P.E.S. University, Bengaluru – 85

(Established Under Karnataka Act 16 of 2013)

Department of Electronics and Communication Engineering

List of Minor Courses offered by ECE Department

Sl No	Course Code	Course Title	Credits
1	UE17EC140	Probability and Random Process (For all branches)	4
2	UE17EC160	Real Time Embedded System (only for EEE)	4
3	UE17EC180	Digital Signal Processing (For all branches except EEE)	4
4	UE17EC240	Computer Network (only for EEE)	4
5	UE17EC260	Embedded System (For all branches except EEE) /	4
6	UE17EC280	Communication Engineering (For all branches)	4

UE17EC140
Probability Theory and Random Process (4-0-0-0-4)

Course Objectives:

- The objective of this course is to equip the students with the basic tools required to build and analyze probabilistic and random process models in both the discrete and continuous context.

Course Description:

- This course introduces probability, probabilistic models and random process models. The basic tools required to build and analyze such models in both the discrete and continuous context, will be dealt in the course.

Course Content:

1. **Probability and Random variables:** Probability: Review, independence and Bernoulli trails. Discrete Random Variable: Definition, Probability mass function, Cumulative distribution and different types of discrete random variable. Continuous random variable: Concept, distribution and density function and different types of continuous random variables.
2. **Moments and Multiple random variables:** Expectation, moments; transformation of random variables, conditional density and distribution function. Vector random variables, Joint distribution and its properties, Joint density and its properties, Conditional distribution and density, Statistical independence, Distribution and density of a sum of random variables. Central limit theorem, Expected value of a function of random variables, Jointly Gaussian random variables, Law of large numbers.
3. **Random Process:** Concept, Stationarity and independence, Ergodicity, Correlation functions, Gaussian, Poisson and Bernoulli random processes.
4. **Power density spectrum of Random Process:** Power density spectrum and its properties, relationship between power spectrum and autocorrelation function, cross-power density spectrum and its properties.
5. **Linear Systems with Random Inputs:** Random signal response of linear systems, System evaluation using random noise, Spectral characteristics of system response, Spectral factorization, Noise bandwidth, Bandpass, Band-limited and narrow band processes.

Reference Books:

1. Peyton Z. Peebles, Jr., *Probability, Random Variables and Random Signal Principles*, 4th Edition, McGraw-Hill, 2001.

2. Sheldon Ross, *A first course in probability*, Pearson Education, 6th edition.

UE17EC280
Communication Engineering (3-0-0-0-1)

Course Objectives:

- The main objective of the course is to understand and develop fundamentals associated with the analysis, design and Communication systems.

Course Outcomes: On successful completion of this Course, the students would be able to;

1. Be able to classify systems based on their properties: in particular. Determine Fourier transforms for continuous-time and discrete-time signals (or impulse-response functions), and interpret and plot Fourier transform magnitude and phase functions.
2. Analyze the performance of different analog communication systems.
3. Apply the concepts of analog modulation & demodulation techniques in developing better circuits of these systems.
4. Analyse the performance capabilities of current digital communication systems.
5. Analyze the Band pass digital modulation and demodulation.

Course Description:

- First unit introduces to different types of signals and the basic operations performed on them. This subject gives an insight into both continuous time and discrete time signals and systems, and their frequency domain representation. Second unit of the course introduces to the concepts of communication, types of communication, modulation and provides with the detailed study of Amplitude and Frequency modulation. Third unit discuss about building blocks of a Digital communication system and concept of sampling and reconstruction of signals.

- Fourth units discuss about the different Digital coding techniques to represent the signals and the advantages and drawbacks of line formats.

- Fifth unit discuss about digital modulation techniques generation and detection.

Course Content:

1. **Review of signals and systems:** Classification of signals, Continuous-time and discrete-time signals, Transformations of the independent variable, Exponential and sinusoidal signals. The Continuous-Time Fourier Transform .The Discrete-Time Fourier Transform .Fourier Series Representation of Periodic Signals.

2. **Analog Modulation:** Generation and detection of AM wave. Generation and Detection of DSBSC.of DSBSC waves: balanced modulator, Ring modulator. SSB,Frequency translation, Frequency division multiplexing. FM, Bandwidth of FM waves, constant average power, Generation of FM waves Demodulation of FM waves.

3. **Introduction to Digital Communication:** Basic signal processing operations in digital communication, Channels for digital communication. Sampling theorem, Reconstruction of a message from its samples, Signal distortion in sampling, Practical aspects of sampling and signal recovery, PAM, TDM.

4. **Coding Techniques :** Waveform Coding Techniques: PCM, Channel noise and error probability, quantization noise and SNR, robust quantization, DPCM, DM, ADM, Coding speech at low bit rates, applications.

5. **Digital Modulation :** Digital modulation techniques, ASK,PSK,FSK,DPSK,QPSK and MPSK generation. Coherent and noon coherent methods of detection.

