadership during adversity and Crisis; Handling Employee and Customer Complaints, Team Motivation - Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories - Needs Hierarchy Theory, Two Factor Theory. |
| **Unit V Controlling (7)** |
| Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems, Control frequency, and Methods. |

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| **Course Outcomes:**  |
| **After successful completion of the course, students will be able to** |
| 1. Explain how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment.
2. Describe the process of management's four functions: planning, organizing, leading, and controlling.
3. Identify and properly use vocabularies within the field of management to articulate one's own position on a specific management issue and communicate effectively with varied audiences.
4. Evaluate leadership styles to anticipate the consequences of each leadership style.
 |
| **Text Books:** |
| 1. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.
 |
| **References:**  |
| 1. Essentials of Management, Koontz Kleihrich, Tata McGraw Hill
2. Principles and Practices of Management- Shejwalkar and Ghanekar.
3. Successful Management the Chanakya Way- Corporate Chanakya
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| **Course Code** | **Course Title** | **Category** |
| **17BTEC833** |  **Business Process Management** | **HSC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basic Problem-solving and decision-making skills, Analytical skills** |
| **Course Objectives:** Define business process management and related concepts.1. Understanding the role of technology in process management.
2. Understand how to design or enhance an existing process using the business process life cycle.
3. Construct a process map
4. Use a variety of tools and techniques to eliminate waste and redundancies.
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**COURSE CONTENT**

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| **Unit I Process Analysis and Design (7)** |
| Introduction, BPM Game, Process Architecture: Core versus Support Processes, Process Modeling: Components of Process Models, From BPMN to XPDL Introduction to BPMN, Advanced BPMN Exercise. |
| **Unit II Technology Support for Processes: Workflow & BPMS (9)** |
| People-Centric and System Centric Processes: Value-adding versus Value-preserving Activities, preparing a Process for Automation, Automating Processes: BPMS and Workflow, Systems Components and Architecture, Workflow and Data, Workflow and Decisions, Task and Resource Allocation, Add Conditional Performers, Rules vs. Processes, Introduction to SBVR |
| **Unit III Managing Processes: Metrics & Dashboards (10)** |
| Managing the Run-Time: Process Metrics, Business Activity Monitoring, Business Intelligence, Process Dashboards, designing a BPM Dashboard: Developing Metrics for a Business Process, Process Mining: Predictive Process Simulation, Data Mining based on Process Data, Integration of Process information into Strategy Maps, Process Mining Exercise. |
| **Unit IV Process Innovation (9)**Process Improvement: Patterns for Process Improvement, Process Innovation Exercise: Improving a given Business Process, Advanced Process Improvement: reinvent the processes, Leveraging Technology to create innovative Processes. |
| **Unit V BPM Maturity & Governance (10)** |

Case Study: Designing Technology Support for a Process Oriented Organization (Air Products Case Study, Harmon Ch. 7), Case Study on HBR Case, Business Process Management Maturity: BPM Maturity Models, BPM Centers of Excellence, Organization Structure of BPM Efforts, Process Governance: Create a BPM Center of Excellence, Advanced BPM Concepts.

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| **Course Outcomes:** |
| **After successful completion of the course, students will be able to** |
| 1. Students will be conversant in the terms used to describe, analyze, and improve Business Processes in organizations.
2. Students will be able to understand BPMN process models.
3. Students will be able to model processes in BPMN for subsequent implementation in Business Process Management Systems.
4. Students will be able to identify weaknesses in a given process design and suggest improvements that will benefit organizational performance.
5. Students will be able to develop an implementation and integration strategy for processes that leverages organizational and technical capabilities of an organization
 |
| **Text Books:** |
| 1. Harmon, Paul: Business Process Change. A Guide for Business Managers and BPM and Six Sigma Professionals. 2nd Edition, Morgan Kaufmann.
 |
| **References:**  |
| 1. Business Process Management – John Jeston
 |

