COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC302	DIGITAL COMMUNICATION	4-0-0-4	2015

Pre-requisites: MA201 Linear Algebra & Complex Analysis, MA204 Probability, Random Processes and Numerical Methods, EC301 Digital Signal Processing

Course Objectives:

1. To understand the concept of Digital representation of analog source
2. To understand the Performance comparison various pulse modulation schemes
3. To discuss Inter Symbol Interference (ISI) problem in digital communication and to derive the Nyquist Criteria for zero ISI in data Transmission
4. To understand signal space representation of signal using Gram Schmidt orthonormalisation procedure
5. To analyse the error probability for different modulation schemes like BPSK, BFSK, and QPSK.
6. To understand the principle of spread spectrum communication and to illustrate the concept of FHSS and DSSS
7. To understand various Multiple Access Techniques

Expected outcome:

At the end of the course, students will be able to

1. Illustrate the digital representation of analog source
2. Compare the performance of various Digital Pulse Modulation Schemes
3. Apply the knowledge of ISI problems in Digital communication to derive Nyquist criteria for zero ISI
4. Analyse the need for introducing ISI in Digital Communication in a controlled manner
5. Construct signal space representation of signal using Gram Schmidt orthonormalisation procedure
6. Compare the error probability for different digital modulation schemes like BPSK, BFSK, QPSK etc.
7. Describe the principle of spread spectrum communication and to illustrate the concept of FHSS and DSSS
8. Understand various Diversity Technique

Syllabus

Overview of Digital Communication, Pulse Code Modulation (PCM), Modifications of PCM, Transmission over baseband channel, Transmission over AWGN Channel, Digital Modulation Schemes, Spread spectrum communication, Transmission over fading channel,Diversity techniques

Text Books

1. Symon Haykins, Digital Communication Systems, Wiley India, 2013.
2. John G Proakis, Masoud Salehi, Digital Communication, McGraw Hill Education Edition, 2014

References:

1. John G Proakis, Masoud Salehi, Gerhard Bauch, Modern Communication Systems using Matlab, Cengage Learning India Pvt Ltd, 2013
2. Nishanth N, Digital Communication, Cengage Learning India Pvt Ltd, 2016
3. Symon Haykins, Communication Systems, 4/e Wiley India, 2012.
4. T L Singal, Digital Communication, McGraw Hill Education (India) Pvt Ltd, 2015

5. Ramakrishna Rao, Digital communication, Tata McGraw Hill Education Pvt. Limited.
6. Hari Bhat, Ganesh Rao, Digital Communication, 3/e, Pearson, 2010
7. Robert G. Gallagar/Principles of Digital Communication, Cambridge University Press, 2008

Course Plan

Module	Course content (54 hrs)	Hours	Sem. Exam Marks
I	**Overview of Digital Communication**- Comparison with Analog Communication **Overview of Random variables and Random process** -Stationarity, Transmission of Random Process through LTI systems, Power Spectral Density (PSD), Importance of random variables and random process in digital communication	4	15
	Pulse Code Modulation (PCM): Pulse Modulation, Sampling process, Performance comparison of various sampling techniques Aliasing, Reconstruction, PAM, Quantization, Noise in PCM system,	**5**	
II	**Modifications of PCM**: Delta modulation, DPCM, ADPCM, ADM, Performance comparison of various pulse modulation schemes, Line codes, PSD of various Line codes.	**5**	**15**
	Transmission over baseband channel: Matched filter, Inter Symbol Interference (ISI), Nyquist Criteria for zero ISI, Ideal solution, Raised cosine spectrum, Eye Pattern	**5**	
FIRST INTERNAL EXAM			
III	**Signal Space Analysis:**Geometric representation of signals, Gram Schmidt orthogonization procedure.	**5**	**15**
	Transmission Over AWGN Channel: Conversion of the continuous AWGN channel into a vector channel, Likelihood function, Maximum Likelihood Decoding, Correlation Receiver	**5**	
IV	**Digital Modulation Schemes:** Pass band transmission model**,** Coherent Modulation Schemes-BASK, BPSK, QPSK, BFSK**,** Non-Coherent orthogonal modulation schemes**,** Differential Phase Shift Keying (DPSK)**,** Detection of Binary modulation schemes in the presence of noise**,** BER for BASK, BPSK, QPSK, BFSK	**8**	**15**
SECOND INTERNAL EXAM			
V	**Spread spectrum communication:** Pseudo noise sequences, Properties of PN sequences. Generation of PN Sequences, Direct Sequence Spread Spectrum (DSSS), Anti jam Characteristics, Frequency Hop spread spectrum with MFSK, Slow and Fast frequency hopping.	**6**	**20**
	Multicarrier Communication: Overview of Orthogonal Frequency	**5**	

