# Autonomous Program Structure of Final Year B. Tech. Eight Semester (Electronics and Telecommunication Engineering) Academic Year: 2023-2024 onwards

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Oral | Practical | | |
| 20EC801 | Broadband Communication Systems | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEEC801 | Program Elective-IV | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEEC802 | Program Elective-V | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 801 | Open Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 802 | Open Elective-IV* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20EC801L | Broadband Communication Systems Lab | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20PEEC801L | Program Elective–IV Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **15** | **0** | **4** | **300** | **250** | **25** | **25** | **600** | **17** |
| | **Grand Total** | **19** | | | **550** | | **50** | | | |

| Programme Elective-IV | | | Programme Elective-IV Lab | | |
|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **Sr. No.** | **Course Code** | **Course Title** |
| 1 | 20PEEC801A | Microwave and Radar Engineering | 1 | 20PEEC801LA | Microwave and Radar Engineering Lab |
| 2 | 20PEEC801B | Remote Sensing | 2 | 20PEEC801LB | Remote Sensing Laab |
| 3 | 20PEEC801C | Industrial Automation | 3 | 20PEEC801LC | Industrial Automation Lab |
| 4 | 20PEEC801D | Embedded RTOS | 4 | 20PEEC801LD | Embedded RTOS Lab |

| Programme Elective-V | | |
|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** |
| 1. | 20PEEC802A | Advanced VLSI Design |
| 2. | 20PEEC802B | Artificial Intelligence |
| 3. | 20PEEC802C | Statistical Signal Processing |
| 4. | 20PEEC802D | Mobile Communication |

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| 20OE801 Open Elective-III | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

| 20OE802 Open Elective-IV | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Systems | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

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# 20EC801 BROADBAND COMMUNICATION SYSTEMS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC402 Analog and Digital Communication

**Course Objectives:**

1. To comprehend the components of fibre optic communication system
2. To understand the system design issues and the role of WDM components in advanced light wave systems
3. To describe optical network architectures
4. To explain the concepts of new services and applications to be supported in future satellite networks

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe the effect of propagation characteristics of Optical communication system
CO2 Apply system design considerations for optical link
CO3 Describe optical access networks
CO4 Design WDM optical network
CO5 Identify and access sources for recent trends in Broadband Communication

**Unit I: Fiber optic communications system (08 )**

Electromagnetic Spectrum and Optical spectral bands, Key elements of fiber optic communications system, Ray theory of propagation: Fiber types, Transmission characteristics of optical fibers, Intra modal Dispersion, Intermodal dispersion. Introduction to optical sources: Wavelength and Material Considerations, LEDs and semiconductor LASERs: principle of working and their Characteristics, Material Considerations, PIN, Avalanche photodiodes.

**Unit II: Design considerations in optical links and Wavelength Division Multiplexing(WDM) (06)**

Point to point Links: System design considerations, Link Power budget, Rise Time budget, Overview of WDM, WDM Components: Fiber Coupler, Optical Isolators and Circulators, Optical Fiber Applications.

**Unit III: Optical Network Architectures (07)**

Architectural choices of next generation transport networks, Designing transmission layer using-SDM, TDM, WDM, Unidirectional versus Bidirectional WDM systems, SONET Layering, Frame Structure, Physical network topologies, Access Networks- PON, Optical Interconnects, Data Centers ,Optical communication for Wireless Fronthauling.

**Unit IV: WDM Network Design (07)**

Cost Trade-Offs: A Detailed Ring Network, Light path Topology Design, Routing and Wavelength Assignment(RWA), Wavelength Conversion, Dimensioning Wavelength-Routing Networks, Online RWA in Rings, Long Haul Network case study, Metro Ring Network Case study.

**Unit V: Multiprotocol Label Switching (MPLS) Networks (07)**
Introduction to MPLS, MPLS and Traffic Engineering, Integrated service Internet, RSVP, Differentiated service Internet, Voice over IP, Metro Ethernet Access networks.

**Unit VI: Next Generation Internet (NGI) Over Satellite (07)**
Overview of satellite communication, New Services and Applications, Traffic Modeling and Characterization, IPv6 Networks over Satellites, Future Development of Satellite Networking.

**Text Books:**

1. Gerd Keiser, **"Optical Fiber Communications",** *Tata McGraw Hill,* ($5^{th}$ Edition), (2013).
2. John M. Senior, **"Optical Fiber Communications: Principles and Practice",** *PHI,* ($3^{rd}$ Edition), (2008).
3. Anthony S. Acampora, "**An Introduction to Broadband Networks LANs, MANs, ATM, B-ISDN, and Optical Networks for Integrated Multimedia**", *Springer US* ($1^{st}$ Edition), (1994).
4. Rajiv Ramaswami, Kumar N. Sivarajan, and Galen H. Sasaki, "**Optical Networks: A Practical Perspective",** *Morgan Kaufmann Publishers Inc*, ($3^{rd}$Edition), (2010).
5. C. Siva Ram Murthy and Mohan Guruswamy, **"WDM Optical Networks: Concepts, Design and Algorithms"**, *PHI*, ($1^{st}$Edition), (2001).
6. Zhili Sun, **"Satellite Networking Principles and Protocols"**, *John Wiley & Son*, ($2^{nd}$ Edition), (2014).


