Savitribai Phule Pune University
Faculty of Science & Technology

B.E. (Electronics & Telecommunication) (2015 Pattern) Syllabus
(With effect from Academic Year 2018-19)
## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course</th>
<th>Teaching Scheme Hours / Week</th>
<th>Semester Examination Scheme of Marks</th>
<th>Credits</th>
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<td>404181</td>
<td>VLSI Design &amp; Technology</td>
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<tr>
<td>404182</td>
<td>Computer Networks &amp; Security</td>
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<td>404183</td>
<td>Radiation &amp; Microwave Techniques</td>
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<td>404184</td>
<td>Elective I</td>
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<td>Elective II</td>
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<tr>
<td>404186</td>
<td>Lab Practice -I (CNS + RMT)</td>
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<td>Lab Practice -II (VLSI + Elective I)</td>
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Total Credits 22

### Elective I
1. Digital Image and Video Processing
2. Industrial Drives and Control
3. Embedded Systems & RTOS
4. Internet of Things

### Elective II
1. Wavelets
2. Electronics Product Design
3. Optimization Techniques
4. Artificial Intelligence
5. Electronics in agriculture

### Audit Course 5
1. Green Energy
2. Human Behaviour
### Final Year E&TC Engineering (2015 Course)
(With effect from Academic Year 2018-19)

#### Semester II

<table>
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<tr>
<th>Course Code</th>
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<th>Teaching Scheme Hours / Week</th>
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**Total Credits** 22

#### Elective III
1. Machine Learning
2. PLC's and Automation
3. Audio and Speech Processing
4. Software Defined Radio
5. Audio Video Engineering

#### Elective-IV
1. Robotics
2. Biomedical Electronics
3. Wireless Sensor Networks
4. Renewable Energy Systems
5. Open Elective*

#### Audit Course 6
1. Team Building, Leadership and Fitness
2. Environmental issues and Disaster Management
Any one course from the list of Elective IV of computer/IT/Electrical/Instrumentation or Institute can offer elective IV based on any industry need with prior approval from BoS(Electronics & Telecommunication). Repetition of course or topics should be avoided.

<table>
<thead>
<tr>
<th>404181</th>
<th>VLSI Design &amp; Technology</th>
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<td>Credits: 03</td>
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<td>Lecture: 03 Hr/Week</td>
<td>In-Sem: 30 Marks</td>
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<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- To explore HDL and related design approach.
- To nurture students with CMOS circuit designs.
- To realize importance of testability in logic circuit design.
- To overview ASIC issues and understand PLD architectures with advanced features.

**Course Outcomes:**
On completion of the course, student will be able to
1. Write effective HDL coding for digital design.
2. Apply knowledge of real time issues in digital design.
3. Model digital circuit with HDL, simulate, synthesis and prototype in PLDs.
4. Design CMOS circuits for specified applications.
5. Analyze various issues and constraints in design of an ASIC
6. Apply knowledge of testability in design and build self test circuit.

**Unit I: HDL Design**
Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modeling of Combinational, Sequential circuits and FSM. Simulations, Synthesis, Efficient coding styles, Hierarchical and flat designs, Partitioning for synthesis, Pipelining, Resource sharing.

**Unit II: Digital design and Issues**
Sequential synchronous machine design, Moore and Mealy machines, HDL code for Machines, FIFO. Metastability and solutions, Noise margin, Fan-out, Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Supply and ground bounce, Power distribution techniques, Power optimization, Interconnect routing techniques; Wire parasitic, Signal integrity issues. I/O architecture.

**Unit III: PLD Architectures and applications**

**Unit IV: Digital CMOS circuits**
N-MOS, P-MOS and CMOS, MOSFET parasitic, Technology scaling, Channel length modulation, Hot electron effect, Velocity saturation, CMOS Inverter, Device sizing, CMOS combinational logic design, Power dissipations, Power delay product, Body Effect, Rise and fall times, Latch Up effect, transmission gates.
**Unit V: Application Specific Integrated Circuit**  
7 Hrs  

**Unit VI: VLSI Testing and Analysis**  
6 Hrs  
Types of fault, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation, Sequential circuit test, Built-in Self Test, JTAG & Boundary scan, TAP Controller.

**Text Books:**
1. Charles H. Roth, “Digital systems design using VHDL”, PWS.

**Reference Books:**

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**404182 Computer Networks & Security**  
Credits: 04

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<td>Lecture: 04 Hrs/Week</td>
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<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- To understand state-of-the-art in network protocols, architectures, and applications
- To provide students with a theoretical and practical base in computer networks issues
- To outline the basic network configurations
- To understand the transmission methods underlying LAN and WAN technologies.
- To understand security issues involved in LAN and Internet.
Course Outcomes:
On completion of the course, student will be able to
1. Understand fundamental underlying principles of computer networking
2. Describe and analyze the hardware, software, components of a network and 
   their interrelations.
3. Analyze the requirements for a given organizational structure and select the most 
   appropriate networking architecture and technologies
4. Have a basic knowledge of installing and configuring networking applications.
5. Specify and identify deficiencies in existing protocols, and then go onto select new and 
   better protocols.
6. Have a basic knowledge of the use of cryptography and network security.

Unit I: Introduction to Local Area Networks 6 Hrs
TCP/IP Protocol Suit, Media Access Control: Random Access, Controlled Access - Reservation, 
Channelization. Wired LAN: Ethernet Protocol, Standard Ethernet, Fast Ethernet (100 MBPS), 
Gigabit Ethernet, 10 Gigabit Ethernet. Wireless LAN: Introduction, IEEE 802.11 Project, Bluetooth

Unit II: Network Layer Part I 7 Hrs
Introduction to Network Layer: Network Layer Services, Packet Switching, Network-Layer 
Performance, IPv4 Addresses, Forwarding Of IPPackets, Network Layer Protocols: Internet Protocol 
(IP), ICMPv4, Mobile IP

Unit III: Network Layer Part II 6 Hrs
Unicast and Multicast Routing: Introduction, Routing Algorithms, Unicast Routing Protocols, 
Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast 
Transition From IPv4 to IPv6.

Unit IV: Transport Layer 6 Hrs
Introduction to Transport Layer: Introduction, Transport-Layer Protocols, Transport Layer 

Unit V: Application Layer 7 Hrs
Introduction to Application Layer, Standard Client Server Protocols: World Wide Web and HTTP, 
FTP, Electronic Mail, Telenet, SSH, DNS. Network Management: Introduction, SNMP.

Unit VI: Network Security 7 Hrs
Cryptography & Network Security: Introduction Confidentiality, Other Aspects Of Security, 
Firewalls.

Text Books:
   Education.

Reference Books:
2. Wayne Tomasi, “Introduction to Data Communication and Networking”, 1/e, Pearson Education

404183 Radiation and Microwave Techniques
Credits: 03
Teaching Scheme: |

Examination Scheme:
### Course Objectives:
- To introduce fundamental theory of radiation and microwaves.
- To understand design principles of various radiating elements.
- To understand theory of passive and active components of microwave systems.
- To learn microwave measurement techniques.

### Course Outcomes:
On completion of the course, student will be able to
1. Differentiate various performance parameters of radiating elements.
2. Analyze various radiating elements and arrays.
3. Apply the knowledge of waveguide fundamentals in design of transmission lines.
4. Design and set up a system consisting of various passive microwave components.
5. Analyze tube based and solid state active devices along with their applications.
6. Measure various performance parameters of microwave components.

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<thead>
<tr>
<th>Unit I: Fundamental Theory of Radiation and Radiating Elements</th>
<th>8Hrs</th>
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<tbody>
<tr>
<td>Fundamental equations for free space propagation, Friis transmission equation, Definition of antenna, radiation mechanism and types of antenna, performance parameters such as radiation pattern, directivity, gain, efficiency, half power beam width, bandwidth, polarization, input impedance, radiation efficiency, effective length, effective area, radiation sphere.</td>
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<tr>
<th>Unit II: Radiating elements and arrays</th>
<th>7 Hrs</th>
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<tbody>
<tr>
<td>Comparison of various radiating elements such as infinitesimal dipole, small dipole, finite length dipole and half wave length dipole, analytical treatment of these elements. Planar, log periodic and YagiUda antenna. Types of arrays, two element array, N-element array, uniform amplitude uniformly spaced linear broad side and end-fire array.</td>
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<tr>
<th>Unit III: Transmission lines and Waveguides</th>
<th>6Hrs</th>
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<tr>
<th>Unit IV: Passive Microwave Components</th>
<th>6Hrs</th>
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<tr>
<td>Construction, working principle and scattering analysis of passive microwave components such as E-plane, H-plane and magic tee. Ferrite composition, characteristics and Faraday rotation principle. Construction, working principle and scattering analysis of isolator, circulator and directional coupler. Construction and operation of gyrator.</td>
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<tr>
<th>Unit V: Active Microwave Components</th>
<th>6Hrs</th>
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<tr>
<td>Limitations of conventional tubes, O and M type classification of microwave tubes, re-entrant cavity, velocity modulation. Construction, operation, performance analysis and applications of -Single cavity and two cavity klystron, Cylindrical wave magnetron and Helix traveling wave. Construction, working principle and applications of two terminal microwave devices such as tunnel diode, Gunn Diode, PIN Diode, Schottky Barrier Diode and Varactor.</td>
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<tr>
<th>Unit VI: Microwave Systems and Microwave Measurement Techniques</th>
<th>6Hrs</th>
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<tr>
<td>Microwave terrestrial and satellite communication system and industrial applications of microwaves such as microwave heating, thickness and moisture measurement, medical application such as microwave diathermy. Microwave measurement devices such as slotted line, tunable detector, VSWR meter, power meter, and their working principles. Microwave measurement techniques to measure S-parameters, frequency, power, attenuation, phase shift, VSWR, impedance. Radiation hazards and protection.</td>
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<td>Text Books:</td>
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<th>Reference Books:</th>
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404184 Digital Image and Video Processing (Elective - I)

Credits: 03

Teaching Scheme: 03 Hr/Week

Course Objectives:
- Understand the fundamental concepts of Digital Image Processing with basic relationship of pixels and mathematical operations on 2-D data.
- Learn design and integrate image enhancement and image restoration techniques.
- Understand object segmentation and image analysis techniques.
- Learn the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques.
- Learn basic concepts of video processing.