	Division Multiplexing (OFDM), Generation and demodulation of OFDM		
VI	**Transmission over fading channel**: multipath channels, classification, Coherence time, Coherence bandwidth, Statistical characterization of multi path channels **Diversity techniques:** Diversity in time, frequency and space.	**6**	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 70 % for theory, derivation, proof and 30% for logical/numerical problems.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC304	VLSI	3-0-0-3	2015

Prerequisite:
PH 100 Engineering Physics, EC203 Solid State Devices, EC204 Analog Integrated Circuit.

Course objectives:
To get the knowledge about IC Fabrication Techniques and to get the skill of analysis and design of MOSFET and CMOS logic circuits.

Syllabus:

IC Fabrication Technology**,** CMOS IC Fabrication Sequence, CMOS inverters, Design rules, Static CMOS Design, Dynamic CMOS circuits, Pass transistor, Read Only Memory, Random Access Memory, Sense amplifiers, Adders, multipliers, Testing of VLSI circuits

Expected outcome:

- At the end of the course, students will be able to Design and Analysis of various MOSFET and CMOS logic circuits

Text Books:

1. S.M SZE, VLSI Technology,2/e, Indian Edition, McGraw-Hill,2003
2. John P Uyemura, Introduction to VLSI Circuits and Systems, Wiley India, 2006

References:

1. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003.
2. Razavi - Design of Analog CMOS Integrated Circuits,1e, McGraw Hill Education India Education, New Delhi, 2003.
3. Jan M.Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.
4. Neil H.E.Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005
5. Yuan Taur& Ning, Fundamentals of Modern VLSI Devices,Cambridge University Press,2008

Course Plan

Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	**Material Preparation**- Purification, Crystal growth (CZ and FZ process), wafer preparation **Thermal Oxidation-** Growth mechanisms, Dry and Wet oxidation, Deal Grove model.	4	15
	Diffusion- Fick's Laws, Diffusion with constant surface concentration and from a constant source, diffusion techniques. **Ion implantation**-Technique, Range Theory, annealing.	3	

II	**Epitaxy :** Vapour phase epitaxy and molecular beam epitaxy **Lithography-** Photo lithographic sequence, Electron Beam Lithography, Etching and metal deposition	**4**	**15**
	Methods of isolation **Circuit component fabrication:** transistor, diodes, resistors, capacitors, N-well CMOS IC Fabrication Sequence	**3**	
FIRST INTERNAL EXAM			
III	**CMOS inverters**- DC characteristics, switching characteristics, power dissipation	**4**	**15**
	Layout Design rules, layout of CMOS Inverter, two input NAND and NOR gates	**3**	
IV	**Static CMOS Design**- basic concept, multiple input CMOS logic circuits, static properties, propagation delay and transistor sizing **Dynamic CMOS circuits**- Issues with dynamic circuits, Domino logic	**4**	**15**
	MOSFET Logic Design -Pass transistor logic, Complementary pass transistor logic and transmission gate logic , realization of functions	**3**	
SECOND INTERNAL EXAM			
V	**Read Only Memory**-4x4 MOS ROM Cell Arrays(OR,NOR,NAND) **Random Access Memory** –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell	**4**	**20**
	Sense amplifiers –Differential Voltage Sensing Amplifiers Introduction to PLDs and FPGAs, Design of PLAs.	**3**	
VI	**Adders**- Static adder, Carry-By pass adder, Linear Carry- Select adder, Square- root carry- select adder, Carry-Look ahead adder **Multipliers**-Array multiplier.	**4**	**20**
	Design for Testability – Fault types and models, Controllability and Observability, Scan based Techniques, Built-In Self-Test Techniques tools.	**3**	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 70 % for theory, derivation, proof and 30% for logical/numerical problems.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC306	ANTENNA & WAVE PROPAGATION	3-0-0 -3	2015

Prerequisite:EC303 Applied Electromagnetic Theory

Course objectives:

1. To learn the basic working of antennas.
2. To study various antennas, arrays and radiation patterns of antennas.
3. To understand various techniques involved in various antenna parameter measurements.
4. To understand the propagation of radio waves in the atmosphere

Syllabus:

Basic principles of antenna and antenna parameters. Duality of antennas. Derivation of electromagnetic fields and directivity of short dipole and half wave dipole. Measurement of antenna parameters Antenna arrays and design of End fire, broadside, binomial and Dolph Chebyshev arrays Principles of practical antennas. Travelling wave antennas, principle and applications of V and rhombic antennas Principles of Horn, Parabolic dish antenna and Cassegrain antenna Log periodic antenna array and Helical antenna. Design of rectangular Patch antennas. Principle of smart antenna Radio wave propagation, Different modes, effect of earth's magnetic field, Fading and diversity techniques.

Expected outcome:

After completion of the course the student will be able to know:

- The basic working of antennas
- Various antennas, arrays and radiation patterns of antennas
- Various techniques involved in various antenna parameter measurements.
- The propagation of radio waves in the atmosphere.

Text Books:

1. John D. Krauss, Antennas for all Applications, 3/e, TMH.
2. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.

References:

1. Jordan E.C. & K G Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI, 2000
2. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.
3. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Interscience,2005
4. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013.
5. Sisir K.Das & Annapurna Das,Antenna and Wave Propagation,McGraw Hill,2015

Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Radio wave propagation , Modes , structure of atmosphere, sky wave propagation , effect of earth's magnetic field , Ionospheric abnormalities and absorption , space wave propagation , LOS distance	4	15
	Field strength of space wave, duct propagation, VHF and UHF Mobile radio propagation, tropospheric scatter propagation, fading and diversity techniques.	4	
II	Principle of Log periodic antenna array and Helical antenna.	3	15

	Antennas for mobile base station and handsets.,		
	Design of rectangular Patch antennas. Principle of smart antenna.	3	
FIRST INTERNAL EXAM			
III	Basic principle of beam steering. Traveling wave antennas. Principle and applications of V and rhombic antennas. Principles of Horn, Parabolic dish antenna, Cassegrain antenna	6	**15**
IV	Arrays of point sources - field of two isotropic point sources - principle of pattern multiplication - linear arrays of 'n' isotropic point sources. Grating lobes.	4	**15**
	Design of Broadside, Endfire & Binomial arrays. Design of Dolph Chebyshev arrays.	4	
SECOND INTERNAL EXAM			
V	Concept of retarded potential. Field, directivity and radiation resistance of a short dipole and half wave dipole.	4	**20**
	Measurement of radiation pattern, gain, directivity and impedance of antenna	3	
VI	Basic antenna parameters - gain, directivity, beam solid angle, beam width and effective aperture calculations. Effective height - wave polarization - antenna temperature - radiation resistance - radiation efficiency - antenna field zones - principles of reciprocity. Duality of antennas.	7	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 308	EMBEDDED SYSTEMS	3-0-0 -3	2015

Prerequisite:EC206 Computer Organization, EC305 Microprocessors & Microcontrollers

Course objectives:

1. To have a thorough understanding of the basic structure and design of an Embedded System
2. To study the different ways of communicating with I/O devices and standard I/O interfaces.
3. To study the basics of RTOS for Embedded systems.
4. To study the programming concepts of Embedded Systems
5. To study the architecture of System-on-Chip and some design examples.

Syllabus:

Introduction to Embedded Systems, Embedded system design process, Serial and parallel communication standards and devices, Memory devices and device drivers, Programming concepts of embedded programming - Embedded C++ and embedded java, Real Time Operating Systems Micro C/OS-II.

Expected outcome:

The student should able to:

1. Understand the basics of an embedded system
2. Develop program for an embedded system.
3. Design, implement and test an embedded system.

Text Books:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TMH, 2003.
2. K.V.Shibu - Introduction to Embedded Systems, 2e, McGraw Hill Education India,2016.

References:

1. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
2. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
3. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
4. David E.Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
5. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003.