**Reference Books:**

1. Djafar K. Mynbaev and Lowell L. Scheiner,**"Fiber Optic Communications Technology",** *Pearson Education*, ($1^{st}$ Edition), (2000).
2. Govind P. Agrawal, **"Fiber Optic Communication Systems",** *Wiley India*, ($3^{rd}$ Edition), (2002).
3. Dennis Roddy, **"Satellite Communications",***McGraw Hill*, ($4^{th}$ Edition), (2017).


**Online Resources:**
1. NPTEL Course "**Fiber Optic Communication Technology"**
   https://nptel.ac.in/courses/108/106/108106167/
2. NPTEL Course **"Satellite Communication Systems"**
   https://nptel.ac.in/courses/117/105/117105131/
3. NPTEL Course **"Broadband Networks: Concepts and Technology"**
   https://nptel.ac.in/courses/117/101/117101050/

# 20PEEC 801A MICROWAVE AND RADAR ENGINEERING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC601 Wave Theory and Antenna

**Course Objectives:**
1. To study the basics of waveguides and various microwave components
2. To analyze microwave components using scattering parameters
3. To study various microwave measurement techniques
4. To explain different types of Radars and its applications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Discuss the advantages and applications of microwaves |
| CO2 | Analyze different modes of propagation in waveguides |
| CO3 | Derive and analyze S parameters for different microwave components |
| CO4 | Explain the operation of different microwave tubes |
| CO5 | Calculate and analyze parameters at microwave frequencies |
| CO6 | Discuss the principle of Radar and compare different types of Radars |

**Unit I: Microwave Transmission Lines (08)**
Introduction of Microwaves and their applications, Rectangular waveguides, Solution of Wave equation in TE and TM modes, Power transmission and Power losses, Planar transmission lines.

**Unit II: Waveguide Components (08)**
Scattering matrix representation of networks, Rectangular cavity resonator, Waveguide Tees, Directional couplers, Faraday rotation principle, Circulators and isolators.

**Unit III: Microwave Tubes (08)**
Introduction to conventional vacuum tubes, High frequency limitations of conventional tubes, Klystron tubes, Magnetron, TWT and their applications.

**Unit IV: Microwave Measurements (06)**
Introduction to microwave measurements, Measurement methods of parameters such as Frequency, Power, Attenuation, Phase shift, VSWR, Impedance, Insertion loss, Q of a cavity resonator.

**Unit V: Radar Fundamentals (06)**
Radar block diagram and operation, Radar range equation, Prediction of range performance, Minimum detectable signal, Radar cross section of targets, Pulse repetition frequency and Range ambiguities, Radar Displays.

**Unit VI: Types of Radar and Applications (06)**
Types of Radars, Doppler effect, CW radar, basic principle and operation of FMCW radar, MTI and Pulse Doppler Radar.

**Text Books:**

1. S.Y. Liao, **"Microwave Devices and Circuits"**, *Prentice Hall India*, (2nd Edition), (2014).
2. M. Kulkarni, **"Microwave and Radar Engineering"**, *Umesh Publications*, (4th Edition), (2013).
3. M. I. Skolnik, "**Introduction to Radar Systems"**, *McGraw Hill*, (3rd Edition), (2008).

**Reference Books:**

1. David M. Pozar, **"Microwave Engineering"**, *John Wiley and Sons*, (5th Edition), (2014).
2. NadowLevanon, **"Radar Principles"**, *John Wiley and Sons*, (5th Edition), (1989).

**Online Resources:**

1. NPTEL Course on **"Microwave Theory and Techniques"**
   https://onlinecourses.nptel.ac.in/noc19_ee57/preview
2. NPTEL Course on **"Basic Blocks of Microwave Engineering"**
   https://nptel.ac.in/courses/117105130/

# 20PEEC801B REMOTE SENSING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite**: PEEC 501 Digital Image Processing, 20EC403 Machine learning with Python

**Course Objectives:**
1. To understand basic concepts, principles and applications of remote sensing
2. To provide knowledge related to remote sensing data collection, reading and analysis
3. To perform image pre-processing, classification and clustering on remote sensing data
4. To learn multidisciplinary applications of remote sensing

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Explain geometric and radiometric principles, Digital Image Processing techniques for pre-processing of Remote Sensing image data
CO2 Illustrate atmospheric and energy interaction, scanning mechanism on earth surface
CO3 Interpret data products from different satellites and calculate image statistics
CO4 Apply machine learning algorithms for dimensionality reduction, clustering and classification on satellite images
CO5 Analyze performance of different machine learning algorithms on multispectral and hyperspectral images
CO6 Demonstrate multidisciplinary applications of remote sensing

**Unit I: Introduction to Remote Sensing (08)**
Energy sources and radiation principles, Energy interactions in the atmosphere, Characteristics and Physics of Remote Sensing systems, Electromagnetic spectrum, Effects of Atmosphere, Scattering and Absorption, Atmospheric window, Energy interaction with surface features: Spectral reflectance of Vegetation, Soil and Water, Atmospheric influence on spectral response patterns.