Reference Books:

1. A. V. Oppenheim and A. S. Willsky with S. H. Nawab, Signals and Systems, 2nd Edition, Pearson Education, 1997.
2. Simon Haykin, Anlaog and *Digital Communication,* 4^{th} edition John Wiley, 2003

Lab Experiments (10 hrs)

1. Collector AM and Demodulation using envelope detector
2. Balanced modulation
3. Transistors mixers – up/down conversions
4. Frequency modulation using IC 8038
5. Pre-emphasis and de-emphasis
6. PAM (modulation and demodulation)
7. Study of Flat Top Sampling
8. ASK generation and detection.
9. FSK generation and detection.
10. QPSK generation and detection.

UE17EC180
Digital Signal Processing (4-0-0-0-4)

Course / Learning Objective:

The study of the subject should enable the student to learn:

- Different types of signals, LTI systems and Z-transform
- Discrete fourier transform, its properties, FFT and its applications
- Design of digital FIR and IIR filters
- Realization of digital filters

Course Description:

- This subject will introduce the student to the fundamentals of signals, systems and processing of digital signals. This course is about understanding the concepts of Discrete Fourier transform and its properties, Fast Fourier transform and applying them on signals. Digital filters design and realization methods are discussed in detail.

Course Content:

1. **Introduction to signals and systems:** Signals, Systems and Processing, Classification of Signals**,** The Concept of Frequency in Continuous-Time and Discrete-Time Signals**,** Analog-to-Digital and Digital-to-Analog Conversion.
2. **Discrete –time signals and systems:** Discrete time signals, discrete time systems, analysis of discrete time LTI systems, discrete time systems described by difference equations.
3. **Z-Transform:** the direct z-transform, inverse z-transform and properties of z-transform
4. **Discrete Fourier Transform (DFT):** Introduction to Fourier Transform**, f**requency domain sampling and reconstruction of discrete signals, DFT as a linear transformation, its relationship with other transforms, properties of DFT.
5. **Fast Fourier Transform (FFT):** Direct computation of DFT, need for FFT, Radix-2 FFT algorithm for computation of DFT and IDFT: decimation-in-time and decimation-in-frequency algorithms.
6. **Design of FIR filters: I**ntroduction to FIR filters, design of FIR filters using window functions, Hilbert transformer and differentiator, FIR design using frequency sampling technique.

7. **Design of IIR filters from analog filters:** Design of analog Butterworth and Chebyshev filters, mapping of transfer function: backward method, bilinear transformation and impulse invariance transformation methods, verification for stability and linearity during mapping**.**

8. **Realization of Digital Filters: Realization of FIR filters:** direct, cascade, and lattice realizations. Realization of IIR filters: direct form I and form II, cascade and parallel realizations.

Course / Learning Outcomes:

- On successful completion of this Course, the students would be able to;
  1. Explain basic concepts of signals and systems
  2. Apply z-Transform and its properties
  3. Develop algorithms to process discrete samples using Discrete Fourier transform (DFT) and Fast Fourier transform
  4. Design digital filters, FIR and IIR filters
  5. Draw realization structures for the given digital system function

Reference Books:

1. Proakis and Manolakis,(2007), *Digital Signal Processing: Principles, Algorithms and Applications*,4th edition,Pearson education,New Delhi.
2. L. C. Ludeman, (1986), *Fundamentals of Digital Signal Processing*, John Wiley and Sons, New York,.
3. S. K. Mitra,(2004), *Digital Signal Processing*, 2nd edition,TMH.
4. Oppenheim and Schaffer,(2003), Digital Signal Processing, PHI.
5. Ashok Ambardar,(1999),*Analog and Digital Signal Processing*, Thomas Learning.

UE17EC260

EMBEDDED SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- Develop knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware and wide competence from different areas of technology.
- Theoretical knowledge in the areas of real time systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
- Ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system.
- To educate students to meet current and future industrial challenges and emerging embedded systems engineering trends.

Course Outcomes:

Students completing the course should be able to

- Design and implement applications on ARM based controllers.
- Write applications in assembly and embedded C
- Develop systems with RTOS features like inter process communication, process synchronization techniques, process scheduling algorithms
- Interface peripherals with standard buses like I2C,SPI, UART,USB and SDIO
- Understand embedded system's hardware components and software tool chain.
- Design an embedded system, Debug and test it
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Course Content:

1. **Embedded System components:** Introduction to embedded systems, Overview of Embedded system blocks Physical system -Processor and peripherals Embedded software: Tool chains, Boot loader, Device Drivers, Embedded OS

2. **ARM Processor Fundamentals:** Registers, Current program status register, Pipeline, Exceptions, Interrupts and vector table, core extensions, architecture revisions, ARM Processor families.

3. **Introduction to ARM9 Instruction Set:** Data Processing Instructions, Branch Instructions, Load- store Instructions, software Interrupt Instruction, Program status register Instructions, Loading constants ARM Extensions, conditional execution. Introduction to Thumb Instruction set. Programming examples

4. **Overview of Operating Systems & RTOS:** Introduction-OS Overview, process management-Process, Process control block, Process states (5 State model), Inter Process Communication using LINUX-Pipes, FIFO.