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks

I	Introduction to Embedded Systems– Components of embedded system hardware–Software embedded into the system –Embedded Processors - CPU architecture of PIC and ARM processors – CPU Bus Organization and Protocol. Design and Development life cycle model - Embedded system design process – Challenges in Embedded system design.	7	**15**
II	Serial Communication Standards and Devices - UART, HDLC, SCI and SPI. Serial Bus Protocols - I2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus.	6	**15**
FIRST INTERNAL EXAM			
III	Memory devices and systems - memory map – DMA - I/O Devices – Interrupts - ISR – Device drivers for handling ISR – Memory Device Drivers – Device Drivers for on-board bus.	6	**15**
IV	Programming concepts of Embedded programming – Features of Embedded C++ and Embedded Java. Software Implementation, Testing, Validation and debugging, system-on- chip. Design Examples: Mobile phones, ATM machine, Set top box.	7	**15**
SECOND INTERNAL EXAM			
V	Inter Process Communication and Synchronization -Process, tasks and threads –Shared data– Inter process communication - Signals – Semaphore – Message Queues – Mailboxes – Pipes –Sockets – Remote Procedure Calls (RPCs).	8	**20**
VI	Real time operating systems - Services- Goals – Structures - Kernel - Process Management – Memory Management – Device Management – File System Organization. Micro C/OS-II RTOS - System Level Functions – Task Service Functions – Memory Allocation Related Functions – Semaphore Related Functions. Study of other popular Real Time Operating Systems.	8	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

SYLLABUS AND COURSE PLAN			
COURSE CODE	**COURSE NAME**	**L-T-P-C**	**YEAR OF INTRODUCTION**
EC 312	**OBJECT ORIENTED PROGRAMMING**	**3-0-0-3**	**2015**

Prerequisite:NIL

Course objectives:

- To introduce the Object Oriented Programming paradigm using C++ and Java as the languages.
- To learn simple Android application development from the fundamentals.

Syllabus:

Object Oriented Programming and basics of C++, Advanced features of C++ programming such as exception handling and templates. Object oriented features of Java and their implementation. Advanced features of Java including packages, multithreading and error management. Introduction to Android application development with a case study.

Expected outcome:

On completion of this course, the students have:

- A thorough understanding of the features of OOP like class construction, polymorphism and inheritance of C++ and Java.
- An understanding of advanced features of C++ such as templates, abstract classes and virtual functions.
- Knowledge of advanced features of Java such as multithreading, packages and error management.
- Skills in designing android application development.
- Skills in debugging, deploying and testing mobile applications.

Text Books:

1. Hardy, Brian, and Bill Phillips, Android Programming: The Big Nerd Ranch Guide. Addison-Wesley Professional, 2013.
2. E Balagurusamy, Object Oriented Programming with C++ and JAVA, McGrawHill, 2015

References:

1. Samanta, Debasis, Object-Oriented programming with C++ and Java, PHI Learning Pvt. Ltd., 2006.
2. Stroustrup, Bjarne. The C++ programming language, Pearson Education India, 1986.
3. Horstmann, Cay S., and Gary Cornell., Core Java 2: Volume I, Fundamentals, Pearson Education, 2002.
4. Deitel, Harvey M., and Paul J. Deitel., Java how to program.,7th International edition." (2007): 390-420.
5. G. Booch, R. A. Maksimchuk, M. W. Engel, and B J. Young, Object-oriented Analysis and Design with Applications, Addison-Wesley, 3rd Edition, 2007.
6. www.tutorialspoint.com/android/android_tutorial.pdf

Course Plan	

Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Concepts of OOP - Introduction to OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP.	2	15
	Beginning with C++: Overview and Structure of C++ Program, Classes and Objects, Constructors and Destructors.	4	
II	Operator Overloading and Inheritance - Overloading Unary Operators, Overloading Binary Operators, Overloading Binary Operators using Friends, Manipulation of Strings Using Operators.	4	15
	Inheritance - Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance. Virtual Base Classes, Abstract Classes, Constructors in Derived Classes, Member Classes: Nesting of Classes	4	
FIRST INTERNAL EXAM			
III	Virtual Functions and Polymorphism - Pointers to objects, this pointer, Pointers to derived classes, Virtual functions, Virtual Constructors and Destructors.	6	15
	Templates and Exception Handling	2	
IV	Programming with JAVA - Overview of Java Language, Classes Objects and Methods, Method Overloading and Inheritance, Overriding Methods, Final Variables and Methods, Working with files – File stream operation, file pointers and their manipulation, File updation.	6	15
SECOND INTERNAL EXAM			
V	Interfaces, Packages and Multithreading - Interfaces: Multiple Inheritance, Packages - Java API packages, Multithreaded programming, Managing Errors and Exceptions.	7	20
VI	Introduction to Android : Setting up Development Environment, Basic Building blocks - Activities, Services, Broadcast Receivers & Content providers, UI Components - Views & notifications, Components for communication -Intents & Intent Filters, Application Structure-Android Manifest.xml, uses-permission & uses-sdk, Layouts & Drawable Resources, First sample Application, Emulator-Android Virtual Device, Basic UI design, Styles & Themes, Content Providers-SQLite Programming, Case study – Develop an App to demonstrate database usage.	7	20
END SEMESTER EXAM			