**Unit II: Multispectral, Thermal, and Hyperspectral Sensing (08)**
Platforms used for Remote Sensing data acquisition and characteristics, Different types of aircrafts, Manned and Unmanned spacecrafts, Sun-synchronous and geo-synchronous satellites, Types and characteristics of different platforms, Opto-mechanical and electro-optical sensors: across-track and along-track scanners, Multispectral scanners and Thermal scanners, Imaging spectroscopy.

**Unit III: Data Representation and Preprocessing (09)**
Resolution: spatial, spectral, radiometric and temporal resolution, Data products and their characteristics, Visual and digital interpretation, Image statistics, Basic principles of data processing: Radiometric correction, Geometric correction, Atmospheric errors and corrections, Image enhancement.

**Unit IV: Data Analysis (09)**
Dimensionality reduction techniques, Image classification: Supervised classification, Unsupervised classification, Classification accuracy assessment, Image segmentation.

**Unit V: Applications of Remote Sensing (08)**

Hyperspectral image analysis, Multispectral image analysis, Time Series Analysis using machine learning techniques in different application areas as urban planning, agricultural, forestry and disaster management.

**Text Books:**

1. Lillesand T.M., and Kiefer, R.W.,"**Remote Sensing and Image interpretation**", *John Wiley & Sons*, (6th Edition), (2000).
2. John R. Jensen, **"Introductory Digital Image Processing: A Remote Sensing Perspective**", *Pearson*, (4th Edition), (2016).
3. George Joseph, **"Fundamentals of Remote Sensing",** *Universities Press,* (2nd Edition), (2005).

**Reference Books:**

1. John A. Richards, **"Remote Sensing Digital Image Analysis"**, *Springer–Verlag*, (5th Edition), (2013).
2. Charles Elachi and Jakob J. Van Zyl, **"Introduction to The Physics and Techniques of Remote Sensing"**, *Wiley Series in Remote Sensing and Image Processing*, (2nd Edition), (2006).
3. JianGuo Liu, Philippa J. Mason,**"Image Processing and GIS for Remote Sensing: Techniques and Applications"**, *John Wiley & Sons, Ltd.*, (2nd Edition), (2016).

**Online Resources:**

1. NPTEL Course**"Remote Sensing and Digital Image Processing of Satellite Data"** https://nptel.ac.in/courses/105/107/105107160/
2. NPTEL Course**"Remote Sensing Essentials"** https://nptel.ac.in/courses/105/107/105107201/
3. https://www.iirs.gov.in

# 20PEEC801C INDUSTRIAL AUTOMATION

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:**

**Course Objectives:**
1. To introduce the basics of process control and automation systems
2. To explain the essential elementsas required for a process control system
3. To introduce the basics of P.L.C. programming and P.L.C. programming standard
4. To familiarize with SCADA and DCS

**Course Outcomes:**
After completion of the course, students will be able to :

| | |
|---|---|
| CO1 | Explain the basics of a Process Control System and Automation System |
| CO2 | Design subsystems of a Process Control application |
| CO3 | Develop P.L.C. ladder diagram for process control application |
| CO4 | Explain communication in P.L.C. (Programmable Logic Control),SCADA(Supervisory Control and Data acquisition) and DCS (Distributed Control System) |

**Unit I: Process Control and Automation (08)**
Process control principles, Servomechanisms, Control System Evaluation, Analog control, Digital control, Types of Automation, Architecture of Industrial Automation Systems, Advantages and Limitations of Automation.

**Unit II: Transmitters and Signal Conditioning (08)**
Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire and 3-Wire transmitters, Analog and Digital signal conditioning for R.T.D., Thermocouple, Differential Pressure Transmitter ( D.P.T.) , Smart and Intelligent transmitters.

**Unit III: Controllers and Actuators (09)**
PID Controller, Cascade PID control, Microprocessor Based control, PAC(Programmable Automation Controller), Mechanical switches, Solid state switches, Electrical Actuators: Solenoids, Relays and Contactors, A.C. Motor, V.F.D., D.C. Motor, B.L.D.C. Motor, Stepper Motor, Servo Motor, Pneumatic and Hydraulic actuators.

**Unit IV: Programmable Logic Controller (09)**
Functions of P.L.C., Types of PLCs, Advantages, Architecture, Working of P.L.C., Selection of P.L.C., Networking of P.L.C.s, Ladder Programming basics, Ladder Programming examples, Interfacing Input and Output devices with P.L.C., P.LC. Programming standard IEC61131.

**Unit V: Industrial Automation Technologies : Supervisory Control And Data Acquisition (S.C.A.D.A.) and Distributed Control System (D.C.S.), Industrial Communication (08)**
Introduction to S.C.A.D.A. (Features, MTU-functions of MTU, RTU-Functions of RTU, Applications of S.C.A.D.A., Communication in S.C.A.D.A.: types, methods and Media used), Introduction to DCS (Architecture, Input and Output modules, Communication module,

Specifications), Industrial Communication: Devicenet, Interbus , Device network : Foundation Fieldbus -H 1, HART, CAN, PROFIBUS-PA, Control network: ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP.