Course Outcomes:
On completion of the course, student will be able to
1. Develop and implement basic mathematical operations on digital images.
2. Analyze and solve image enhancement and image restoration problems.
3. Identify and design image processing techniques for object segmentation and recognition.
4. Represent objects and region of the image with appropriate method.
5. Apply 2-D data compression techniques for digital images.

Unit I: Fundamentals of Image Processing 5 Hrs
Steps in Image processing, Human visual system, Sampling & quantization, Representing digital images, spatial and gray level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Basic operations on images – image addition, subtraction, logical operations, scaling translation, rotation. Color fundamentals and models – RGB, HIS, YIQ

Unit II: Image Enhancement and Restoration 8 Hrs
Point – Log transformation, Power law transformation, Piecewise linear transformation, Image histogram, histogram equalization, Mask processing of images, filtering operations- Image smoothing, image sharpening, frequency domains image enhancement: 2D DFT, smoothing and sharpening in frequency domain, Pseudo coloring. Image Restoration: Noise models, restoration using Inverse filtering and Wiener filtering

Unit III: Image Compression 6 Hrs

Unit III: Image Segmentation 8 Hrs
Pixel classification, Bi-level thresholding, Multi-level thresholding, Adaptive thresholding, Otsu’s method, Edge detection – First order derivative Prewitt and Sobel, Second order derivative – LoG, DoG, Canny. Edge linking, Hough transform, Region growing and region merging. Morphological operators: Dilation, Erosion, Opening, Closing, Hit or Miss transform, Boundary detection, Thinning, Thickening, Skelton.
<table>
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<tr>
<th>Unit V : Representation and Description 5 Hrs</th>
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<tbody>
<tr>
<td>Representation – Chain codes, Polygonal approximation, Signatures, Boundary descriptors, Shape numbers, Fourier descriptors, Stastical moments, Regional descriptors – Topological, texture, Principal components for description</td>
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<tr>
<th>Unit VI : Video Processing 6 Hrs</th>
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<tr>
<td>Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards MPEG.</td>
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<tr>
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<tbody>
<tr>
<td>2. Iain E. G. Richardson, “H.264 and MPEG</td>
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<th>404184 Industrial Drives and Control (Elective-I)</th>
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<th>Course Objectives:</th>
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<tr>
<td>• Describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology</td>
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<tr>
<td>• Study and understand the operation of electric motor drives controlled from a power electronic converter and to introduce the design concepts of controllers for closed loop operation</td>
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<tr>
<td>• Study DC, AC, special machines like stepper motor, servo motor and brushless motor and their control.</td>
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</table>
Course Outcomes:
On completion of the course, student will be able to
1. Understand the basic principles of power electronics in drives and its control, types of drives and basic requirements placed by mechanical systems on electric drives for various applications.
2. Understand the operation of 1φ & 3φ converter drives for separately excited & series DC motors, dual converter drives, 2 quadrant and 4 quadrant DC chopper drives, Open-loop & closed-loop control of DC drives with transfer function, Dynamic and regenerative braking. Protection circuits for DC drives.
3. Learn speed control of induction motor drives in an energy efficient manner using power electronics. To study and understand the operation of both classical and modern induction motor drives like FOC or Vector control.
4. Learn and understand working of various types of synchronous motors and their drive systems.
5. Learn stepper motors & drives, BLDC and SRM motors and drives.
6. Understand modern control techniques of Fuzzy logic and ANN in motor drive application.

Unit I : Motor Drive as system 5 Hrs
Electrical drive as system, Parts of Electrical drives AC / DC drives, Components, nature and classification of load torques. Four quadrant operation of a motor drive. Control of Electrical drives, steady state stability Closed loop control, Selection of motor power rating.

Unit II : DC Motors and drives 6 Hrs
Basic characteristics of DC motors, Operating modes, Motor performance parameters, 1φ & 3φ converter drives for separately excited & series DC motors for continuous & discontinuous operations. Chopper fed DC drives, Comparison of converter fed drive & chopper fed drive. Open loop & closed loop control of dc drives with transfer function PLL control, Microprocessor based control of dc drives, Dynamic and regenerative braking of DC motors.

Unit III : Induction Motors and Drives 8 Hrs
Induction motor characteristics, Control strategies like stator voltage control, v/f control, rotor resistance control, Variable frequency Square wave VSI Drives, Variable frequency PWM VSI Drives, Variable frequency CSI Drives, Closed loop control of Induction motors, v/f control of three phase IM using PWM inverter, Vector Control (Field oriented Control): Basic principle of vector control, Direct vector control & indirect vector control, DQ Transformation, Braking of induction motor, soft acceleration and deceleration, various protections.

Unit IV : AC and DC synchronous Motors and drives 6 Hrs
Cylindrical rotor motor Drive, Salient pole motor Drive, Switched reluctance motor (SRM) drive, Synchronous Reluctance motor drive, self-controlled synchronous motor drives Permanent magnet Brushless DC motor drive, Permanent magnet AC synchronous motor drive, Variable reluctance & permanent magnet stepper motor and drive. Servo motor Drives.

Unit V : Power Electronics applications in Renewable Energy 6 Hrs
Wind power system: System component, Turbine rating, Electrical load matching, fixed speed and variable speed operation, System design features, Maximum power operations and System control requirement WECS: Principle of WECS, role of power electronics in WECS, Drive selection criteria for fixed speed and variable speed WECS, Stand-alone PV systems, Grid connected PV systems. Power Electronics for Photovoltaic Power Systems Basics of Photovoltaic: The PV cell, Module and array, I-V and P-V curves, PV system component, Stand-alone PV systems, Grid connected PV systems.
### Unit VI: Artificial Intelligence in Motor Drives
5 Hrs


<table>
<thead>
<tr>
<th><strong>Text Books:</strong></th>
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<tbody>
<tr>
<td>2. Power Electronics, circuits, devices and applications by Muhammad Rashid, Pearson</td>
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<tr>
<td>2. Thyristor DC drives, P. C Sen, John Wiley.</td>
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# 404184 Embedded Systems and RTOS(Elective-I)

**Credits:** 03

<table>
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<td>Lecture : 03Hr/Week</td>
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<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- To understand and able to design an application specific systems.
- To develop implementation skill for application specific systems.
- To understand design and implementation of real time system using RTOS.
- To understand open source platform for embedded system

**Course Outcomes:**
On completion of the course, student will be able to

1. Understand design of embedded system
2. Use RTOS in embedded application
3. Use modern architecture for embedded system
4. Use Linux for embedded system development
5. Use open platform for embedded system development

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## Unit I: Embedded System Overview 6 Hrs
Embedded System Introduction, Hardware and software architectures of ES, Design metrics(technical and techno- economical), Prototyping models, Development tool chain insights(GNU), guidelines for Selection of hardware and memory architecture, embedded C programming, embedded system design challenges, standard programming practices in embedded system.

## Unit II: Real time system and RTOS 7 Hrs
Real time system, types, design approaches and considerations, Usage of Shared resources and related issues, Concept of RTOS, Types of RTOS, differences from GPOS (Multitasking, Inter-process communication, Timers, Device drivers, protection mechanism etc.), real time scheduling algorithms, commercial RTOS, survey of RTOS.

## Unit III: μcos-II –RTOS8 Hrs
μcos-II features, kernel structure, data structure, μcos-II services as task management, time management, inter-process communication (mailbox, queue, events, pipes etc.), memory management, μcos-II porting on ARM7/Cortex (M3/M4) architecture.

## Unit IV: Advanced embedded architectures (Cortex-M3/M4) 8 Hrs
Introduction to ARM CORTEX series, Design Philosophy, processors series, versions, features and applications. CMSIS standard for ARM Cortex. Survey of CORTEX M3/M4 based controllers. ARM-CM3 Based Microcontroller LPC1768: Features, Architecture (Block Diagram & its Description), System Control, Clock & Power Control, GPIO, Pin Connect Block, interfacing with RGB LED, Seven Segment, TFT Display, MOTOR control using PWM.

## Unit V: Embedded Linux 8 Hrs
Linux for embedded systems, embedded Linux development system, kernel architecture and configuration, file systems, porting Linux on ARM architecture, boot loaders, tool utilities such as Minicomp, Busybox, Redboot, Libc, Device drivers- concept, architecture, types, sample character device driver.
Unit VI: Open hardware/development systems and Case study 7 Hrs
Arduino open platform (IDE), development using ATmega328p based Uno board, structure of Arduino programs, introduction to Arduino library, sample GPIO program. Case study of implementation with control, compute and communication modules using Arduino platform.

Text Books:
3. Parag H Dave, Himanshu H. Dave, “Embedded systems” Concepts, design and programming, Pearson India

Reference Books:
2. David Simon, ”Embedded system primer”
5. MSP430x5xx: http://www.ti.com/product/msp430f5529
7. MSP430x2xx: http://www.ti.com/product/msp430g2302-ep

| 404184 Internet of Things (Elective-I) |
| Credits: 03 |
| Teaching Scheme: | Examination Scheme: |
| Lecture : 03 Hr/Week | In-Sem: 30 Marks |
| End-Sem: 70 Marks |

Course Objectives:
- To study fundamental concepts of IoT
- To understand roles of sensors in IoT
- To Learn different protocols used for IoT design
- To be familiar with data handling and analytics tools in IoT

Course Outcomes:
1. On completion of the course, student will be able to
2. Understand the various concepts, terminologies and architecture of IoT systems.
3. Use sensors and actuators for design of IoT.
4. Understand and apply various protocols for design of IoT systems.
5. Use various techniques of data storage and analytics in IoT.
6. Understand various applications of IoT.

Unit I : Fundamentals of IoT 6Hrs
Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.

Unit II : Sensors Networks 7Hrs
Definition, Types of Sensors, Types of Actuators, Examples and Working, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.
### Unit III: Wireless Technologies for IoT (6 Hrs)
WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.

### Unit IV: IP Based Protocols for IoT (6 Hrs)
IPv6, 6LowPAN, RPL, REST, AMQP, CoAP, MQTT.

### Unit V: Data Handling & Analytics (6 Hrs)
- Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Statistical Models, Analysis of Variance, Data Dispersion, Contingence and Correlation, Regression Analysis, Precision and Error limits.

### Unit VI: Applications of IoT (7 Hrs)
- Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, IoT design Ethics, IoT in Environmental Protection.