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC834** | **Elective V: Mobile Communication** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basic knowledge of Electronics Devices and Circuits** |
| **Course Objectives:**1. To realize importance of cellular concepts and its propagation mechanism.
2. To understand the different multiple access and switching techniques.
3. To understand architecture of GSM system.
4. To understand the concepts of multiple antenna techniques.
 |

**Unit I Introduction to Mobile Communication System (9)**

Introduction to cellular telephone system, Evolution of wireless communication starting from 1G to 5G Cellular concept: Introduction, Frequency reuse, Channel assignment, Handoff strategies : Handoff - inter BS handoff-Inter system handoff - Hard handoff and soft handoff, Interference and System capacity. Propagation Mechanism: Free space and two ray propagation model, Basic propagation mechanism. Small Scale Fading and Multipath: Types of Small scale fading.

**Unit II Coding and Multiple Access Techniques for Wireless Communication (9)**

Coding: Vocoders, Linear Predictive Coders, Selection of Speech Coders for Mobile Communication, GSM Codec. Multiple Access techniques - FDMA, TDMA, FHMA, CDMA, SDMA, OFDM, Packet Radio, Capacity of Cellular Systems.

**Unit III Switching techniques for Voice and Data (9)**

Switching techniques for Voice: Manual Switching System, Electronic Switching System and Time Division Switching. Single Stage networks, Gradings, Two stage and Three stage networks. Synchronization, Control of switching systems: Call processing Functions, Common Control, Reliability, Availability and Security. Switching techniques for Data: Circuit switching, Message Switching and packet switching in perceptive with mobile communication.

**Unit IV Global System for Mobile Communication and 3G Networks (9)** Global System for Mobile communications (GSM) - Functional architecture of GSM, GSM Interfaces, Logical and Physical channel, Short Message Service (SMS) - Network architecture of SMS - Protocol hierarchy of SMS.

3G Networks - Features and Performance of 3G networks -Frequency allocation for IMT (International Telecommunications Union) 2000 - IMT 2000 family - Architecture of Universal Mobile Telecommunications System (UMTS) network

**Unit V Multiple Antenna Techniques (9)**

Introduction to MIMO systems, MIMO Formats: SIMO, MISO, MIMO, spatial multiplexing, System model, Pre-coding, Beam forming, MIMO Diversity: transmitter diversity, receiver diversity, Alamouti (STBC), Channel state information, capacity in fading and non-fading channels.

**Course Outcomes:**

**After successful completion of the course, students will be able to**

1. Differentiate thoroughly the generations of mobile technologies.
2. Apply the concepts of switching technique to design multistage networks.
3. Explore the architecture of GSM.
4. Apply the knowledge about the importance of MIMO in today's communication.

**Text Books**

1. Theodore Rappaport, ―Wireless Communications Principles and Practice‖ Second Edition, Pearson Education
2. Jochen Schiller, “Mobile Communications”, Second Edition, Pearson Education, 2003.Education
3. Andreas F. Molisch, Wireless Communications, 2nd Edition, John Wiley & Sons Ltd, 2011.

**Reference Books:**

1. Shinsuke Hara and Ramjee Prasad, Multicarrier Techniques for 4G Mobile Communications, 2003
2. William C.Y. Lee., "Wireless & Cellular Telecommunications", 3rd edition, McGraw Hill.2006
3. David Tse, Pramod Viswanath, "Fundamentals of Wireless Communications". Cambridge University Press | ISBN 0521845270 | 2005

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC835** | **Elective-V Biomedical Signal Processing**  | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basic knowledge of Biomedical Engineering and Digital Signal Processing** |
| **Course Objectives:**1. Study of Human Physiological Systems from Engineering Perspectives.
2. Understand basic biomedical signals and their analysis using Digital Signal Processing Techniques.
3. Understand applications using Soft computing approach.
 |