**Text Books:**

1. Curtis Johnson, **"Process Control Instrumentation Technology"**, Pearson Education, (8th Edition), (2013).
2. S. Sen, S. Mukhopadhyay, A. K. Deb, **"Industrial Instrumentation Control and Automation"**, Jaico Publishing House, (1st Edition), (2013).
3. Madhuchhanda Mitra, Samarjit Sengupta, **"Programmable Logic Controllers and Industrial Automation"**, Penram International Publishing India Pvt. Ltd., (2nd Edition), (2012).
4. Stuart A. Boyer, **"SCADA (Supervisory Control and Data Acquisition)"**, ISA Publication, (4th Edition), (2010).

**Reference Books:**

1. John W. Webb, Ronald A. Reis, **"Programmable Logic Controllers, Principles and Applications"**, Prentice Hall of India Pvt. Ltd., (5th Edition), (2016).
2. Kilian, **"Modern Control Technology: Components & Systems"**, Cengage India, (3rd Edition), (2021).
3. BelaG. Liptak, **"Process Software and Digital Networks"**, CRC Press, (3rd Edition), (2011).

**Online Resources:**

1. **NPTEL Course on Industrial Automation and Control**
   https://onlinecourses.nptel.ac.in/noc21_me67/preview

# 20PEEC801D EMBEDDED DESIGN AND RTOS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester:50 Marks
**Credits: 3**

**Prerequisite:** 20EC503 Advanced Processors, 20ES02 Fundamentals of Programming Language I

**Course Objectives:**

1. To discuss embedded system design challenges
2. To explain Operating System (OS) requirement for embedded systems
3. To describe real time operating system concepts
4. To discuss features of Linux OS
5. To interface real world input and output devices

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Identify and analyze design metrics for development of embedded systems
CO2 Compare and contrast different types of software development model for a given application
CO3 Explore the structures, task services, states and other basic operations of the real time operating systems
CO4 Apply real time system concepts for developing embedded systems
CO5 Explain Linux kernel configuration and bootloader

**Unit I : Introduction to Embedded Systems (07)**

Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Embedded processor technology: IC technology, Design technology, Software development life cycle (SDLC) models like Waterfall, Spiral, V, Rapid Prototyping models and comparison.

**Unit II: Structure of μCOS II (07)**

Kernel Structure: Foreground and background systems, Pre-emptive and Non-Preemptive, Starting the OS, Tasks, Task States, Task Control Blocks (TCB), Ready list, Task Scheduling, Task Level, Multitasking , Context Switching, Idle Task, Statistics Task, Task Management: Creating/Deleting and Suspending/Resuming Task, Task Stacks and checking, Changing Task's Priority.

**Unit III : Synchronization in μCOS II (07)**

Critical Session, Shared resources, Inter task communication, Mutual exclusion, Semaphore Management: Creation/Deletion, Pending/Posting/Acceptance/Query, Mutual Exclusion Semaphores: Creation/Deletion, Pending/Posting/Acceptance/Query, Event Flag Management: Internals, Creation/ Deletion of Event Flag groups, Waiting/Setting/Clearing/Looking for/Querying an Event Flag Group.

**Unit IV: Structure of μCOS II (07)**

Static and Dynamic Priorities, Priority inversion, Synchronization mechanism, Interrupts: Latency, Response and Recovery, Clock Tick, Memory requirements. Schedulers, Locking and unlocking of scheduler, Interrupts, Clock Tick, Initialization, Time Management: Delaying/Resuming task, System Time.

**Unit V: Communication in µCOS II (07)**

Message Mailbox Management: Creating/Deleting a Mailbox, Waiting/ Sending /Getting without waiting a Message from Mailbox, Status of Mailbox, and Alternate uses of Mailbox, Message Queue Management: Creating/Deleting/Flushing a Message Queue, Waiting/Sending/Getting without waiting a Message from Queue, Status and Alternate use of Message Queue, Memory Management: Memory Control Block(MCB), Creating a partition, Obtaining /Returning/Waiting for a memory Block, Partition Status, Porting of µCOS-II: Development tools, Directories and Files, Configuration and testing of Port.

**Unit VI: Linux Kernel Construction (07)**

Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS Versus Boot loader Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration, Role of a Bootloader, Bootloader Challenges, A Universal Bootloader: Das U-Boot, Porting U-Boot.

**Text Books:**

1. Jean J. Labrosse, **"MicroC OS II, The Real-Time Kernel",** *CMP Books*, ($2^{nd}$Edition), (2011).
2. Christopher Hallinan, **"Embedded Linux Primer - A Practical, Real-World Approach",** *Prentice Hall Pvt.*, ($2^{nd}$ Edition), (2010).
3. Raj Kamal, **"Embedded Systems –Architecture, Programming and Design",** *McGraw Hill*, ($2^{nd}$ Edition), (2008).