### Text Books:
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, WileyPublications

### References
4. [https://onlinecourses.nptel.ac.in/noc17_cs22/course](https://onlinecourses.nptel.ac.in/noc17_cs22/course)

### 404185  Wavelets (Elective-II)

**Credits:** 03

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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</thead>
<tbody>
<tr>
<td>Lecture : 03 Hr/Week</td>
<td>In-Sem: 30 Marks</td>
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<td></td>
<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- Learn and understand basic linear algebra
- Understand the need of time frequency resolution
- Understand the basics of Discrete Wavelet transform and various wavelets available
- Learn the signal analysis using multi-resolution analysis
- Study the applications of Wavelets in compression, enhancement, noise removal etc.
Course Outcomes:
1. On completion of the course, student will be able to
2. Explore and learn the basics of linear algebra.
3. Identify the need of Wavelet transform and its properties.
4. Analyze the 1-D and 2-D signal using discrete wavelet transform.
5. Analyze the signal using Multi resolution analysis
6. Use wavelet transform in different applications like data compression, denoising, enhancement etc.

<table>
<thead>
<tr>
<th>Unit I : Fundamentals of Linear Algebra6 Hrs</th>
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<thead>
<tr>
<th>Unit II : Introduction to Wavelet 6 Hrs</th>
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<tbody>
<tr>
<td>Concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's uncertainty principle and time frequency tiling, why wavelet transform? The origin of wavelets, Properties of Wavelet Transform, Wavelet and other wavelet like transformer, different communities and family of wavelets, different families of wavelets within wavelet communities, Continuous and discrete wavelet transform</td>
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<table>
<thead>
<tr>
<th>Unit III : Discrete Wavelet Transform 8 Hrs</th>
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<tbody>
<tr>
<td>Haar scaling function and function spaces, translation and scaling of $\varphi(t)$, function spaces $V_0$ Finer Haar Scaling Functions, concept of nested vector spaces, Haar wavelet function, scaled and translated Haar wavelet functions, orthogonality of $\varphi(t)$ and $\gamma(t)$. Normalization of Haar bases at different scales, daubechies wavelets, plotting of Daubechies wavelets. 1-D and 2-D decomposition (analysis) of signals using Wavelet.</td>
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<table>
<thead>
<tr>
<th>Unit IV : Multi-resolution Analysis 6 Hrs</th>
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<tbody>
<tr>
<td>Signal decomposition and its relation with filter banks, frequencies response, signal reconstruction course to fine scale, upsampling and filtering, QMF conditions, concepts of multi-Resolution analysis and multi-rate signal processing, Perfect matching filters, Vanishing moments of wavelet function and filter properties, introduction to wavelet lifting.</td>
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<table>
<thead>
<tr>
<th>Unit V : Wavelet Transform in Data Compression 6 Hrs</th>
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<tbody>
<tr>
<td>Transform coding, image compression using DWT, Embedded tree image coding, comparison of JPEG and JPEG 2000, Audio masking, MPEG Coding for audio, Wavelet based audio coding, video coding using Multi-resolution technique (introduction).</td>
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</table>

<table>
<thead>
<tr>
<th>Unit VI : Applications of Wavelet Transform 4 Hrs</th>
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</thead>
<tbody>
<tr>
<td>Wavelet denoising, speckle removal, Edge detection and object isolation Image fusion, wavelet watermark, image enhancement. Communication application scaling functions as signaling pulses, Discrete Wavelet Multitone modulation.</td>
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</tbody>
</table>

Text Books:

Reference Books:
# Electronic Product Design (Elective-II)

<table>
<thead>
<tr>
<th>Course</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Teaching Scheme:</td>
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<tr>
<td>Lectures: 3 Hrs./ Week</td>
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<tr>
<td>Examination Scheme:</td>
<td></td>
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<tr>
<td>In Sem: 30 Marks</td>
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<tr>
<td>End Sem: 70 Marks</td>
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</table>

**Course Objectives:**
- To understand the stages of product (hardware/software) design and development.
- To learn the different considerations of analog, digital and mixed circuit design.
- To be acquainted with methods of PCB design and different tools used for PCB Design.
- To understand the importance of testing in product design cycle.
- To understand the processes and importance of documentation.

**Course Outcomes:**
After Successfully completing the course students will be able to
- Understand various stages of hardware, software and PCB design.
- Importance of product test & test specifications.
- Special design considerations and importance of documentation.

**Unit I: Introduction to Electronic Product Design**
6 Hrs
Man machine dialog and Industrial design, user-centered design, five element of successful design, cognition, ergonomics. Packaging and factors, design for manufacture, assembly and disassembly, wiring, temperature, vibration and shock. Safety, noise, energy coupling, grounding, filtering and shielding.

**Unit II: Hardware Design & testing methods**
6 Hrs
Design process. Identifying the requirements, formulating specifications, design specifications, Specifications verses requirements, System partitioning. Functional design, architectural design, Functional model verses architectural model. 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, white box test, grey box test.

**Unit III: Software Design and Testing methods**
6 Hrs

**Unit IV: PCB design**
6 Hrs
**Unit V: Product Debugging and Testing  6 Hrs**
Steps of Debugging, Techniques for troubleshooting, characterization, Electromechanical components, passive components, active devices, operational amplifier, Analog-Digital Conversion, Digital Components, Inspection and test of components, Simulation, Prototyping and testing. Integration, validation and verification. EMI & EMC issues.

**Unit VI: Documentation  6 Hrs**

**Text Books:**

**Reference Books:**

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits: 03</th>
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<tbody>
<tr>
<td>404185</td>
<td>Artificial Intelligence (Elective II)</td>
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</table>

**Teaching Scheme:**

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<th>Lecture :</th>
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<tbody>
<tr>
<td>In-Sem : 30 Marks</td>
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<tr>
<td>End-Sem: 70 Marks</td>
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</table>

**Course Objectives:**
- To learn various types of algorithms useful in Artificial Intelligence (AI).
- To convey the ideas in AI research and programming language related to emerging technology.
- To understand the concepts of machine learning, pattern recognition, and natural language processing.
- To understand the numerous applications and huge possibilities in the field of AI that go beyond the normal human imagination.

**Course Outcomes:**
On completion of the course, student will be able to
1. Design and implement key components of intelligent agents and expert systems.
2. To apply knowledge representation techniques and problem solving strategies to common AI applications.
3. Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems.

**Unit I: Foundation 6 Hrs**
### Unit II: Searching 6 Hrs
Search and exploration, Informed search strategies, heuristic function, local search algorithms and optimistic problems, local search in continuous spaces, online search agents and unknown environments, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP, Structure of problems, Games: Optimal decisions in games, Alpha-Beta Pruning, imperfect real-time decision, games that include an element of chance.

### Unit III: Knowledge Representation 6 Hrs
First order logic, representation revisited, Syntax and semantics for first order logic, Using first order logic, Knowledge engineering in first order logic, Inference in First order logic, prepositional versus first order logic, unification and lifting, forward chaining, backward chaining, Resolution, Knowledge representation, Uncertainty and methods, Bayesian Probability and Belief network, probabilistic Reasoning, Bayesian networks, inferences in Bayesian networks, Temporal models, Hidden Markov models.

### Unit IV: Learning 6 Hrs
Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Inductive logic programming, Statistical learning methods, Learning with complete data, Learning with hidden variable, EM algorithm, Instance based learning, Neural networks - Reinforcement learning, Passive reinforcement learning, Active reinforcement learning, Generalization in reinforcement learning.

### Unit V: Pattern Recognition and Expert System 6 Hrs
Basic steps of pattern recognition system, Feature Extraction - Principal Component Analysis, Linear Discriminant Analysis, Classification, Object Recognition - Template Matching theory, Prototype Matching Theory, Speech Recognition, Pattern Mining - Apriori Algorithm,

### Unit VI: Natural Language Understanding 6 Hrs
Why NL, Formal grammar for a fragment of English, Syntactic analysis, Augmented grammars, Semantic interpretation, Ambiguity and disambiguation, Discourse understanding, Grammar induction, Probabilistic language processing, Probabilistic language models

**Text Books:**
   Reference Books

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### 404185 Optimization Techniques (Elective II)
**Credits: 03**

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<tr>
<th>Teaching Scheme:</th>
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<tbody>
<tr>
<td>Lecture : 03hr/week</td>
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<td></td>
<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- To understand the need and origin of the optimization methods.
- To get a broad picture of the various applications of optimization methods used in engineering
- To define an optimization problem and its various components.
**Course Outcomes:**
Upon completion of the course, students will be able to:
1. Describe clearly a problem, identify its parts and analyze the individual functions.
3. Design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.
4. Discover, study and solve optimization problems.
5. Investigate, study, develop, organize and promote innovative solutions for various applications.

<table>
<thead>
<tr>
<th>Unit I : Introduction to Optimization</th>
<th>6Hrs</th>
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<table>
<thead>
<tr>
<th>Unit II : Classical Optimization Techniques</th>
<th>7Hrs</th>
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<tbody>
<tr>
<td>Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem.</td>
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<tr>
<th>Unit III : Linear Programming</th>
<th>6 Hrs</th>
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<tr>
<th>Unit IV : Nonlinear Programming -I</th>
<th>7Hrs</th>
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<tbody>
<tr>
<td>Unimodal Function, Elimination Methods: Unrestricted Search, Unrestricted Search, Dichotomous Search, Interval Halving Method, Fibonacci Method. Interpolation Methods: Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods, Practical Considerations,</td>
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<tr>
<th>Unit V : Nonlinear Programming-II</th>
<th>7Hrs</th>
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<tr>
<th>Unit VI : Modern Methods of Optimization</th>
<th>6 Hrs</th>
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<tbody>
<tr>
<td>Genetic algorithms, Simulated annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy systems, Neural Network based optimization</td>
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**Text Books:**

**Reference Books:**
404185  Electronics in Agriculture    (Elective II)

Credits: 03

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<td>Lecture : 03 Hr/Week</td>
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<td>End-Sem: 70 Marks</td>
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**Course Objectives:**
- To inculcate the ability to recognize environmental problems and to provide solutions to agricultural sector.
- An overview of technology of advanced topics like DAS, SCADA and Virtual Instrumentation.
- The ability to select the essential elements and practices needed to develop and implement the Engineering Automation for Agricultural sector.

**Course Outcomes:**
After successfully completing the course students will be able to
1. Understand Role of computers & virtual instrumentation.
2. Provide communication solution for interpreting environmental parameters with Electronics systems.
3. Describe Instrument technology used in agriculture.
4. Apply knowledge of Electronics in Agriculture.
5. Understand Greenhouse Technology & Role of Electronics Governance.