Assignment:

1. A group assignment on simple android mobile app (eg: managing students' details and rank calculation of a class).
2. Assignment for implementing virtual base class in C++ related to some application.

3. Assignment for implementing a simple interactive applet in Java (eg: calculator)

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 30 % for theory and 70% for logical/numerical problems, programming, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 362	MODELLING & SIMULATION OF COMMUNICATION SYSTEMS	3-0-0-3	2015

Prerequisite: MA204 Probability, Random Processes and Numerical Methods, EC301 Digital Signal Processing

Course objectives:

1. To impart the basic concepts of modeling and simulation of Communication Systems
2. To study and evaluate the behavior and performance of the systems.

Syllabus: Simulation and Modelling Methodology, Review of Random Processes, Random Number generation, Modelling of Transmitter and Receiver subsystems, Communication channels and models, Estimation of parameters in simulation, Estimation of performance measures from simulation, Analysis of simulation results.

Expected outcome:

The student should be able to

- Apply modelling and computational techniques to problems in the communication field.

Text Books:

1. M.C. Jeruchim, Philip Balaban , K.Sam Shanmugam, Simulation of communication systems, Kluwer Academic/Plenum Press, New York, 2000
2. Raj Jain. The Art of Computer Systems Performance Analysis, John Wiley and Sons, 1991 (Chapter 25)

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks
I	Simulation and Modelling Methodology**:** Review of Random Processes, Univariate and multivariate models, Transformation of random variables	3	15
	Bounds and approximations, Random process models, Markov and ARMA Sequences, Poisson Process, Gaussian Process	3	
	Random Number Generation , Generation of Random sequences	1	
	Testing Random Number Generators	1	
II	Modelling of Transmitter and Receiver subsystems: Information sources	1	15
	Channel coding ,Radio frequency and optical modulation,	2	
	Demodulation and detection , Filtering	1	
	Multiple Access : Issues in the simulation of Multiple Access	1	
FIRST INTERNAL EXAM			
III	Communication channels and models: Fading and multipath channels, The Almost Free space channel	3	15

	Conducting and Guided wave media	1	
	Finite state channel models, Methodology for simulating Communication systems operating over Fading Channels.	4	
IV	Estimation of parameters in simulation: Quality of an estimator, Estimating the average level of a waveform,	3	**15**
	Estimating the average power of a waveform, Estimating the power spectral density of a process	2	
	Estimating Delay and Phase.	2	
SECOND INTERNAL EXAM			
V	Estimation of performance measures from simulation: Estimation of SNR	3	**20**
	Estimating Performance measures for digital systems-The Monte Carlo Method	2	
	Importance sampling method	2	
VI	Analysis of simulation results: Model Verification Techniques, Model Validation Techniques	3	**20**
	Transient Removal, Terminating Simulations	2	
	Stopping Criteria, Variance Reduction	2	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 30 % for theory and 70% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC364	**COMPUTER VISION**	**3-0-0-3**	**2015**

Prerequisite: MA204 Probability, Random Processes and Numerical Methods, EC301 Digital Signal Processing

Course objectives:

1. To review image processing techniques for computer vision
2. To understand shape and region analysis
3. To understand three-dimensional image analysis techniques and motion analysis
4. To study some applications of computer vision algorithms
5. To introduce methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving

Syllabus:

Review of Image processing operations, Image formation models, Image processing and feature extraction, Motion Estimation, Shape representation and Object recognition.