**Reference Books:**

1. Dr. K. V. K. K. Prasad **"Embedded / real time System: Concepts, Design, & Programming - Black Book"**, *Dreamtech Press Publication*, ($2^{nd}$ Edition), (2003).
2. Frank Vahid and Tony Givargis, **"Embedded System Design – A Unified hardware/ Software introduction"**, *Wiley Publication*, ($3^{rd}$ Edition), (2006).

**Online Resources:**

1. NPTEL Course on "**Real Time Operating System"**
   https://onlinecourses.nptel.ac.in/noc20_cs16/
2. NPTEL Course on "**Real-Time Systems"**
   https://onlinecourses.nptel.ac.in/noc21_cs98/

# 20PEEC802A ADVANCED VLSI DESIGN

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC502 VLSI Design

**Course Objectives:**

1. To discuss the coverage of timing analysis
2. To study the fundamentals of static timing analysis
3. To understand logic fault models and learn test generation for sequential and combinational logic circuits
4. To learn power distribution and power optimization techniques

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Apply the timing constraints, including clocks and external delays for performance improvement |
| CO2 | Apply Static Timing Analysis(STA) checks for timing closure |
| CO3 | Analyze the faults in digital circuits |
| CO4 | Analyze the design for testability methods for combinational and sequential circuits |
| CO5 | Describe power distribution and power optimization techniques |

**Unit I: Introduction to Timing Analysis (08)**

Performance axes, Design flow, Static versus dynamic methods, Intrinsic and extrinsic delays, Delay factors, Path delays, Combinational paths, Synchronous paths, Pipelining and analysis, Clock definitions: Skew, Frequency and phase, Clock distribution.

**Unit II: Static Timing Analysis (08)**

True paths, Transitions, Multi-cycle operations, Clock specification, Interface specification, Timing checks, Timing constraints, Design rule constraints, Wire-load model, Gate delay, Net delay, Timing reports, Back annotation, Delay Formats: Standard Delay Format (SDF).

**Unit III: Basics of Testing (08)**

Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits, Current sensing based testing, Classification of sequential ATPG methods, Fault collapsing and simulation.

**Unit IV: Design for Testability (DFT) (08)**

Scan design, Partial scan, Use of scan chains, Boundary scan, DFT for other test objectives, Memory Testing. Built-in self-test (BIST): Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

**Unit V: Power Analysis and Clock Synthesis (10)**

Introduction, Power Basic, Key Factors in Accurate Power Estimation, Power Estimation Early in the Design Cycle, Simulation Based Power Estimation, Best Practices for Power Estimation, Supply and ground bounce, Power distribution techniques, Power optimization, Clock Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Interconnect routing techniques.

**Text Books:**

1. J. Bhasker, Rakesh Chadha, **"Static Timing Analysis For Nano-meter Designs: A Practical Approach"**, *Springer*, ($1^{st}$ Edition), (2009).
2. Jan M. Rabaey, **"Digital Integrated Circuits Design Perspective"**, *Prentice Hall of India Pvt. Ltd.*, ($2^{nd}$ Edition), (2002).

**Reference Books:**

1. Srivastava Ashish, Sylvester Dennis, Blaau David, **"Statistical Analysis and Optimization for VLSI: Timing and Power"**, *Springer*, ($1^{st}$ Edition), (2005).
2. Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, **"VLSI Test Principles and Architectures: Design for Testability"**, *Elsevier*, ($1^{st}$ Edition), (2006).
3. M. L. Bushnell and V. D. Agrawal, **"Essential of Electronic Testing for Digital, Memory, and Mixed Signal VLSI Circuits"**, *Springer*, ($1^{st}$ Edition), (2005).

**Online Resources:**

1. NPTEL Course **"Advanced VLSI Design"**
   https://nptel.ac.in/courses/117/101/117101004/
2. NPTEL Course **"VLSI Physical Design"**
   https://nptel.ac.in/courses/106/105/106105161/

# 20PEEC802B ARTIFICIAL INTELLIGENCE

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester:50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC403 Machine Learning with Python

**Course Objectives:**
1. To explain the basics of Artificial Intelligence
2. To introduce various types of algorithms useful in Artificial Intelligence
3. To explain the types of reasoning
4. To explain the code of ethics for Artificial Intelligence

**Course Outcomes:**
After completion of the course, students will be able to
1. Explain the components of intelligent agents and expert systems
2. Apply knowledge representation techniques and problem solving strategies to Artificial Intelligence applications
3. Explain and analyze the search and learning algorithm along with the reasoning
4. Describe the code of ethics for the Artificial Intelligence systems

**Unit I: Basics of Artificial Intelligence (05)**
Categories of Artificial Intelligence (AI), Applications of AI, Intelligent agents, Agents and environments, Good behavior, The nature of environments, Structure of agents. Applications of Artificial Intelligence, Game Playing, Expert Systems, Natural Language Processing, Image Understanding, Robotics, Pattern Recognition, Virtual Reality, Computer Vision, Intelligent Control

**Unit II: Problem Solving (07)**
Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic function, Local search algorithms and optimistic problems, Optimal decisions in games, MINIMAX algorithm, Alpha Beta Pruning, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP.