**Unit I: Review of computers & Virtual instrumentation**  
6 Hrs  
Data loggers, Data acquisitions systems (DAS), Supervisory control and data acquisition (SCADA), Basics of PLC, Functional block diagram of computer control system, alarms, interrupts. Virtual Instrumentation: Historical Perspective, advantages, Block diagram and architecture of virtual instrument, data flow techniques, graphical programming in data flow, comparison with conventional programming.

**Unit II: Communication Systems**  
6 Hrs  

**Unit III: Instrument technology for agriculture**  
6 Hrs  
Instrument for measurement of pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content, and soil moisture & temperature.

**Unit IV: Precision Farming**  
6 Hrs  
<table>
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<tr>
<th>Unit V: Electronics in Agriculture</th>
<th>6 Hrs</th>
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<table>
<thead>
<tr>
<th>Unit VI: Applications &amp; Electronics Governance</th>
<th>6 Hrs</th>
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</thead>
</table>

**Text Books:**
2. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication

**Reference Books:**
# 404186 Lab Practice I

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tr>
<td>Practical: 04 Hrs/week</td>
<td>Oral: 50 Marks</td>
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<td>Term-work: 50 Marks</td>
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</table>

**Computer Networks & Security**

**List of the Experiments** *(Minimum 8 experiments are to be performed)*

1. Implementation of LAN using suitable multiuser Windows operating System and demonstrating client-server and peer to peer mode of configuration.
2. Installation and configuration of Web server, FTP Server.
3. Study of DNS, SMTP & POP3 Determine the local host address, Ping to a host using its NetBIOS name Add IP addresses/host name mappings to the local host file Configure DNS service on Windows 2000 server Use Domain Name Service to resolve hostnames into IP addresses. Interact with an Email server using SMTP and POP3 protocols commands.
4. Installation and configuration of Telnet server for Telnet communication.
5. Installation and configuration of Proxy server.
6. Installation and configuration of DHCP server.
7. Study of IP Addresses subnetting and CIDR
10. Simulating LAN or WAN using suitable network simulator.
11. Write a program to simulate leaky bucket/token bucket.
12. Echo Client and Server Program Using TCP or UDP or both in C/Java
13. Write a program for Encryption and Decryption
14. Study of HTTPS, IPSec and SSH using Wireshark.
Radiation & Microwave Techniques

List of Experiments [Minimum 08 ]

**Group A** [Any 2]
1. To measure and compare radiation pattern, return loss, impedance, gain, beam width of dipole antenna and folded dipole antenna at microwave frequency
   **OR**
2. Design, simulate and compare performance of microwave dipole antennas of length $2\lambda$, $\lambda$, $\lambda/2$ and $\lambda/4$.
3. Design, simulate and compare the performance of two element broad side and end fire uniform amplitude and uniformly spaced linear array.

**Group B** [Any 6]
4. To measure and plot mode characteristics of reflex klystron.
5. To measure VI characteristics of Gunn Diode and study of PIN modulator.
6. To measure and verify port characteristics of microwave tees (E, H, E-H or magic planes).
7. To measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
8. To measure and verify port characteristics of isolator and circulator and calculate insertion loss and isolation in dB.
9. To measure wavelength of the microwave using microwave test bench and verify with its theoretical calculations.
10. To plot standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using slotted section with probe carriage.
11. Study the network analyzer and carry out the measurements of s-parameters.

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404186 Laboratory Practice II

Credits: 02

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<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tr>
<td>Practical : 04 hr/week</td>
<td>Practical : 50 Marks</td>
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<td></td>
<td>Termwork : 50 Marks</td>
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Digital Image and Video Processing

List of Practicals
(Perform any 8 practical on appropriate software)
1. Perform basic operations on images.
2. Perform conversion between color spaces.
3. Perform histogram equalization.
4. Perform image filtering in spatial domain.
5. Perform image filtering in frequency domain.
7. Perform image compression using DCT / Wavelet transform.
8. Perform edge detection using various masks.
10. Apply morphological operators on an image.
12. Extraction of frames from video, improve the quality and convert them back to compressed video.
**Industrial Drives and Control**
(Minimum 8 experiments are to be performed):
1. DC motor control using semi/full 1-Φ /3-Φ converter. (Open loop and closed loop)
2. 4-Quadrant chopper fed reversible DC drive
3. Dual converter fed DC Drive (Single phase/ Three phase)
4. Induction motor speed control using VFD
5. Speed Control of Universal Motor.
7. BLDC Motor drive.
8. Three phase brushless generator for wind energy applications.
9. Simulation of closed loop controlled DC motor drive using PSIM/Matlab/MathCad/ open source software
10 Simulation of closed loop controlled AC motor drive using PSIM / Matlab/MathCad/ open source software

**Embedded Systems & RTOS**
Minimum 08 experiments
Any 02 Lab exercise from Sr.No 2,3,4
Any 01  Lab exercise from Sr.No 05,06

**List of Practicals:**
1. Porting of ucos-II on ARM7/Cortex controller.
2. Implementation/Verification of multitasking (minimum 03 tasks) with ucos-II on ARM7/Cortex controller.
4. Implementation of interprocess communication with ucos-II mailbox and message queue service on ARM7/Cortex controller.
5. Programming with exploring onchip ADC of Cortex /MSP430 based microcontroller.
7. Exercise on Porting of Linux on ARM board (ARM9 preferably)
8. Programming for device driver with Embedded Linux.
Case study of any compute/communication/control application on Arduino Uno board

**Internet of Things**
A Project based Learning approach will be followed for this course hence the experiments will be small projects to be built by the students.
Suggested List of the Experimental Projects(Minimum 6 are to be performed):
1. Study & Survey of various development boards for IoT.
2. Study & Survey of various IoT platforms.
3. Interfacing sensors and actuators with Arduino.
4. Build a cloud-ready temperature sensor with the Arduino Uno and the anyIoT Platform: This project shows the building of a temperature sensor.
6. IoT based Stepper Motor Control with Raspberry Pi: The combination of Raspberry Pi and IoT is an exciting one. Raspberry Pi has many general purpose I/O pins and has the ability to control different actuators like stepper motors. In this project, an internet control of stepper motor using...
Raspberry Pi computer is developed. The connectivity is divided into server side software and client side software.


8. A Simple IoT Project with the ESP8266 WiFi module: Here is a simple project with ESP8266 wifi module. This project collects the temperature and is displayed on the network.

9. Implement a RFID Based IoT Project

<table>
<thead>
<tr>
<th>404188 Project Phase-I</th>
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<td><strong>Credits:</strong> 02</td>
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<tr>
<td>Tutorial: 2 Hrs/week</td>
<td>OR :50Marks</td>
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**Note:**

1. Term work assessment is based on the project topic. It consists of Literature Survey and basic project work. The abstract of the project should be submitted before Term work assessment.
2. The report consists of the Literature Survey, basic project work and the size of the report should be maximum of 40 pages.
3. The examination is conducted by two examiners (internal and external) appointed by the university. The examiners appointed must have minimum 5 years of experience with UG qualification or 2 years with PG qualification.
4. The assessment is based on Innovative Idea, Depth of understanding, Applications, Individual contributions, presentation, and the grade given by the internal guide based on the work carried out in a semester.
5. A log book of Work carried out during the semester will be maintained with monthly review remarks by the guide and HoD.
6. A certified copy of report is required to be presented to external examiner at the time of final examination.

**Audit Course 5 (1): Green Energy**

**About the course**

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The students will explore society’s present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized.

**Course Objectives:**

- To understand the conventional and non-conventional energy sources
- To understand different renewable energy sources and their generation
- To understand the various applications & benefits of renewable energy sources
- To enable student to understand project management, energy audit and Installation
Course Outcomes:
After the successful completion of this course, the student is expected to have/be able to:
1. List and generally explain the main sources of energy and their primary applications in the India, and the world.
2. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
3. Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.
4. List and describe the primary renewable energy resources and technologies.
5. Describe/illustrate basic electrical concepts and system components.
6. Convert units of energy—to quantify energy demands and make comparisons among energy uses, resources, and technologies.
7. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Unit 1: Introduction of conventional & renewable energy sources:
Environment aspects, Energy Efficient materials, Pollution Control techniques, Energy conservation, Energy Audits

Unit II: Details of renewable energy sources & various systems
Solar, Wind, Hydro, Bio-power, Waste to Power

Unit III: Various applications & benefits

Unit IV: Project management
Installation & commissioning techniques & standards, Remote monitoring & control techniques, Performance optimization & control, Practical’s / Hands-on exposure, Maintenance & Service of plants, Government policies

Guidelines for Conduction (Any one or more of following but not limited to)
- Guest Lectures
- Group Activities
- Assignments
- Taking up small project for short duration

Guidelines for Assessment (Any one or more of following but not limited to)
- Practical Test
- Presentation
- Paper / (Theory assessment test)
- Report

Sources/ References:
# Audit Course 5 (2): Human Behavior

## About the Course:

Human behavior is the responses of individuals or groups of humans to internal and external stimuli. It refers to the array of every physical action and observable emotion associated with individuals, as well as the human race. Social behavior is a subset of human behavior and includes the study of considerable influence of social interaction and culture. Additional influences include ethics, encircling, authority, rapport, hypnosis, persuasion and coercion.

The behavior of humans falls within a range with some behavior being common, some unusual, some acceptable, and some beyond acceptable limits. The acceptability of behavior depends heavily upon social norms and is regulated by various means of social control. Human behavior is experienced throughout an individual’s entire lifetime. It includes the way they act based on different factors such as genetics, social norms, core faith, and attitude. An attitude is an expression of favor or disfavor toward a person, place, thing, or event.

## Course Objectives:

- To develop understanding of Behavioral Aspects.
- To identify and develop Attitude and Core Faith values
- To expose students to Family Relations, time and career management
- To enable student to understand Creative Thinking and Problem solving
- To enable students to understand Humanistic Education.

## Course Outcomes:

On completion of the course, society will observe –

1. Change in awareness levels, knowledge and understanding of student
2. Change in attitudes / behavior of students with regards to their education improved teamwork, institutional leadership and other life skills
3. Improvement in social health and attitude.

## Unit 1:

Why Human Relations are so important? Understanding Behavior, Human Relations, and Performance, Personality, Stress, Learning, and Perception, Attitudes, Self-Concept, Natural acceptance of human values, and Ethics, Dealing with Conflict, Leading and Trust.