Expected outcome:

The student should able to:

1. Implement fundamental image processing techniques required for computer vision
2. Perform shape analysis and boundary tracking techniques
3. Implement motion related techniques
4. To develop applications using computer vision techniques

Text Books:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall,2002
2. Robot Vision, B. K. P. Horn, McGraw-Hill,1986

References:

1. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
2. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011

Course Plan

Module	Course content	Hours	Sem. Exam Marks
I	Review of image processing techniques : filtering , thresholding	1	15
	Mathematical morphology, Texture	1	
	Binary shape analysis, connectedness , object labelling and counting	2	
	Boundary descriptors	1	
II	Monocular and binocular imaging system	2	15
	Orthographic & Perspective Projection	2	
	Camera models	2	

	Camera Calibration, Stereo vision: introduction; concept of disparity and its relationship with depth	3	
FIRST INTERNAL EXAM			
III	Image Processing for Feature Detection and Image Synthesis, Edge detection	1	**15**
	Corner detection, Harris corner detection algorithm, Line and curve detection,Hough transform	3	
	SIFT operator, Mosaics, snakes	2	
IV	Shape from X - Shape from shading, Photometric stereo, Texture, Occluding contour detection.	3	**15**
	Motion Analysis- Regularization theory,Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method	4	
	Structure from motion.	2	
SECOND INTERNAL EXAM			
V	Object recognition: Hough transforms and other simple object recognition methods	3	**20**
	Shape correspondence and shape matching ,Principal Component Analysis	**3**	
	Shape priors for recognition	**1**	
VI	Application: Photo album, Face detection, Face recognition , Eigen faces , Active appearance and 3D shape models of faces	**3**	**20**
	Application: In-vehicle vision system: locating roadway, road markings, identifying road signs, locating pedestrians	**3**	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC366	REAL TIME OPERATING SYSTEMS	3-0-0-3	2015

Prerequisite: EC206 Computer Organization

Course objectives:

- To understand the basics of operating systems tasks and basic OS architectures and develop these to RTOS
- To understand concepts of task scheduling
- To understand problems and issues related with multitasking
- To learn strategies to interface memory and I/O with RTOS kernels
- To impart skills necessary to develop software for embedded computer systems using a real-time operating system.

Syllabus:

Introduction to OS and RTOS, Process management of OS/RTOS, Process Synchronization, Memory and I/O management, Applications of RTOS

Text Books:

1. Jean J Labrosse,Embedded Systems Building Blocks Completeand Ready-to-use Modules in C,CMP books,2/e, 1999.
2. C.M.Krishna and G.Shin, Real Time Systems, McGraw-Hill International Edition, 1997.

References:

1. Wayne Wolf, Computers as Components: Principles ofEmbedded Computing System Design, 2/e, Kindle Publishers,2005.
2. Tanenbaum, Modern Operating Systems, 3/e, Pearson Edition, 2007.
3. Real-Time Embedded Components and Systems: With Linux and RTOS (Engineering) by Sam Siewert, John Pratt ,2015
4. Micro C/OS-II, The Real Time Kernel, CMP Books, Jean J Labrosse, 2011
5. VxWorks: Programmer's Guide 5.4, Windriver, 1999

Course Plan

Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Operating system objectives and functions, Virtual Computers, Interaction of O. S. & hardware architecture, Evolution of operating systems	2	15
	Architecture of OS (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures)	3	
	Batch, Multi programming, Multitasking, Multiuser, parallel, distributed & real –time O.S.	3	

II	Uniprocessor Scheduling: Types of scheduling	2	**15**
	Scheduling algorithms: FCFS, SJF, Priority, Round Robin,	3	
	UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept	3	
III	Concurrency: Principles of Concurrency, Mutual Exclusion H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques	2	**15**
	Classical Problems of Synchronization: Readers-Writers Problem, Producer Consumer Problem, Dining Philosopher problem.	3	
	Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategies.	3	
IV	Memory Management requirements, Memory partitioning: Fixed, dynamic, partitioning	2	**15**
	Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Fragmentation, Swapping, Segmentation, Paging, Virtual Memory, Demand paging	3	
	Page Replacement Policies (FIFO, LRU, Optimal, clock), Thrashing, Working Set Model	2	
V	I/O Management and Disk Scheduling: I/O Devices, Organization of I/O functions	2	**20**
	Operating System Design issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), Disk Caches	3	
VI	Comparison and study of RTOS: Vxworks and µCOS	3	**20**
	Case studies: RTOS for Control Systems.	3	

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC368	ROBOTICS	3-0-0 -3	2015

Prerequisite:EC307 Power Electronics &Instrumentation, EC305 Microprocessors & Microcontrollers

Course objectives:

To impart knowledge about the engineering aspects of Robots and their applications.