Concurrency issues (Race condition, Deadlock, Starvation).Semaphore and Programming examples. Threads- Threads and programming example, Process Scheduling-Basic concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, RR, Priority Scheduling) , Memory management-Protection, Relocation, Partition (Fixed, Dynamic), Paging, Segmentation. RTOS features. Priority inversion, Priority inheritance and Priority ceiling.

5. **Peripherals:** Overview of Device drivers, I2C, SPI, UART, USB, SDIO overview. Case Study of Embedded Systems with RTOS.

Reference Books:

1. “ARM System Developer’s Guide – Designing and Optimizing System Software”, Andrew N Sloss, Dominic Symesand Chris Wright, Morgan Kaufmann Publishers, 2004.
2. “ARM System Architecture”, Stephen B. Furber, Addison Wesley, 1996.
3. “Operating Systems Internals and Design”, William Stallings, Person Prentice Hall, 6th Edition, 2009.
4. “Operating System Concepts”, Silberschatz, Galvin and Gagne, Wiley, 8th edition, 2010.
5. “Introduction to Embedded System”, Shibu K.V., Tata McGraw Hill, 2009

UE17EC240

COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

- The objective of this course is to give the students an in-depth understanding and hands on experience of internet protocols and algorithms.
- This course aims to enable the students to design and analyze simple computer networks.
- The course begins with an introduction to the internet architecture and service models. A top down approach is followed to explain the complex operation of sending data from one host to another.
- The standard application protocols, transmission protocols, networking protocols and MAC layer protocols are covered.

Course Outcomes:

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

1. Analyze the internet protocols related to the application layer, transport layer, network layer and link layer
2. Design simple computer networks using GNS3 and analyze packet capture using Wireshark
3. Implement routing algorithms, client and server socket programs
4. Solve numerical problems and logical problems in the design of computer networks
5. Apply networking concepts to simple projects in the computer networks

Course Content:

1. **Introduction:** Introduction to internet, ISPs and their hierarchy, Access networks and Physical media, Delays in transmission, circuit and packet switching, core networks, Concept of protocol stack and TCP/IP model, National and international Internet regulatory authorities;
2. **Application layer and Sockets:** Architectures and service models, HTTP, FTP, Mail access protocols (SMTP, POP3 and IMAP), DNS, Peer-to-peer applications (Torrent, DHT and Skype), Introduction to Sockets, Socket programming, Connectionless Transport (UDP sockets), Connection Oriented Transport (TCP sockets)
3. **Transport Layer and Network Layer:** UDP segment structure, TCP segment structure, Reliable data transfer under TCP, Congestion control, Flow control; Internal organisation of a Router, IPv4 Addressing format, CIDR, sub-netting and super-netting, IPv4 Datagram format, Network address translation (NAT), ICMP, IPv6 addressing and datagram format.
4. **Routing**: Dijkstra and Bellman-Ford routing algorithms, RIP, OSPF, BGP, Brief treatment of IS-IS, Brief overview of MPLS, Brief overview of SDN.
5. **Link Layer:** Role and importance of link layer, Error detection and error correction techniques, switching and addressing, Forwarding and filtering, Basic random access techniques, Ethernet: protocol and frame format, Point to Point Protocol (PPP), Virtual Local Area Networking (VLAN);

Prerequisite Course : None

Reference Books:

1. "Computer Networking: A Top Down Approach", James F Kurose and Keith W Ross, 6th Edition, Pearson Education, 2013.
2. "Computer Networks", Andrew S. Tanenbaum, 4th Ed., Prentice Hall, 2003
3. "Telecommunication Networks, Protocols, Modeling and Analysis", Schwartz M, 2nd Edition., Addison-Wesley, 1987.
4. "Data and Computer Communications", William Stallings, 8th Edition, Prentice Hall, 2007.

UE17EC160

REAL TIME EMBEDDED SYSTEMS (4-0-0-0-4)

Course Objectives:

- The primary goal of this course is to meet the basics of real-time systems and enable the students with the knowledge and skills necessary to design and develop embedded applications by means of real-time operating systems.

Course outcomes

Students completing the course should be able to

1. Use the multitasking techniques in real-time systems.
2. Use real time scheduling policies in applications
3. Design embedded applications using RTOS.
4. Use RTOS software mechanisms
5. Identify real time service and estimate the WCET and schedule it

Course Content:

1. **Introduction to Real-Time Embedded Systems:** Brief history of Real Time Systems, A brief history of Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Reentrant Functions.
2. **Processing:** Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies. **I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
3. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems. **Multi-resource Services:** Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion
4. **Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services **Embedded System Components:** Firmware components, RTOS system software mechanisms, Software application components.
5. **High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable Software, Available Software, Design trade offs, Hierarchical applications for Fail-safe design.

Reference Books:

1. Sam Siewert, 2007, *“**Real-Time Embedded Systems and Components**”***,** Cengage Learning India Edition,.
2. Dreamtech Software Team, 2008, ***“Programming for Embedded Systems”***, Jhon Wiley, India Pvt. Ltd.
3. Qing Li and Croline Yao “Real Time Concepts for Embedded Systems”, CMP Books,India Edition,2011