## Unit 2:

Time and Career Management, Interpersonal Communication, Organizational Structure and Communication, Team Dynamics and Leadership, Teams and Creative Problem Solving and Decision Making

## Unit 3:

Understanding Harmony in the Family and Society, Harmony in Human Relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman; Difference between respect and differentiation. Understanding the harmony in the society: Samadhan, Samridhi, Abhay, Sahasitvaas comprehensive Human Goals.

## Unit 4:

Justice in Humankind, Nurturing and Exploitation, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics.
Reference Books:
# Semester-II

## 404189 Mobile Communication

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
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<tbody>
<tr>
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<td>In-Sem : 30 Marks</td>
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<td>End-Sem : 70 Marks</td>
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</table>

### Course Objectives
- To understand switching techniques for voice and data traffic.
- To nurture students with knowledge of traffic engineering to design networks.
- To realize importance of cellular concepts and its propagation mechanism.
- To understand architecture of GSM system.
- To overview 4G LTE and 5G technologies.

### Course Outcomes
On completion of the course, student will be able to
1. Apply the concepts of switching technique and traffic engineering to design multistage networks.
2. Explore the architecture of GSM.
3. Differentiate thoroughly the generations of mobile technologies.

### Unit I - Switching techniques for Voice and Data


Switching techniques for Data: Circuit switching, Message Switching and packet Switching in perceptive with mobile communication.

### Unit II - Traffic Engineering and Signalling


Signaling: Customer line signaling, FDM carrier systems, PCM signaling, Inter-register signaling, Common channel signaling, CCITT signaling system and Digital customer line signaling.

### Unit III - Cellular Concept

Introduction to cellular telephone system, Cellular concept : Expansion of mobile system capacity through frequency reuse, Cell geometry, Selection of cluster size, Cell splitting and sectoring, Coverage and capacity in cellular system and Handoff strategies.

**Propagation Mechanism**: Free space and two ray propagation model, Basic propagation mechanism. Hata outdoor propagation model. **Small Scale Fading and Multipath**: Types of Small scale fading, Small scale multipath propagation, Impulse response model of multipath channel and Small scale multipath measurements.

### Unit IV - GSM Fundamentals

Unit V - GSM Channels and Services  
8Hrs  
Traffic and Logical Channels in GSM, GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover mechanism in GSM, Security in GSM.  
Data transmission in GSM: Data Services, SMS, HSCSD, GPRS, EDGE.  
Multiple Access Techniques- TDMA, CDMA and OFDMA.

Unit VI - Evolution of Mobile Technologies  
6Hrs  
Evolution of Mobile Generation and its comparison(GSM & CDMA)  
Overview of LTE : LTE basics, LTE frame structure, LTE Design parameters with Standardization and Architecture of LTE.  
Overview of 5G Networks : Comparison of 4G and 5G technology, Opportunities and requirements in 5G network, Open Wireless Architecture of 5G network and Disruptive technologies for 5G.

Text Books  
1. Thiagarajan Vishwanathan, “Telecommunication Switching Systems and Networks”; PHI Publications  

Reference Books  
2. J. E. Flood, “Telecommunications Switching, Traffic and Networks”, Pearson Education  

**404190 Broadband Communication Systems**  
Credits: 04

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Lecture : 04 hr/week</td>
<td>In-Sem : 30 Marks</td>
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<td>End-Sem : 70 Marks</td>
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Course Objectives:  
• To comprehend the three primary components of a fiber optic communication system.  
• To understand the system design issues and the role of WDM components in advanced light wave systems.  
• To understand the basics of orbital mechanics and the look angles from ground stations to the satellite.  
• To apply subject understanding in Link Design.

Course Outcomes:  
After successfully completing the course students will be able to:  
1. Perform Link power budget and Rise Time Budget by proper selection of components and check its viability.  
2. Perform Satellite Link design for Up Link and Down Link.
## UNIT I: Light wave System Components  
**8Hrs**  
Key Elements of optical fiber system, Optical fibers as a communication channel: Optical fiber modes and configurations, Mode theory for Circular waveguides, Single mode fibers, Graded index fiber structure, Signal degradation in optical fibers. Optical sources: Basic concepts and characteristics of LEDs and LASERs. Photo detectors: Basic concepts, Common photo detectors.

## UNIT II: Light wave Systems  
**6 Hrs**  
System architectures, Point to point links: System considerations, Design guidelines: Optical power budget, Rise time budget, Long - Haul systems.

## UNIT III: Multichannel Systems  
**6 Hrs**  
Overview of WDM, WDM Components: 2 x 2 Fiber coupler, Optical isolators and circulators, Multiplexers and De-multiplexers, Fiber Bragg Grating, FBG applications for multiplexing and de-multiplexing function, Diffraction gratings, Overview of optical amplifiers: SOA, EDFA and RFA in brief.

## UNIT IV: Orbital Mechanics and Launchers  
**8 Hrs**  
History of Satellite communication, Orbital mechanics, Look angle determination, Orbital perturbations, Orbital determination, Launchers and launch vehicles, Orbital effects in communication system performance.

## UNIT V: Satellite sub systems  
**6 Hrs**  

## UNIT VI: Satellite communication link design  
**8Hrs**  
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.

### Text Books:

### Reference Books:

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### 404191 Machine Learning (Elective III)  
**Credits: 03**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Lecture : 03 Hr/week</td>
<td>In-Sem : 30 Marks</td>
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<td>End-Sem: 70 Marks</td>
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### Course Objectives:
- Explore supervised and unsupervised learning paradigms of machine learning used for regression and classification.
- To design and analyze various machine learning algorithms using neural networks
- To explore Deep learning technique and various feature extraction strategies.
**Course Outcomes:**
On completion of the course, student will be able to
1. To compare and contrast pros and cons of various machine learning techniques and to get an in sight of when to apply a particular machine learning approach.
2. To mathematically analyze various machine learning approaches and paradigms.
3. To implement convolution neural networks in recognition applications.

<table>
<thead>
<tr>
<th>Unit I : Introduction to Machine Learning</th>
<th>4 Hrs</th>
</tr>
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<tbody>
<tr>
<td>Why Machine learning, Types of machine learning, basic concepts in machine learning like parametric and non-parametric modeling, linear and nonlinear regression, overfitting and dimensionality reduction. Decision trees, Feature reduction.</td>
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</table>

<table>
<thead>
<tr>
<th>Unit II : Models for Regression and Classification</th>
<th>8 Hrs</th>
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</thead>
<tbody>
<tr>
<td>Linear Models for Regression : Least Squares and Nearest Neighbors, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison Linear Models for Classification : Discriminant Functions, Probabilistic Discriminative Models, Multivariate Data, Parameter Estimation, Multivariate Classification, Multivariate Regression Kernal Methods : Support Vector machines and Relevance Vector Machines</td>
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<tr>
<th>Unit III : Clustering</th>
<th>6 Hrs</th>
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<tbody>
<tr>
<td>Dimensionality Reduction : Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Clustering : k-Means Clustering, Mixtures of Gaussians.</td>
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<thead>
<tr>
<th>Unit IV : Artificial Neural Networks I</th>
<th>6 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological neuron, Artificial neuron model, concept of bias and threshold, Activation functions, McCulloch-Pits Neuron Model, learning paradigms, concept of error energy, gradient descent algorithm and application of linear neuron for linear regression, Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations.</td>
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<table>
<thead>
<tr>
<th>Unit V : Artificial Neural Networks II</th>
<th>6 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multilayer perceptron (MLP) and back propagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps, Learning vector quantization, Radial Basis Function networks.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit VI : Deep Learning and Convolution Neural Networks</th>
<th>6 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement of the Deep Neural Network: Vanishing Gradient, Overfitting, Computational Load, ReLU Function, Dropout Architecture of ConvNet, Convolution Layer, Pooling Layer, Applications of CNN’s.</td>
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</table>

**Text Books:**

**Reference Books:**
404191 PLC & Automation (Elective III)

Credits: 03

Teaching Scheme:

<table>
<thead>
<tr>
<th>Lecture: 03hr/week</th>
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<td>In-Sem: 30 Marks</td>
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<td>End-Sem: 70 Marks</td>
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</table>

Course Objectives:
- Student will get the ability to recognize industrial control problems suitable for PLC control
- The learners will get an overview of technology of advanced topics such as SCADA, DCS Systems, Digital Controller, CNC Machines.
- Student will gain the ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC approach.

Course Outcomes:
On successful completion of the course, students able to:
1. Understand PLC architecture
2. Develop PLC ladder programs for simple industrial applications
3. Design Automation systems for industrial applications
4. Implement the Engineering Automation using PLC approach.

Unit I: Process Control & Automation 6Hrs

Unit II: Transmitters and Signal Conditioning 6Hrs
Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for RTD, Thermocouple, DPT etc., Smart and Intelligent transmitters.

Unit III: Controllers and Actuators 6Hrs
PID Controller, Cascade PID control, Microprocessor Based control, PAC (Programmable automation controller), Mechanical switches, Solid state switches, Electrical actuators: Solenoids, Relays and Contactors, AC Motor, VFD, energy conservation schemes through VFD, DC Motor, BLDC Motor, Stepper Motor, Servo Motor, Pneumatic and hydraulic actuators.

Unit – IV Introduction to PLC 6Hrs
PLC: Characteristics, Operation, function, Types of PLC, Architecture Of PLC, Applications of PLC, PC v/s PLC, PLC programming, 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.

Unit – V Industrial Automation 6 Hrs
Basic Concept, History and Hierarchy of DCS, Functions of each level, Advantages and Disadvantages, Architecture of SCADA, MTU- functions of MTU, RTU- Functions of RTU, Working of SCADA, Comparison, suitability of PLC, DCS and SCADA, Applications: Thermal power plant, Irrigation and Cement factory.
Unit VI: Automation and CNC (Computer Numeric Control) Machines  7 Hrs

Text Books:

Reference Books:
1. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication.

404191 Audio and Speech Processing (Elective III)
Credits: 03

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<th>Teaching Scheme</th>
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<td>End-Sem: 70 Marks</td>
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Course Objectives:
- To understand basics of speech production and perception mechanism.
- To understand classification of speech sounds based on acoustic and articulatory phonetics.
- To understand the motivation of short-term analysis of speech and audio.
- To understand various audio and speech coding techniques.
- To perform the analysis of speech signal using LPC.
- To extract the information of the speech or audio signals in terms of cepstral features.
- To provide a foundation for developing applications in the field of speech and audio processing.