Syllabus: Robots: Introduction, anatomy, Robot specifications, Robot characteristics, Areas of application, classification of robots. Robotic arm, Sensors, Encoders, Tachometers,Robotic drive systems and actuators, Specification, principle of operation and areas of application of: DC motor, Stepper motor, Servo motor and brushless DC motor, Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge, Robotic vision systems, Image processing techniques, kinematics, inverse kinematics, Velocity kinematics, Application of velocity kinematics for all serial manipulators, Digital and Programmable Logic (PLC) controllers. Robot Programming, Industrial applications of Robots, Mobile robots, Microbots , Recent developments in Robotics.

Expected outcome:

- On completion of this course, the students will have a thorough understanding about Robots and their applications
- Students will be able to analyse and design robotic structures.

Text Books:

1. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
2. Mikell and Groover, Industrial Robotics – Technology, Programming and Applications,McGraw Hill, 2e,2012
3. Saeed B. Niku Introduction to Robotics. Analysis and control, applications- Wiley student edition,2010

References:

1. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach,PHI,2007
2. Fu, K.S,Gonzalez,R.C,Lee, C.S.G.,Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill,1987.
3. John. J.Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005.
4. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education,2000
5. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.
6. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006

Course Plan

Module	Course content (42 hrs)	Hours	Sem. Exam Marks

I	Introduction – Definition and origin of robotics, Robot Anatomy, Robot specifications, Robot characteristics – accuracy, precision, repeatability, Areas of application, classification of robots. Robotic arm – Components and structure, Types of joints and workspace, Common kinematic arrangements, Wrists, End effectors- classifications, tools and grippers.	**7**	**15**
II	Sensors: Types and applications of sensors in Robotics, position and displacement sensors, Tactile sensors, Proximity and Range Sensors, Strain gauge based force-torque sensors, Encoders, Tachometers. Robotic drive systems and actuators: Hydraulic, Pneumatic and Electric drives. Specification, principle of operation and areas of application of: DC motor, Stepper motor, Servo motor and brushless DC motor. Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge.	6	**15**
FIRST INTERNAL EXAM			
III	Robotic vision systems: Imaging, Sensing and Digitization, Image processing techniques, Areas of application in robotics and future scope. Introduction to kinematics: Position and orientation of objects, Rotation, Euler angles, Rigid motion representation using Homogenous Transformation matrix.	7	**15**
IV	Forward kinematics: Link coordinates, Denavit-Hartenberg Representation, Application of DH convention to different serial kinematic arrangements fitted with spherical wrist. Inverse kinematics – General properties of solutions, Kinematic Decoupling, Inverse kinematic solutions for all basic types of three-link robotic arms fitted with a spherical wrist.	10	**15**
SECOND INTERNAL EXAM			
V	Velocity kinematics – Derivation of the Jacobian, Application of velocity kinematics for all serial manipulators, importance of Singularities. Manipulator Dynamics. Introduction to Legrangian mechanics and Dynamic equation for 2 DOF robots, Introduction to position control and force control of robotic manipulators, Robot actuation and control using PID, Digital and Programmable Logic (PLC) controllers.	5	**20**
VI	Robot Programming – Programming methods, Robot language classification, Robot language structure, elements and its functions. Motion, End-effecter and Sensor commands in VAL programming language. Simple programs. Industrial applications of Robots in Material handling, Machine loading and unloading, Assembly and spray painting. Mobile robots, Microbots , Recent developments in Robotics.	7	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 70 % for theory and 30% for logical/numerical problems, programming, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 370	DIGITAL IMAGE PROCESSING	3-0-0 -3	2015

Prerequisite: MA204 Probability, Random Processes and Numerical Methods, EC301 Digital Signal Processing

Course objectives:

- To study the image fundamentals and mathematical transforms necessary for image transform
- To study the image enhancement techniques
- To study image restoration procedures
- To study image compression procedures
- To study image segmentation and representation techniques

Syllabus:

Digital image fundamentals, 2D Transforms, Image enhancement, Image restoration, Image segmentation, Image compression

Expected outcome:

The student should able to:

1. Distinguish / Analyse the various concepts and mathematical transforms necessary for image processing
2. Differentiate and interpret the various image enhancement techniques
3. Illustrate image segmentation algorithm
4. Analyse basic image compression techniques

Text Books:

1. I.Gonzalez Rafel C, Digital image Processing ,Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, Digital image processing ,Tata Mc Graw Hill,2015

References:

1. Fundamentals of digital image processing: Jain Anil K, PHI,1988
2. Digital image processing : Kenneth R Castleman, Pearson Education,2e,2003
3. Digital Image Processing: Pratt William K, John Wiley,4e,2007

Course Plan

Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model	3	15
	Vidicon and Digital Camera working principles	1	
	brightness, contrast, hue, saturation, mach band effect,	1	
	colour image fundamentals-RGB, CMY, HIS models, 2D sampling, quantization.	2	
II	Review of matrix theory, row and column ordering- Toeplitz, Circulant and block matrix,	2	15
	2D transforms - DFT, its properties, Walsh transform, Hadamard	3	

	transform, Haar transform,		
	DCT, KL transform and Singular Value Decomposition.	3	
FIRST INTERNAL EXAM			
III	Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging	3	**15**
	Spatial filtering- smoothing filters, sharpening filters	1	
	Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter.	2	
IV	Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration	2	**15**
	inverse filtering- removal of blur caused by uniform linear motion, Weiner filtering,	2	
	Geometric transformations-spatial transformations	2	
SECOND INTERNAL EXAM			
V	Classification of Image segmentation techniques, region approach, clustering techniques	2	**20**
	segmentation based on thresholding, edge based segmentation	2	
	classification of edges, edge detection, hough transform, active contour	3	
VI	need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding, dictionary based compression, transform based compression,	5	**20**
	Image compression standards- JPEG& MPEG, vector quantization, wavelet based image compression.	3	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC332	COMMUNICATION ENGG LAB (ANALOG & DIGITAL)	0-0-3-1	2015

Prerequisite:

EC204 Analog Integrated Circuit, EC208 Analog Communication Engineering, EC302 Digital Communication.

Course objectives:

To provide experience on design, testing, and analysis of few electronic circuits used for communication engineering.

List of Experiments:

Cycle I (Six mandatory)

1. AM generation using discrete components.
2. AM using multiplier IC AD534 or AD633.
3. AM detection using envelope detector.
4. IF tuned amplifier.
5. FM using 555 IC.
6. FM generation and demodulation using PLL.
7. Frequency multiplier using PLL
8. Pre-emphasis and de-emphasis circuits
9. Analog signal sampling & Reconstruction

Cycle II (Six mandatory)

10. Generation of Pseudo Noise Binary sequence using Shift registers
11. Time Division Multiplexing and Demultiplexing
12. Generation & Detection of DM/SIGMA DELTA/ ADM
13. Generation & Detection of PAM/PWM/PPM
14. Generation & Detection of BPSK/DPSK/DEPSK
15. Generation & Detection of PCM
16. 16 QPSK Modulation and Demodulation

Expected outcome:

The student should able to:

1. Understand the basic concepts of circuits used in communication system.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 334	MICROCONTROLLER LAB	0-0-3-1	2015

Prerequisite:
EC305 Microprocessors & Microcontrollers

Course objectives:

- To understand Assembly Language/embedded C programming of Microcontroller.
- To interface simple peripheral devices to a Microcontroller.
- To equip student groups to design and implement simple embedded systems .

List of Experiments:

Programming experiments using 8051 simulator (KEIL).

1. Addition and subtraction.
2. Multiplication and division.
3. Multiplication by shift and add method.
4. Addition of series of 8 bit binary and decimal numbers.
5. Subtraction of 2 decimal numbers.
6. Sorting of a series of 8 bit numbers.
7. Multiplication by shift and add method.
8. LCM and HCF of two 8 bit numbers.
9. Matrix addition

Interface experiments - Direct down loading the programs from Personal computer.

1. Display (LED, Seven segments, LCD) interface.
2. Parallel interfacing I/O ports (Matrix keyboards)
3. ADC interface.
4. DAC interface with wave form generation.
5. Stepper motor interface.
6. Relay interface.
7. Serial communication with PC
8. Interfacing with serial EEPROM
9. I2C communication with 8051: Read, write and validate data from a serial EPROM or I2C based temperature sensor etc.
10. Simple project work including multiple peripheral interfaces.

Expected outcome:

The student should able to:

1. Program Micro controllers.
2. Interface various peripheral devices to Micro controller.
3. Function effectively as an individual and in a team to accomplish the given task.