**COURSE CONTENT**

**Unit I Introduction to Biomedical Signals & System (10)**

Introduction to Biomedical Signals, Nature of Biomedical Signals, Examples of Biomedical Signals – EMG, ECG, EEG, VAG Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Biomedical Instrumentation System, Cell structure, Bio-Cell potential, Concept of Bio-electrodes, Types of Bio-electrodes to measure Bio-signal, Transducers and Sensors to measure Bio signals: EEG, ECG, EMG, Respiration,. Artefacts in Bio signal Acquisition: Noise, Power line, Baseline, Skin Impedance and Motion Artefacts, Techniques to reduce the artefacts,

**Unit II Cardiological Signal Processing (10)**

Introduction to Heart, Physiology and Anatomy of Heart, Pre-processing. QRS Detection Methods. Rhythm analysis. Arrhythmia Detection Algorithms. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis. Adaptive Noise Cancelling: Principles of Adaptive Noise Cancelling. Adaptive Noise Cancelling with the LMS Adaptation

**Unit III Neurological Signal Processing (9)**

Nerve Cell and Nerve potential, Brain structure, 10-20 Electrode Placement for EEG, Modelling of EEG Signals. Detection of spikes and spindles, Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modelling of seizure EEG. Sleep Stage analysis. Inverse Filtering. Least squares and polynomial modelling.

**Unit IV Medical Devices (8)**

Introduction to Blood Pressure Measurement (non-invasive), Phonocardiogram (PCG), Life saving Devices Pacemakers and Defibrillators, Bedside Monitors, Central Monitoring system, Stress Test System, X Ray, CT scan,

**Unit V Biomedical Applications (8)**

Soft computing approaches for Biomedical Signal Diagnostics: Artificial Neural Networks, (Multilayer Perceptron, Radial Basis Function Networks, Support Vector machines) as classifiers.

**Text Books:**

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, 4th Edition, Prentice Hall
2. R. Rangayan, “Biomedical Signal Analysis”, Wiley
3. R.S.Khandpur, “Handbook of Biomedical Instrumentation‖”, Tata McGraw Hill, New Delhi 2nd Edition

**Reference Books:**

1. D.C.Reddy, “Digital Bio signal Processing”, TMH
2. Akay M, “Biomedical Signal Processing”, IEEE Press
3. Cohen.A, “Biomedical Signal Processing”, -Vol. I Time & Frequency Analysis CRC Press
4. Jaakko Malmivuo & Robert Plonsey, Bio electromagnetism - Principles and Applications of Bioelectric and Bio magnetic Fields, Oxford University Press, New York
5. Eugene N. Bruce, “Biomedical Signal Processing and Signal Modelling”, John Wiley & Sons

**Course Outcomes**

**After successful completion of the course, students will be able to**

1. Model a Biomedical System
2. Process the Cardiological and Neurological signal and to remove the noise from those signals
3. Make use of Soft Computing Techniques for analysis of different bio-medical signals

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC836** | **Elective-V Microwave & Satellite Communication** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Wave Theory and Antenna** |
| **Course Objectives:** 1. To lay the foundation for microwave engineering2. To understand the applications of microwave engineering3. Carryout the microwave network analysis.4. To understand the basics of orbital mechanics and the look angles from ground stations tothe satellite.5. To apply their subject understanding in Link Design. |

**COURSE CONTENT**

**Unit I Introduction to Microwave and Devices (10)**

Evolution of Microwave, Standard frequency bands and behavior of circuits at conventional & microwave frequencies, Microwave Applications. Wave guides: Over view of wave guided waves; TE, TM & TEM modes, Analysis of these modes through rectangular waveguide, circular wave guide, waveguide dimensions.

**Microwave Components and Devices:** S parameters, Scattering Matrix and its properties Termination, E-plane Tee, H-plane Tee, Magic Tee, Microwave Hybrid Circuits, Hybrid Rings (Rat-Race Circuits), Directional Couplers, Two-Hole Directional Couplers, Hybrid Couplers, Microwave Circulators, Microwave Isolators, Waveguide Corners, Bends and Twists, Coupling probes, Coupling loops, Windows, Waveguide Tuners.

**Unit II Microwave Generators and Transferred Electron Devices (10)** Transit Time Effect, Limitations of conventional Tubes, Two cavity and Multi-cavity Klystron, Reflex Klystron, TWT and Magnetrons, Reentrant Cavities, spark gap switches.