Course Outcomes:
On completion of the course, student will be able to
1. Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
2. Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
3. Analyze speech signal for extracting LPC and MFCC Parameters of speech signal.
4. Apply the knowledge of speech and audio signal analysis to build speech processing applications like speech coding, speech recognition, speech enhancement and speaker recognition/verification.
<table>
<thead>
<tr>
<th>Unit I: Fundamentals of speech production</th>
<th>6 Hrs</th>
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</thead>
<tbody>
<tr>
<td>Anatomy and physiology of speech production, Human speech production mechanism, LTI model for speech production, Nature of speech signal, linear time varying model, articulators, articulatory phonetics, manner of articulation, place of articulation, acoustic phonetics, spectrogram, classification of speech sounds: vowels, semivowels, nasal diphthongs, stops, affricates, fricative, vowel triangle.</td>
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<table>
<thead>
<tr>
<th>Unit II: Human auditory system and speech perception</th>
<th>6 Hrs</th>
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<tbody>
<tr>
<td>Anatomy and physiology of the ear, outer ear, middle ear and inner ear. Human auditory system, simplified model of cochlea. Sound perception, Auditory psychophysics, thresholds, just noticeable differences (JNDs), Sound pressure level and loudness. Sound intensity and Decibel sound levels. Pitch perception, masking, Concept of critical band and introduction to auditory system as a filter bank, Uniform, non-uniform filter bank, mel scale and bark scale. Speech perception: vowel perception. Coarticulation effects. Consonant perception, perception of manner of articulation feature. Perception of place of articulation.</td>
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| Unit III: Time and frequency domain methods for speech and audio signal analysis | 6Hrs |
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### Reference Books:

2. ShailaApte, “Speech and audio processing”, Wiley India Publication

### 404191 Software Defined Radio (Elective III)

**Credits: 03**

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<th>Teaching Scheme:</th>
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<td>End-Sem: 70 Marks</td>
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**Course Objectives:**

- To understand “Modern Radio Communication System “ that can be reconfigured
- To understand GNU Radio
- To understand how SDR platform provides easy access to wireless network system
- To understand how unlike simulation in Communication Projects, SDR allows easy access to both PHY and MAC layer
- To understand the concept of Cognitive Radio and Spectrum sharing

**Course Outcomes:**

On completion of the course, student will be able to

1. Compare SDR with traditional Hardware Radio HDR.
2. Implement modern wireless system based on OFDM, MIMO & Smart Antenna.
3. Build experiment with real wireless waveform and applications, accessing both PHY and MAC, Compare SDR versus MATLAB and Hardware Radio
4. Work on open projects and explore their capability to build their own communication System.

**Unit I: Introduction to SDR and RF Implementation**

**6Hrs**

Introduction to SDR, Need of SDR, Principles of SDR, Radio and SDR, SDR characteristics, required hardware specifications, Software/Hardware platform, GNU radio - What is GNU radio, GNU Radio Architecture, Hardware Block of GNU, GNU software, MATLAB in SDR, Radio Frequency Implementation issues, Purpose of RF front End, Dynamic Range, RF receiver Front End topologies, Flexibility of RF chain with software radio, Duplexer, Diplexer, RF filter, LNA, Image reject filters, IF filters, RF Mixers Local Oscillator, AGC, Transmitter Architecture and their issues, Sampling theorem in ADC, Noise and distortion in RF chain, Pre-distortion

**Unit II: SDR Architecture**

**7Hrs**

<table>
<thead>
<tr>
<th>Unit III : Multi Rate Signal Processing</th>
<th>6Hrs</th>
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<tbody>
<tr>
<td>Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi Rate, Multi Rate DSP, Multi Rate Algorithm, DSP techniques in SDR, OFDM in SDR</td>
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<thead>
<tr>
<th>Unit IV : Smart/MIMO Antennas using Software Radio</th>
<th>6Hrs</th>
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<tbody>
<tr>
<td>Smart Antenna Architecture, Vector Channel Modeling, Benefits of Smart Antenna Phased Antenna Array Theory, Adaptive Arrays, DOA Arrays, Applying Software Radio Principles to Antenna Systems, Beam forming for systems-Multiple Fixed Beam Antenna Array, Fully Adaptive Array, Relative Benefits and Trade-offs OF Switched Beam and Adaptive Array, Smart Antenna Algorithms, Hardware Implementation of Smart Antennas, MIMO -frequency, time, sample Synchronization, Space time block coding-Space Time Filtering, Space Time Trellis Coding</td>
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<tr>
<td>Case Study : Principles of MIMO-OFDM</td>
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<tr>
<th>Unit : Cognitive Radio</th>
<th>6Hrs</th>
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<tr>
<th>Unit VI : Applications of SDR</th>
<th>7Hrs</th>
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<tbody>
<tr>
<td>Case Study : 1)CR for Public Safety –PSCR, Modes of PSCR, Architecture of PSCR</td>
<td></td>
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<tr>
<td>2)Beagle board based SDR 3)Embedded PCSR using GNU radio</td>
<td></td>
</tr>
</tbody>
</table>

**Text Books:**

**Reference Books:**
2. Dr.Taj Struman, Evaluation of SDR –Main Document
# 404191 Audio Video Engineering (Elective III)

**Credits:** 03

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<td>End-Sem: 70 Marks</td>
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## Course Objectives:
- After learning AVE course, students will get benefit to learn and understand the working of real life video system and the different elements of video system plus the encoding/decoding techniques.
- The learners will be groomed up to understand different channel allocations, difference between various systems present in this world, their transmission and reception techniques.
- Students will get insight on functioning of individual blocks, different standards of compression techniques and they will be acquainted with different types of analog, digital TV and HDTV systems.
- The students will get overview of fundamentals of Audio systems and basics of Acoustics.

## Course Outcomes:
On successful completion of the course, students able to:
1. Apply the fundamentals of Analog Television and Colour Television standards.
2. Explain the fundamentals of Digital Television, DTV standards and parameters.
3. Study and understand various HDTV standards and Digital TV broadcasting systems and acquainted with different types of analog, digital TV and HDTV systems.
4. Understand acoustic fundamentals and various acoustic systems.

## Unit I: Fundamentals of Colour Television  8Hrs
The basic Television system and scanning principles, Composite video signal and television standards, Color TV systems, fundamentals, mixing of colours, colour perception, chromaticity diagram. NTSC, PAL, SECAM systems, colour TV transmitter, (high level, low level), colour TV receivers.

## Unit II: Digital TV and Display Devices  6Hrs

## Unit III: HDTV  6Hrs
HDTV standards and systems, HDTV transmitter and receiver/encoder, Digital TV satellite Systems, video on demand, CCTV, CATV, direct to home TV, set top box with recording facility, conditional access system (CAS), 3D TV systems, HD video cameras, Digital broadcasting, case study (Cricket match, Marathon, Football match).

## Unit IV: Advanced TV Systems  6Hrs
IP Audio and Video, IPTV systems, Mobile TV, Video transmission in 3G/4G mobile System, Digital Video Recorders, Wi-Fi Audio / Video Transmitter and Receivers.

## Unit V: Fundamentals of Audio-Video Recording  8Hrs
Methods of sound recording & reproduction, optical recording, CD recording, audio standards. Digital Sound Recording, CD/ DVD player, MP3 player, Blue Ray DVD Players, MP3 Player.
### Unit VI: Fundamentals of Acoustics  
**6 Hrs**  
Studio acoustics & reverberation, P.A. system for auditorium, acoustic chambers, Cordless microphone system, special types of speakers & microphones, Digital Radio Receiver Satellite radio reception.  

#### Text Books  
2. R. R. Gulati, “Monochrome and colour television”  

#### Reference Books  
5. Audio Video Systems, R.G. Gupta, TMH Publication

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### 404192 ROBOTICS (Elective-IV)  
**Credits: 03**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tr>
<td>Lecture : 03Hr/Week</td>
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<td>End-Sem: 70 Marks</td>
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</table>

#### Course Objectives:  
- To understand the history, concept development and key components of robotics technologies.  
- To understand basic mathematics manipulations of spatial coordinate representation and transformation.  
- Able to solve basic robot forward and inverse kinematic problems  
- To understand and able to solve basic robotic dynamics, path planning and control problems

#### Course Outcomes:  
On completion of the course, student will be able to  
1. Familiar with the history, concept development and key components of robotics technologies.  
2. Implement basic mathematics manipulations of spatial coordinate representation and transformation.  
3. Solve basic robot forward and inverse kinematic problems  
4. Understand and able to solve basic robotic dynamics, path planning and control problems

---

### Unit I :Basic concepts in robotics  
**6 Hrs**  
Definition ; anatomy of robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics, Industrial Applications of Robots.

### Unit II: Robot drivers, Sensors and Vision  
**6 Hrs**  
**Drives for robots:** Electric, hydraulic and pneumatic.  
**Sensors:** Internal-External, Contact-noncontact, position, velocity, force, torque, proximity and range.  
**Vision:** Introduction to techniques, Image acquisition and processing
Unit III: End Effectors and Actuators 6Hrs
Different types of grippers - Mechanical, Magnets, vacuum, Adhesive, Gripper force Analysis & Gripper Design, overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.

Unit IV: Robot Kinematics and Dynamics 8Hrs
Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Lagrangian formulation, Link inertia tensor and manipulator inertia tensor, Newton–Euler formulation for RP and RP manipulators, Trajectory planning, interpolation, static force and moment transformation, solvability, stiffness.

Unit V: Programming methods 6Hrs

Unit VI: Developing and building a robot 6Hrs
Models of flexible links and joints, Robotic arm – Components and structure, Types of joints and workspace, Design models for mechanical arms and lifting systems.
Case Study: 1. Robots in material handling and assembly.

Text Books:
1. Introduction to Robotics By S.K.Saha, Tata McGraw Hill.

Reference Books:
4. Robot Motion and Control (Recent Developments) by M. Thoma & M. Morari.

404194 Biomedical Electronics (Elective-IV)
Credits: 03

Teaching Scheme:
<table>
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<th>Lecture : 03 hr/week</th>
<th>Examination Scheme:</th>
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<td>In-Sem : 30 Marks</td>
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<td></td>
<td>End-Sem : 70 Marks</td>
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</table>

Course Objectives:
- To study Human Physiological Systems from Engineering Perspectives.
- To understand the basic signals in the field of biomedical.
- To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, PCG, Pulse.
- To understand Sources and characteristics of noise and artifacts in bio signals.
- To understand use of bio signals in diagnosis, patient monitoring and physiological investigation.