**Unit III: Knowledge Representation (07)**
Logic, Propositional logic, First order logic, Knowledge engineering in first order logic, inference in first order logic, Prepositional versus first order logic, Forward chaining, backward chaining, Resolution , Knowledge representation, Uncertainty and methods, Bayesian probability and Belief network.

**Unit IV: Reasoning (06)**
Types of Reasoning, Non-monotonic Inference Methods Non-monotonic Reasoning, Truth Maintenance Systems, Reasoning with Fuzzy Logic, Fuzzy Sets, Fuzzy Reasoning, Rule-based Reasoning, Diagnosis Reasoning, Case-based Reasoning Systems, Model-based Reasoning Systems

**Unit V: Learning (07)**

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, Statistical learning, Hidden Markov Models, Association Learning: Apriori Algorithm, Eclat Algorithm, Fuzzy Network, Fuzzy Systems, Info Fuzzy Networks, Fuzzy Neural Systems

**Unit VI: Expert systems and Ethics for Artificial Intelligence (10)**

Introduction to Expert System, Architecture and functionality, Examples of Expert system, Basic steps of pattern recognition system, Object Recognition- Template Matching theory, Prototype Matching Theory, Pattern Mining.
Ethics of AI : Privacy and Surveillance, Manipulation of Behavior, Opacity of AI Systems, Bias in Decision Systems, Human-Robot Interaction, Automation and Employment, Autonomous Systems, Machine Ethics, Artificial Moral Agents Privacy

**Text Books:**

1. Vinod Chandra S. S., Anand Hareendran S., "**Artificial Intelligence and Machine learning**", *PHI*, (1st Edition) (2014).
2. Stuart Russell, Peter Norvig, **"Artificial Intelligence", A Modern Approach '**, *Pearson Education/Prentice Hall of India*, (3rd Edition), (2010).
3. Elaine Rich, Kevin Knight and Shivshankar Nair, **"Artificial Intelligence"**, *Tata McGraw Hill*, (3rd Edition), (2009).
4. Paula Boddington**, "Towards a Code of Ethics for Artificial Intelligence", ***Springer international Publishing***,** (1st Edition), (2017).

**Reference Books:**

1. Nils J. Nilsson, **"Artificial Intelligence: A new Synthesis"**, *Morgan Kaufmann Publishers*, (1st Edition), (1998).
2. George F. Luger, **"Artificial Intelligence: Structures and Strategies for Complex Problem Solving",** *Pearson Education***,** (6th Edition), (2008).

**Online Resources:**

1. NPTEL Course **"Artificial Intelligence"**
   http://nptel.ac.in/courses/106105077/
2. https://plato.stanford.edu/entries/ethics-ai/
3. https://intelligence.org/files/EthicsofAI.pdf
4. https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf

# 20PEEC 802C STATISTICAL SIGNAL PROCESSING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC501 Digital Signal Processing

**Course Objectives:**
1. To explain concepts of statistical signal processing that have been used in many applications fields such as communications, speech signal processing, image processing
2. To describe Signal Modeling methods and its importance in signal processing
3. To explain Parametric and non-parametric spectral estimation methods
4. To introduce Linear prediction and optimum filters and its necessity for noise filtering
5. To explore necessity of adaptive filters and algorithms for real time noise filtering

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Apply statistical models for analysis of signals using Stochastic processes |
| CO2 | Design Optimum filters for prediction and filtering of real world signals |
| CO3 | Analyze real world signals by estimating its power spectral densities using parametric and non-parametric spectral estimation methods |
| CO4 | Apply Adaptive filtering algorithms for real world signals |

**Unit I: Signal Modeling (08)**
Random processes, Introduction to signal modeling, Signal modeling using Least Square methods, Pade' method, Prony's method, Signal modeling using MA(q), AR(p) , ARMA(p,q) models.

**Unit II: Linear Prediction of Signals (08)**
Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters, Linear Minimum Mean-Square Error (LMMSE) Filtering.

**Unit III: Wiener Filter (08)**
Wiener Hoff Equation, Causal and Non Causal FIR filter, Linear Prediction using FIR Filter, Lattice representation of FIR filter, Causal IIR Wiener filter, Application of Wiener Filter as Noise Canceller.

**Unit IV: Adaptive Filtering (10)**
Principle and Applications, Steepest Descent Algorithm Convergence characteristics, LMS algorithm, Convergence, Excess mean square error, Leaky LMS algorithm, Application of Adaptive filters, Kalman filtering**:** State-space model and the optimal state estimation problem, Discrete Kalman filter, Extended Kalman filter.

**Unit V: Spectral Analysis (08)**
Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing, Periodogram: Parametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

**Text Books:**

1. Charles W. Therrien, **"Discrete Random Signals and Statistical Signal Processing",** *Prentice Hall Signal Processing Series*, (1st Edition), (2004).
2. Monson H. Hayes, **"Statistical Digital Signal Processing and Modeling"**, *John Wiley and Sons, Inc, Singapore*, (1st Edition), (2002).

**Reference Books:**

1. Simon Haykin, **"Adaptive Filter Theory",** *Prentice Hall*, (5th Edition), (2013).
2. J. G. Proakis, **"Algorithms for Statistical Signal Processing",** *Pearson Education*, (1st Edition), (2002).