**Transferred Electron Devices (TEDs):** Transit time limitations in transistors, Microwave bipolar transistors, power frequency limitations, microwave field effect transistors, HEMT, Gunn effect and Gunn Diode, High-field domain and modes of operation microwave amplification - Avalanche transit time devices – IMPATT, TRAPATT, BARITT and Schottky diodes, comparison parametric amplifiers.

**Unit III MICROWAVE MEASUREMENTS (08)**

Slotted line VSWR measurement, VSWR through return loss measurements, power measurement, impedance measurement insertion loss and attenuation measurements- measurement of scattering parameters. Measurement of reflection coefficient. VSWR and Noise, Microwave Test bench.

**UNIT IV INTRODUCTION TO SATELLITE ORBITAL MECHANICS (09)**

History of Satellite Communication, Orbital Mechanics, Look angle determination, Orbital

Perturbations, Orbital determination, Launchers and Launch Vehicles, Orbital effects in

Communication system performance. Satellite Subsystems, Attitude and control systems (AOCS), Telemetry, Tracking, Command and Monitoring, Power systems, Communication subsystems, Satellite antennas, Equipment Reliability and space qualification. Introduction to IRNSS.

**UNIT V SATELLITE COMMUNICATION LINK DESIGN (08)**

Introduction, Basic transmission Theory, System Noise Temperature and G/T Ratio, Design of Downlinks, Satellite Systems using Small Earth Stations, Uplink Design, Design of Specified C/N: Combining C/N and C/I values in Satellite Links, System Design Examples

**Course Outcomes:**

After successfully completing the course students will be able to

1. Formulate the wave equation in wave guide for analysis.
2. Identify the use of microwave components and devices in microwave applications.
3. Understand the working principles of all the microwave devices.
4. Choose a suitable microwave measurement instruments and carry out the required.
5. Carry out Link power budget and Rise Time Budget by proper selection of components and check its viability.
6. Carry out Satellite Link design for Up Link and Down Link.

**TEXT BOOKS**

1. Samuel Y. Liao, “Microwave Devices and Circuits” - Prentice Hall of India
2. M. Kulkarni, “Microwave Engineering”, Umesh Publications
3. Annapurna Das and SisirK.Das, “Microwave Engineering” - Tata McGraw-Hill
4. Timothy Pratt, Charles Bostian, Jeremy Allnutt “Satellite Communications”, John Wiley & Sons.

**REFERENCE BOOKS**

1. R.ECollin, “Foundations for Microwave Engineering”, IEEE Press
2. David M. Pozar, “Microwave Engineering” John Wiley & Sons.
3. P. A. Rizzi “Microwave Engineering” (Passive ckts), PH1.
4. Dennis Roody, “Satellite Communications”, McGraw Hill

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC837** | **Elective-V Audio Video Engineering**  | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **3** |
| **Prerequisite: Basic knowledge of Audio and Video Engineering**  |
| **Course Objectives:**1. To learn and understand the working of real-life video system and the different elements of video system plus the encoding/decoding techniques. 2. To understand the different TV and advanced TV Systems like HDTV, Digital TV, LED TV, IPTV etc.3. To study the fundamentals of audio engineering and basics of Acoustics. |

**COURSE CONTENT**

**Unit I Fundamentals of Audio-Video Recording and Playback Techniques (8)**

Different method of Sound Recording and its reproduction methods, Optical Recording, CD & DVD recording, Audio Standards. Digital Sound Recording, CD & DVD player, Blue Ray DVD Players, MP3 Player.

**Unit II Digital Audio Fundamentals and Acoustics Fundamentals (9)**

Audio as Data, what is an Audio Signal, Why Binary, Why Digital, Outline of Digital Audio Processes, Time Compression and Expansion, Audio Compression, Digital Audio Broadcasting, Networks.