Course Outcomes:
After successfully completing the course students will be able to:
1. Model a biomedical system.
2. Understand various methods of acquiring bio signals. Understand various sources of bio...
3. signal distortions and its remedial techniques.
4. Get an Overview of major Devices currently used in Medical field
5. The students will have an understanding of analyzing bio-signal and classifying them

<table>
<thead>
<tr>
<th>Unit I: Introduction to Biomedical System</th>
<th>6Hrs</th>
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<table>
<thead>
<tr>
<th>Unit II: Cardiovascular System 6Hrs</th>
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<tbody>
<tr>
<td>Introduction to Heart, Physiology and anatomy of Heart, Lead Configurations to acquire ECG, ECG preamplifiers, ECG recorder, Heart Sounds and Murmurs, Phonocardiography</td>
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<tr>
<th>Unit III: Nervous System 6Hrs</th>
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<tbody>
<tr>
<td>Nerve Cell and nerve potential, Neural Communication, Brain structure, 10-20 electrode placement for EEG, Types of Montage configuration, Types of EEG signals and its significance, EEG machine, EEG applications for Epilepsy and Sleep apnea.</td>
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</table>

| Unit IV: Medical Instrumentation | 8Hrs |
|----------------------------------|
| Design of Instrumentation system for ECG acquisition, Isolation Amplifier, Right Leg drive Mechanism, Noise removal techniques using Active Filters, Wiener Filters, Adaptive Filters: Basic Concept, Principle noise cancellation model, removal of periodic events, using adaptive cancellation, adaptive cancellation of maternal ECG from fetal ECG of Interest. Grounding and shielding Concepts |

| Unit: Analysis of Electrical Activity of Heart | 6Hrs |
|-----------------------------------------------|

| Unit VI: Medical Devices | 4Hrs |
|--------------------------|
| Introduction To Blood Pressure Measurement (noninvasive), Life saving Devices Pacemakers and Defibrillators, Bedside Monitors, Central Monitoring system, Stress Test System, X Ray, CT scan, Dental instruments |

**Text Books:**

**Reference Books:**
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits: 03</th>
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<tbody>
<tr>
<td>404194</td>
<td>Wireless Sensor Networks (Elective-IV)</td>
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</table>

**Teaching Scheme:**
- Lecture : 03 hr/week

**Examination Scheme:**
- In-Sem : 30 Marks
- End-Sem: 70 Marks

**Course Objectives:**
- To learn basic concepts of Wireless sensor networks
- To be familiar with architecture and protocols used in Wireless sensor networks
- To provide knowledge of deployment and security issues of Wireless sensor networks

**Course Outcomes:**
- On completion of the course, student will be able to
  1. Explain various concepts and terminologies used in WSN
  2. Describe importance and use of radio communication and link management in WSN
  3. Explain various wireless standards and protocols associated with WSN
  4. Recognize importance of localization and routing techniques used in WSN
  5. Understand techniques of data aggregation and importance of security in WSN
  6. Examine the issues involved in design and deployment of WSN

**Unit 1: Introduction**

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<th>Time</th>
<th>Topic</th>
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**Unit 2: Radio Communication And Link Management**

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<th>Time</th>
<th>Topic</th>
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**Unit 3: Wireless Standards And Protocol Stack**

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<th>Time</th>
<th>Topic</th>
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<tr>
<td>7 Hrs</td>
<td>WSN Standards- IEEE802.15.4 Low rate WPAN, Zigbee, WirelessHART, ISA 100.11a, 6LoWPAN,IEEE802.15.3, Wibree,BLE, Zwave, ANT, Insteon, Wavenis, Protocol stack of WSNs, Cross Layer Protocol Stack</td>
</tr>
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</table>

**Unit 4: Localization And Routing**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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**Unit 5: Data Aggregation And Security**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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<tbody>
<tr>
<td>7 Hrs</td>
<td>Clustering Techniques, In-Network Processing and Data Aggregation, Compressive Sampling, Security Issues in Wireless Sensor Networks, Attacks, Defensive Measures, Security requirements and threat model,</td>
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</table>

**Unit 6: Designing And Deploying WSN Applications**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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<tbody>
<tr>
<td><strong>Text Books</strong></td>
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<table>
<thead>
<tr>
<th><strong>Reference Books</strong></th>
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</table>
## 404194 Renewable Energy Systems (Elective-IV)

### Credits: 03

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Lecture: 03hr/week</td>
<td>In-Sem: 30 Marks</td>
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<td>End-Sem: 70 Marks</td>
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### Course Objectives:
- To study energy generation, different energy sources and their utilization and impact on environment
- To gain knowledge of solar radiation and its applications
- To understand the wind energy and its nature
- To analyze the performance of solar collectors and wind turbines
- To learn fuel cell and its efficiency

### Course Outcomes:
On successful completion of the course, students able to:

1. Interpret energy reserves of India and potential of different energy sources.
2. Measure the solar radiation parameters and performance of different solar collectors.
3. Calculate different parameters of wind turbine rotor.
4. Implicit the importance and applications of geothermal and ocean energy.
5. Demonstrate knowledge in field of fuel cell and potential for power generation.

### Unit I: Energy Resources and Utilization: 6Hrs
Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power potential, India’s power scene, impact on environment, renewable energy sources, energy parameters, cogeneration, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation.

### Unit II: Solar Energy 8Hrs
Solar constant, spectral distribution of extraterrestrial radiation, terrestrial solar radiation, solar radiation geometry, computation of COSθ, sunrise, sunset, day length, LAT, Empirical equation, solar radiation measurement, Solar Thermal energy collectors, design parameters, laws of thermal radiation, radiation heat transfer between real bodies, radiation optics, transmittivity, heat losses and coefficient, Solar Thermal energy storage.

### Unit III: Solar photovoltaic systems & Solar Applications 8Hrs
**Solar photovoltaic systems:** Photovoltaics, Different types of PV Cells, Mono-poly crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems

**Solar Applications:** Solar water heating, solar distillation, solar ponds, solar pumping system, solar cooker, solar green house.

### Unit IV: Wind energy 8Hrs
Classification, types of rotors, terminology, operation of wind turbines, wind energy extraction, wind characteristics, wind speed, energy estimation, power density duration curve, density function, field data analysis, direction and wind speed, variation of wind speed, wind scale, energy pattern factor in wind power studies, land for wind energy, design of wind turbine rotor, regulating system, wind power generation curve, horizontal axis wind turbine generator, modes of wind power generation, advantages and disadvantages, wind energy farms.
<table>
<thead>
<tr>
<th>Unit V: Ocean and Geothermal Energy</th>
<th>6Hrs</th>
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<tbody>
<tr>
<td><strong>Ocean Energy:</strong> Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme. Wave energy—characteristics—energy and power from the waves.</td>
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</tr>
<tr>
<td><strong>Geothermal energy:</strong> Structure of earth’s interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy.</td>
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<table>
<thead>
<tr>
<th>Unit VI : Fuel Cells</th>
<th>6Hrs</th>
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<tbody>
<tr>
<td>Principle of operation of an acidic Fuel Cell, Technical parameter, Fuel Processor, methanol fuel cell, fuel cell types, Advantages of fuel cell power plants, comparison between acidic and alkaline hydrogen-oxygen fuel cells, state of art fuel cells, energy output of a fuel cell, efficiency and EMF of a fuel cell, Gibbs-Helmholtz equation, operating characteristics of fuel cells.</td>
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<th>Text Books:</th>
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<tr>
<th>Reference Books:</th>
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## 404193 Laboratory Practice III

**Credits: 02**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Practical: 02 Hr/week</td>
<td>TW : 50 Marks</td>
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<td>PR : 50 Marks</td>
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### Mobile Communication:

**List of Practicals: (Any Eight)**

1. Perform an experiment to explain PSTN TST switch.
2. Write a program to elaborate Lost call system/ delay system used in the analysis of voice/data traffic.
3. Write a program to measure bit error rate in presence of AWGN model.
4. Write a program to simulate speech coding and decoding technique used in mobile Communication.
5. Set up and carry out experiment on AT commands for call operation.
6. Write a program to simulate experiment on GMSK modulation.
7. Write a program to measure bit error rate in presence of Hata/ Multipath propagation model.
8. Set up and carry out experiment to explain VoIP call routing process.
10. Perform an experiment / Simulate to elaborate the operation of Multiple access techniques such as TDMA/CDMA/OFDMA.

### Broadband Communication System:

**List of the Experiments:**

- **Minimum 8 experiments are to be performed excluding tutorials.**
- **Tutorials are mandatory. (Expt. 5 and 12)**

1. Estimation of Numerical aperture of fiber.
2. Plot the characteristics of various sources and detectors.
3. Measure attenuation of MMSI and SMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend.
4. Set up a digital link and analyze.
5. Tutorial on Power budget and time budget analysis of optical fiber system.
6. Establishing a direct communication link between Uplink Transmitter and Downlink Receiver using tone signal.
7. To set up an Active Satellite link and demonstrate Link Fail Operation.
8. To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver.
9. To communicate VOICE signal through satellite link.
10. To transmit and receive three separate signals (Audio, Video, Tone) simultaneously through satellite Link.
11. To transmit and receive PC data through satellite link.
12. Tutorial on satellite link design
13. Students, as a part of their term work, should visit satellite earth station and submit a report of visit. (Optional).
<table>
<thead>
<tr>
<th>Machine Learning</th>
<th>PLC &amp; Automation</th>
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</thead>
<tbody>
<tr>
<td><strong>List of Practical’s:</strong></td>
<td><strong>List of Experiments (Minimum 8 experiments are to be performed).</strong></td>
</tr>
<tr>
<td>1. Implement simple logic network using MP neuron model</td>
<td>1. Control the speed of servo motor using analog voltage 0-10V.</td>
</tr>
<tr>
<td>2. Implement a simple linear regressor with a single neuron model</td>
<td>2. Rotate the servo motor according to X, Y co-ordinates.</td>
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<tr>
<td>3. Implement and test MLP trained with back-propagation algorithm</td>
<td>3. Temperature detection using RTD &amp; control the temperature of water at desired set point.</td>
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<tr>
<td>5. Implement SOFM for character recognition.</td>
<td>5. Control the speed of AC 3ф motor using VFD.</td>
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<tr>
<td>6. Implement SVM classifier for classification of data into two classes. Student can use datasets such as flower classification etc.</td>
<td>6. Design simulation of 3 cylinder piston pump using pneumatic kit &amp; PLC.</td>
</tr>
<tr>
<td>7. Implement and test Multiclass SVM classifier.</td>
<td>7. Detect the angle of shaft using Encoder &amp; PLC.</td>
</tr>
<tr>
<td>8. Implement and test CNN for object recognition.</td>
<td>8. Control the speed of 3ф AC motor from Mobile/HMI with PLC.</td>
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<tr>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Oral : 50 Marks</td>
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</table>
### Audio and Speech Processing

List of Experiments (Minimum 8 experiments are to be performed):

- **NOTE:** To perform the experiments software like MATLAB, SCILAB or any appropriate open source software can be used. For analysis of speech signals tools like PRAAT, Audacity can be used. Open source software is encouraged.