**Online Resources:**

1. NPTEL Course **"Statistical Signal Processing"**
   https://nptel.ac.in/courses/108/103/108103158/

# 20PEEC 802D MOBILE COMMUNICATION

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC 402 Analog and Digital Communication

**Course Objectives:**
1. To explain the fundamentals of cellular system design and the techniques used to maximize the capacity of cellular network
2. To describe the basics of multi-path fading and various parameters used to characterize small scale fading
3. To explain various multiple access techniques
4. To explore the architecture and call processing of GSM and CDMA system

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the basics and design challenges of cellular networks |
| CO2 | Analyze signal propagation issues and their impact on the communication system performance |
| CO3 | Compare and determine capacity of different multiple access techniques |
| CO4 | Describe the architecture, operation and call processing of GSM system |
| CO5 | Describe CDMA system and analyze it's design parameters |

**Unit I: Cellular Fundamentals (10)**
Introduction to wireless Communication Systems, Evolution in cellular standards, Cellular concepts, Frequency reuse, Channel assignment, Handoff, Interference and System capacity, Trunking and Grade of service, Improving coverage and capacity.

**Unit II: Mobile Radio Propagation (10)**
Propagation mechanism, Free space path loss, Fading and Multipath, Small scale multipath propagation, Impulse response model of multipath channel, Parameters of mobile multipath channels, Types of small scale fading, Equalization techniques.

**Unit III: Coding and Multiple Access Techniques for Wireless Communications (06)**
Selection of Speech Coders for Mobile Communication, Linear Predictive Coders, Vocoders, GSM Codec, Multiple Access Techniques, Orthogonal Frequency Division Multiplexing(OFDM), OFDM applications.

**Unit IV: Global System for Mobile Communications (08)**
Evolution of Mobile standards, System Overview, The air interface, Logical and Physical channels, Synchronization, GMSK modulation, Call establishment, Handover.

**Unit V: Code Division Multiple Access (08)**
Basics of spread spectrum, Orthogonal codes, Physical and logical channels of IS-95, Handover mechanism, Factors affecting the performance of CDMA system, Comparison of WCDMA and CDMA 2000, Overview of LTE Standard, Architecture and Frame structure of LTE, Introduction to 5G standard, Comparison between 4G and 5G.

**Text Books:**

1. Theodore S Rappaport, **"Wireless Communications Principles and Practice",** *Pearson Education*, (2nd Edition), (2010).
2. Andrea Goldsmith, **"Wireless Communications",** *Cambridge University Press*, (1st Edition), (2005).
3. William C.Y. Lee, **"Mobile Communications Engineering: Theory and applications"**, *McGraw-Hill Education*, (2nd Edition), (2017).

**Reference Books:**

1. Vijay K. Garg, Joseph E. Wilkes, **"Principles and Applications of GSM"**, *Pearson Education*, (6th Edition), (2009).
2. *Vijay K. Garg*, **"IS-95 CDMA and CDMA 2000 Cellular/PCS Systems Implementation"**, *Pearson Education*, (1st Edition), (2000).
3. R. Blake, "**Wireless Communication Technology",** *Thomson Delmar*, (1st Edition), (2015).

**Online Resources:**

1. NPTEL Course on **"Introduction to wireless and cellular communication"**
   https://onlinecourses.nptel.ac.in/noc20_ee61/

# 20EC 801L BROADBAND COMMUNICATION SYSTEMS LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Oral : 25 Marks
**Credits: 1**

**Course Objectives:**

1. To interpret performance parameter of optical fiber
2. To interpret characteristics parameter for optical source and detector
3. To understand aspects of optical fiber communication link
4. To understand satellite communication link

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Compute parameters of optical fiber: Numerical Aperture (NA), attenuation and bending losses
CO2 Illustrate characteristics parameters of optical source and detectors
CO3 Simulate power budget and rise time budget of optical link
CO4 Simulate Satellite scenario to measure BER and PER

**List of Experiments:**

1. Measure numerical aperture of optical fiber.
   Program to compare the acceptance angle for meridional ray and skew rays which change direction by 100 degrees at each reflection.
2. Program to Estimate the a) delay difference between the slowest and fastest modes at the fiber output b) the rms pulse broadening due to dispersion c) the maximum bitrate and bandwidth supported.
3. Program to determine the total carrier recombination lifetime, the power internally generated. Plot V-I characteristics of LED used in optical fiber communication.
4. Program to determine Quantum efficiency and responsivity of photodiodes .
   Compare performance of APD for different load resistors and biasing voltage.
5. Simulate Power budget and Rise time budget analysis of optical fiber system
6. Program to design wavelength channel plan for
   (a) 8 band, 32 channel dense WDM Interleave Waveband Filter band.
   (b) The overall bandwidth of the filter in each case.
7. End-to-End DVB-S2 Simulation with RF Impairments and Corrections.
8. Satellite link design/ Model, Visualize, and Analyze Satellite Scenario.