Studio Acoustics & Reverberation, P.A. system for Auditorium, Acoustic Chambers, Cordless Microphone System, Special types of Speakers & Microphones, Digital Radio Receiver Satellite Radio Reception

**Unit III Colour Television Fundamentals (9)**

Elements of TV Communication System, Scanning, Synchronization, Aspect Ratio, Pixels, Resolution, Bandwidth, Composite Video Signal, Luminance and Chrominance signal, Colour Composite Video Signal and Television Standards, Colour TV systems, Colour Mixing, Colour Perception, Chromaticity Diagram. Transmitters & Receivers: NTSC, PAL, SECAM systems, High Level and Low-Level Colour TV Transmitter

**Unit IV Digital TV and High Definition TV (HDTV) (9)**

Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters, MAC signals, Advanced MAC signal transmission, Digital TV receivers, Basic principles of Digital Video compression techniques, MPEG Standards. Digital TV recording techniques

HDTV Standards, HDTV Transmitter and Receiver / Encoder, Digital TV Satellite Systems, Video On Demand (VOD), CCTV, Direct To Home TV (DTH), Set Top Box,

**Unit V Advanced TV Systems (9)**

Plasma TV, LCD TV, Flat Panel Display TV Receivers, Three-Dimensional (3 -D) Television, Advances in 3D TV Technology, Present status of new 3D Receivers, Introduction to LED TV, RGB dynamic LEDs, Edge -LEDs, Comparison of LCD TV, Plasma TV and LED TV, Introduction to OLED TVs, IPTV systems, Mobile TV, Wi-Fi Video Transmitter and Receivers

**Text Books:**

1. R.G. Gupta , “Audio Video Systems”, TMH Publication
2. A. M. Dhake , “Television and Video Engineering”, TMH Publication.
3. R. R. Gulati, “Modern Television Practice – Principles, Technology and Service”, New Age International Publication, Edition III

**Reference Books:**

1. S. P. Bali, “Colour TV Theory and Practice‖”, TMH
2. Bernard Grobb, Charles E, “Basic TV and Video Systems”, McGraw Hill
3. Kelth Jack, Penram, “Video Demystified”, International Publication
4. John Watkinson, Snell, “Essential Guide to Digital Video”, Wilcox Inc.
5. Bali & Bali, “Audio Video Systems Principles Practices and Troubleshooting”, Khanna Publishing Compan
6. S.P.Bali, “Consumer Electronics”, Pearson Education

**Course Outcomes:**

**After successful completion of the course the students will be able to**

1. Understand Audio / Video recording and Acoustics fundamentals
2. Apply the fundamentals Colour Television System and Standards
3. Explain the fundamentals of Digital Television, Advanced TV systems

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC838** | **Elective-V Soft Computing**  | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **3** | **0** | **0** | **40** | **60** | **4** |
| **Prerequisite: Basic knowledge of Machine Learning, Neural Networks & Fuzzy Logic**  |
| **Course Objectives:** 1. To learn the various soft computing frame works.
2. To understand various neural networks, fuzzy logic and genetic algorithms.
3. To study hybrid systems for solving real world problems.
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**COURSE CONTENT**

**Unit I Soft Computing Basics (9)**

Introduction, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing, Historical Developments and Definitions, Soft Computing Characteristics and Problem Solving– Strengths and Weaknesses, Constitutes of Soft Computing. Basic tools of Soft Computing – Fuzzy Logic, Neural Network, Evolutionary Computing. Introduction: Neural Networks, Application Scope of Neural Networks, Fuzzy Logic, Genetic Algorithm, and Hybrid Systems.

**Unit II Artificial Neural Network (9)**

Biological Neuron, Concept of Bias and Threshold, McCulloch‐ Pits Neuron Model, implementation of logical AND, OR, XOR functions. Activation Functions: Binary, Bipolar (Linear, Signup, Log Sigmoid, Tan Sigmoid) Learning Mechanisms: Hebbian, Delta Rule of Perceptron and its limitations.