1. Record speech signal (isolated words, continuous speech) and analyze the speech signal using speech analysis tool (e.g. PRAAT). Observe spectrogram, pitch, formants, intensity etc.
2. Write a program to compute short time Energy and ZCR for different frame rates and comment on the result.
3. Write a program to classify voiced, unvoiced and silence frames using frame level energy and zero crossing rate.
4. Write a program to compute narrow band and wide band spectrogram. Comment on the time and frequency resolution of wide band and narrow band spectrogram.
5. Write a program for extracting pitch period for a voiced part of the speech signal using autocorrelation method and average magnitude difference function (AMDF).
6. Write a program to design a Mel filter bank and using this filter bank write a program to extract MFCC features.
7. Write a program to perform the cepstral analysis of speech signal and detect the pitch from the voiced part using cepstrum analysis.
8. Write a program to find LPC coefficients using Levinson Durbin algorithm.
9. Write a program to enhance the noisy speech signal using spectral subtraction method.
10. Write a program to extract frequency domain audio features like SC, SF and Spectral roll off.

### Software Defined Radio

List of the Experiments (Minimum 8 experiments are to be performed):

1. Introduction to GNU Radio
2. Introduction to 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

### Audio Video Engineering

List of Experiments (Minimum 8 experiments are to be performed).

1. Voltage and waveform analysis for color TV.
2. Study of direct to home TV and set top box.
3. Study Wi-Fi TV system
5. Study of HDTV
6. Study of Digital TV.
7. Simulation of Video, Audio and Image compressing techniques (Software Assignments)
8. Study of Audio system: CD players and MP3 player.
9. Study of PA system with chord less microphone
10. Directivity pattern of Microphones / Loud speakers
11. Visit to TV transmitter/ Digital TV Studio/ All India Radio / TV Manufacturing factory
### 404195 Project Phase-II

**Credits:** 06

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
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<tbody>
<tr>
<td>Tutorial: 6 Hrs/Week</td>
<td>TW: 150 Mark</td>
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<td>OR: 50 Marks</td>
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</table>

1. **Group Size**  
The student will carry the project work individually or by a group of students. Optimum group size is in 3 students. However, if project complexity demands a maximum group size of 4 students, the committee should be convinced about such complexity and scope of the work.

2. **Selection and Approval of Topic**  
Topic should be related to real life application in the field of Electronics and Telecommunication  
OR  
Investigation of the latest development in a specific field of Electronics or Communication or Signal Processing  
OR  
The investigation of practical problem in manufacture and / or testing of electronics or communication equipment  
OR  
The Microprocessor / Microcontroller based applications project is preferable.  
OR  
Software development project related to VHDL, Communication, Instrumentation, Signal Processing and Agriculture Engineering with the justification for techniques used / implemented is accepted.  
OR  
Interdisciplinary projects should be encouraged. The examination will be conducted independently in respective departments.

3. **Note:**  
The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by internal and external guides.  
Project report must be submitted in the prescribed format only. No variation in the format will be accepted. One guide will be assigned at the most 3 project groups.
Audit Course 6 (1)
Team Building, Leadership and Fitness

About the course
Team building allows students to work together in social situations just as they would in the classroom, their daily lives, or down the road in the workplace. Team building challenges students to solve problems and execute working with others. It shows them how to be accountable. It allows team members to stay motivated and energized to work on the project together. They work on jobs and tasks cohesively, rather than working alone without interaction. By working together, members of the team can “work together, stay together, and achieve together”. Trust and communication issues can also be noticed from team building exercises. Team building is known to improve performance in teams; members will remain motivated and can easily overcome indifferences to see the strengths in all team members.

Leadership is about the art of motivating, influencing and directing people so that they work together to achieve the goals of a team or broader organization. It’s important for students to experience leadership opportunities during their schooling, to learn the art of building relationships within teams, defining identities and achieving tasks effectively. It also provides an opportunity to learn to identify and display effective communication and interpersonal skills. Leadership begins with identifying and understanding our values. Our values are our fundamental beliefs – those principles we consider to be worthwhile and desirable. Fitness does not only refer to being physically fit, but also refers to a person’s mental state as well. If a person is physically fit, but mentally unwell or troubled, he or she will not be able to function optimally. Mental fitness can only be achieved if your body is functioning well. You can help relax your own mind and eliminate stresses by exercising regularly and eating right. People who are physically fit are also healthier, are able to maintain their most optimum weight and are least prone to cardiac and other health problems. In order to maintain a relaxed state of mind, a person should be physically active. A person who is fit both physically and mentally strong enough to face the ups and downs of life, and is not affected by drastic changes if they take place.

Course Objectives:
- To develop understanding of team skills and dynamics
- To identify and develop personal skills to become a more effective team member
- To introduce to the students the social change model of leadership
- To expose students to the leadership skills and imbibe within them that the fact that Leadership is a process, not a characteristic associated with an individual or role.
- To enable student to understand principles of fitness training and exercise
- To enable students to understand human posture, nutritional values and mental fitness

Course Outcomes:
On completion of the course, society will observe –
1. Change in awareness levels, knowledge and understanding of today’s youth
2. Change in attitudes / behavior of students with regards to their improved teamwork, institutional leadership and other life skills
3. Increase in the body’s fitness levels and also reduced health problems
4. Improvement in social health and attitude.

Unit 1: Team Building
Types of Teams, Characteristics of a Team, Stages of Team Development (Forming, Storming, Norming, Adjourning), Systematic Approach to Team Work, High Performing Team (Characteristics, Maintenance, Causes of low performance Why Teams Fail, People, Communication, Resources, Objectives)
Unit II: Leadership

Unit III: Educational Leadership
Key challenges for educational leaders, Characteristics, Capabilities of authentic leader, values and ethics in decision making, Continuous professional Development suitable for 21st century pedagogy, Emotional intelligence for educational leaders. Need of Educational research for educational leadership

Unit IV: Fitness for Engineers
Fundamentals of Exercise Science: Skeletal, muscular, cardiovascular, nervous system, nutrition, flexibility, special population and injuries, Basics of fitness, Weight management and supplementation

Guidelines for Conduction (Any one or more of following but not limited to)
- Guest Lectures
- Group Activities
- Assignment
- Taking up assisted Health challenge for short duration (ex. Yoga and Pranayam, Weight management, stability in mental health)

Guidelines for Assessment (Any one or more of following but not limited to)
- Practical Test
- Presentation
- Paper / (Theory assessment test)
- Report

Sources/References:
1. Organizational Behavior by Fred Luthans
2. Organizational Behavior by M N Mishra
4. Leadership Games, Stephen S Kogan,
6. Sculpt and Shape: The Pilates Way by Yasmin Karachiwala
7. Total Fitness: The LeenaMogre Way by LeenaMogre
8. Don’t Lose Your Mind, Lose Your Weight: RutujaDiwekar
Audit Course 6 (2)
Environmental Issues And Disaster Management

About the Course:
The importance of environmental science and environmental studies cannot be disputed. The need for sustainable development is a key to the future of mankind. Continuing problems of pollution, loss of forget, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues.

It is clear that no citizen of the earth can afford to be ignorant of environment issues. Environmental management has captured the attention of health care managers. Managing environmental hazards has become very important. In spite of the deteriorating status of the environment, study of environment has so far not received adequate attention in our academic programmes.

Course objective:
- To develop understanding of Environment Issues and Biodiversity
- To introduce to the students the environment, Disaster Management
- To enable students to understand ecosystem and preservation of environment
- To understand Disaster Management and handling them

Course Outcomes:
On completion of course students will be able:
1. To learn the different environmental issues and disasters.
2. To deal with problems associated with environment and effectively handle the disasters.

Unit 1: Environmental Pollution
A) Definition, Cause, effects and control measures of :-
Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management, urban and industrial wastes.
Role of an individual in prevention of pollution. Pollution case studies.
B) Social Issues and the Environment:
Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

Unit 2: Ecosystems, Biodiversity and its conservation
A) Concept of an ecosystem.
Structure and function of an ecosystem, Producers, consumers and decomposers, • Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids.
Structure and function of the following ecosystem:
a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
Biodiversity at global, National and local levels, India as a mega-diversity nation
Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
Unit 3: Disaster Management
a) Causes – Natural disaster and Manmade disaster
b) Speed of onset – Sudden and Slow

Natural Disasters
These types of disaster naturally occur in proximity to, and pose a threat to, people, structures or economic assets.
Examples are Storm, Flood, Earthquake, Tsunamis

Manmade Disasters
Accidents: Road, Rail, Air, Sea, Building collapse.
Industrial Mishaps: Gas leak, Explosion, Safety.
Fire: Building, Coal, Oil.
Forest Fire (In tropical counters, forest fires are often manmade)

Speed of onset
1 Sudden onset: little or no warning, minimal time to prepare. For example, an earthquake, tsunami, cyclone, volcano, etc.
2 Slow onset: adverse event slow to develop; first the situation develops; the second level is an emergency; the third level is a disaster.
For example, drought, civil strife, etc.

Unit 4: Case Studies
• Environmental ethics: Awareness, Issues and possible solutions.
• Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
• Wasteland reclamation.
• Consumerism and waste products.
• Environment Protection Act.
• Air and Water (Prevention and Control of Pollution) Act
• Wildlife Protection Act and Forest Conservation Act
• Issues involved in enforcement of environmental legislation.
• Role of an individual in prevention of pollution and case studies.

References:
2. An Introduction To Disaster Management EBook By S. Vidyanathan - Publisher: IKON
3. Textbook for environmental studies, Erach Bharucha For UGC.