# 20PEEC 801LA MICROWAVE AND RADAR ENGINEERING LAB

**Teaching Scheme**
Lectures: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To learn reciprocal and non reciprocal passive microwave components.
2 To learn the characteristics of active devices like reflex klystron and Gunn diode.
4. To learn the nature of standing waves formed due to impedance mismatch.
5. To learn the working principle of Radar.

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Measure and Analyze the characteristics of reciprocal and non-reciprocal passive microwave components.
CO2 Analyze the characteristics of various microwave sources like Reflex Klystron and Gunn Diode.
CO3 Analyze Standing waves for various terminations.
CO4 Simulation of Radar to measure range and speed of the target.

**List of Experiments:**

1. Measure and plot mode characteristics of the Reflex klystron.
2. Measurement of the free space wavelength of the microwave (for TE 10 mode) with the help of the X-band microwave test bench and verify with its theoretical calculation.
3. Measure VI characteristics of Gunn Diode and study of PIN modulator.
4. Measure and verify port characteristics of microwave tees (E, H, E-H or magic tee).
5. Measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
6 Measure and verify port characteristics of Isolator and Circulator. Calculate insertion loss and isolation in dB.
7. Measure wavelength of the microwave using a microwave test bench and verify with its theoretical calculations.
8. Plot a standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using a slotted section with probe carriage.
9. To simulate the operation of Radar.

# 20PEEC801LB REMOTE SENSING LAB

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Practical: 2 Hours / Week | In Semester: 25 Marks |
| | Practical: 25 Marks |
| | **Credits: 1** |

**Course Objectives:**

1. To introduce Geographic information system (GIS) software and operations on geo data using Quantum GIS (QGIS)
2. To provide knowledge about collecting and reading remote sensing data
3. To develop programming skills for satellite image analysis
4. To apply digital image processing and machine learning techniques on multispectral and hyperspectral images

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Apply QGIS software for geospatial data analysis
CO2 Choose and apply image pre-processing and enhancement techniques on satellite images
CO3 Collect data from different satellites and apply data analysis steps using Python
CO4 Develop algorithms for clustering and classification of multispectral and hyperspectral images

**List of Experiments:**

1. (a) Introduction to Quantum GIS (QGIS) software, (b) Read and display satellite images, Process raster data and create composites.
2. Implement image enhancement techniques for satellite images.
3. Implement pan-sharpening algorithm on satellite data.
4. Develop an algorithm to perform data analysis on satellite images (Sentinel/Landsat)- Read data, Visualize bands, Plot histogram, Calculate vegetation and soil indices.
5. Develop an algorithm to perform dimensionality reduction and clustering in hyperspectral images.
6. Develop an algorithm for supervised classification in multispectral/hyperspectral images.

# 20PEEC801LC INDUSTRIAL AUTOMATION LAB

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Practical: 2 Hours / Week | In semester: 25 Marks |
| | Practical: 25 Marks |
| | **Credits: 1** |

**Course Objectives :**

1. To demonstrate the measurement& control of a physical variable using an appropriate measurement and control circuit
2. To plot the response of Proportional (P), Proportional and Integral (PI) and PID Controllers
3. To introduce interfacing of I/O devices with PLC
4. To develop Ladder Program for Process Control Applications
5. To interface PLC with SCADA

**Course Outcomes :**

After completion of the course, students will be able to

CO1 Detect & control a physical variable using an appropriate measurement & control circuit
CO2 Plot the response of a Proportional, Proportional & Integral and PID Controllers
CO3 Interface I/O devices for a process control application with PLC
CO4 Develop PLC Ladder Programs for Process Control Applications
CO5 Interface PLC with RTU (Remote Terminal Unit) and SCADA

**List of Experiments:**

1. Temperature detection & control using RTD.
2. Temperature detection & control using Thermocouple.
3. Plotting step response of Proportional, Proportional & Integral and PID Controllers ( Matlab based )
4. Interfacing of I/O devices ( eg. Mechanical Switches, Relays ) with PLC
5. Controlling the speed of Servo Motor using an analog voltage of 0-10V
6. Interfacing of PLC to Pneumatic Circuit
7. Developing PLC Ladder Programs for basic logical operations
8. Developing PLC program for a given Process Control Application
9. Interfacing PLC with RTU & SCADA at remote location.

# 20PEEC801LD EMBEDDED DESIGN AND RTOS LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**
1. Interface real world input and output devices
2. Discuss use of μCOS-II RTOS functions in programming
3. Explain porting of Linux OS

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Interface real world input and output devices
CO2 Apply RTOS concepts to external peripheral devices
CO3 Write C program using RTOS functions
CO4 Port Linux OS in embedded system

**List of Experiments:**
1. Port μCOS-II RTOS on ARM7.
2. Multitasking in μCOS-II RTOS using min 4 tasks on ARM 7
3. Semaphore as Signaling and Synchronizing on ARM 7.
4. Mailbox implementation for message passing on ARM 7.
5. Implement MUTEX on ARM 7.
6. Use OS service(s) to accept keyboard input and display/transmit.
7. Building tool chain for embedded Linux and porting Kernel on ARM 9 target board.
8. Write a program 'Hello world; using embedded Linux on ARM 9.