**Complex Architectures Learning**: Competitive Learning-Self Organizing Maps, Hopfield Networks, Adaptive Resonance Theory (ART) Networks, Deep Learning Architecture of Neural Networks, Applications of Neural Networks

**Unit III Fuzzy Logic (9)**

Concept of Fuzzy Number, Fuzzy Set Theory (Continuous, Discrete) Operations on fuzzy sets, Fuzzy Membership Functions (Core, Boundary, Support), Primary and Composite Linguistic Terms, Concept of Fuzzy Relation, Defuzzification Methods, Fuzzy if‐then rules. Fuzzy Inference Systems, Mamdani Fuzzy Models – Sugeno Fuzzy Models, Applications of Fuzzy Modelling for Decision Making

**Unit IV Genetic Algorithm (GA) (9)**

What are Genetic Algorithms? Why Genetic Algorithms, Basic Concepts, Working Principle, procedures of GA, Flow Chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional Algorithm vs Genetic Algorithm, Simple GA, General Genetic Algorithm, Classification of Genetic Algorithm, Applications & Advances in GA, Differences & similarities between GA & other Traditional Method

**Unit V Hybrid Soft Computing Techniques & Applications (9)**

Neuro-Fuzzy Hybrid Systems - Genetic Neuro Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP - Applications: A fusion approach of multispectral images with SAR, Optimization of Traveling Salesman Problem using Genetic Algorithm Approach, GA Based Internet Search Technique; Soft Computing Based Hybrid Fuzzy Controllers.

**Course Outcomes:**

**After successful completion of the course, the students will be able to**

1. Have a general understanding of soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy, genetic algorithms & hybrid soft computing techniques
2. Gain knowledge of soft computing domain which opens up a whole new career option
3. Tackle problems of interdisciplinary nature

**Text Books:**

1. J.S.R. Jang, C.T. Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
2. S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.
3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India, 3rd Edition

**Reference Books:**

1. S. Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
2. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.
3. David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.
4. James A. Freeman, David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Education India, 1991.
5. Simon Haykin, “Neural Networks Comprehensive Foundation” Second Edition, Pearson Education, 2005.

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| **Course Code** | **Course Title** | **Category** |
| **17BTEC821** | **Project Phase II** | **DCC** |
| **Contact Hours per Week** | **CA** | **FE** | **Credits** |
| **L** | **T** | **D/P** |
| **0** | **0** | **20** | **100** | **200** | **10** |
| **Course Objectives:**1. To study application specific implementation aspects.
2. To study system integration facets. E.g. wire harnessing etc.
3. To study functionality verification method—test set generation and verification parameters. e.g. reliability test etc.
4. To study presentation aspects of the work.
 |
| **Project Phase-II (Implementation & Verification) stages**1. Simulation results
2. PCB design and drawing of the layout
3. PCB fabrication
4. Component mounting, testing and board debugging
5. Chassis mounting, cabinet fitting, encasing design
6. Experimentation and results
7. Functional verification
8. Performance evaluation

**Documentation**1. Project Diary (Every Project group)
2. Synopsis
3. Interfacing diagrams, rough calculation notebook
4. Reviewed papers, data sheets of microcontroller and other components and sensors
5. PCB layout design blueprint
6. Encasing and wire harnessing layout
7. Heat sink and power calculations
8. Project report (prescribed in the project diary)-Hard bound (plagiarism check)
9. Sponsoring agency completion letter (if required)
10. Publications/patent – documents (plagiarism check)
11. Continuous assessment sheet
12. Presentation, Report soft copy, functionality video, source codes and passwords submission in a CD

**Student participation in various project competitions/ conferences/ Hackathon /Techfest etc.****Final project assessment by panel members after demonstration and presentation by a project group.****Course Outcomes:****On successful completion of the course students will be able to:**1. Select components/packages/boards specific to the application and design a board for the required performance considering signal integrity issues.
2. Get know-how about wire harnessing, chassis fitting, cabinet fitting, knobs and display mounting and heat sink calculations if required.
3. Realize testing and verification techniques.
4. Develop technical writing and presentation skills of the work pertaining to intellectual property rights (if required).
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