RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2019 – 2021

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

M. TECH (DIGITAL ELECTRONICS AND COMMUNICATION)

I – IV Semester M. TECH

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Ramaiah Institute of Technology (RIT) (formerly known as M. S. Ramaiah Institute of Technology) is a self-financing institution established in Bangalore in the year 1962 by the industrialist and philanthropist, Late Dr. M S Ramaiah. The institute is accredited with "A" grade by NAAC in 2014 and all engineering departments offering bachelor degree programs have been accredited by NBA. RIT is one of the few institutes with prescribed faculty student ratio and achieves excellent academic results. The institute was a participant of the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. All the departments have competent faculty, with 100% of them being postgraduates or doctorates. Some of the distinguished features of RIT are: State of the art laboratories, individual computing facility to all faculty members. All research departments are active with sponsored projects and more than 150 scholars are pursuing PhD. The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus. RIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air conditioned library with over 1,35,427 books with subscription to more than 300 International and National Journals. The Digital Library subscribes to several online e-journals like IEEE, JET etc. RIT is a member of DELNET, and AICTE INDEST Consortium. RIT has a modern auditorium, several hi-tech conference halls and all are air-conditioned with video conferencing facilities. It has excellent hostel facilities for boys and girls. RIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. RIT obtained Academic Autonomy for all its UG and PG programs in the year 2007. As per the National Institutional Ranking Framework, MHRD, Government of India, Ramaiah Institute of Technology has achieved 64th rank in 2019 among the top 100 engineering colleges across India.

About the Department

The Department of Electronics and Communication was started in 1975 and has grown over the years in terms of stature and infrastructure. The department has well equipped simulation and electronic laboratories and is recognized as a research center under VTU. The department currently offers a B. E. program with an intake of 120, and two M. Tech programs, one in Digital Electronics and Communication, and one in VLSI Design and Embedded Systems, with intakes of 30 and 18 respectively. The department has a Center of Excellence in Food Technologies sponsored by VGST, Government of Karnataka. The department is equipped with numerous UG and PG labs, along with R & D facilities. Past and current research sponsoring agencies include DST, VTU, VGST and AICTE with funding amount worth Rs. 1 crore. The department has modern research ambitions to develop innovative solutions and products and to pursue various research activities focused towards national development in various advanced fields such as Signal Processing, Embedded Systems, Cognitive Sensors and RF Technology, Software Development and Mobile Technology.

Vision of the Institute

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio economic needs

Mission of the Institute

RIT shall meet the global socio-economic needs through

1. *Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization*
2. *Establishing research clusters in emerging areas in collaboration with globally reputed organizations*
3. *Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs*

Quality Policy

We at Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established central Quality Management System complemented by the synergistic interaction of the stakeholders concerned.

Vision of the Department

To evolve into a department of national and international repute for excellence in education and cutting-edge research in the domain of Electronics and Communication Engineering

Mission of the Department

The department will continuously strive to

1. *Provide a world-class learning environment that caters to local and global technological and social requirements*
2. *Initiate research collaborations with academia and industries to perform cutting edge research leading to socio-technological innovations*
3. *Develop skills for pursuing innovation and entrepreneurial ventures for graduating engineers*

Program Educational Objectives (PEOs)

PEO1: *Be successful practicing professionals or pursue doctoral studies in areas related to the program, contributing significantly to research and development activities*

PEO2: *Engage in professional development in their chosen area by adapting to new technology and career challenges*

PEO3: *Demonstrate professional,ethical,and social responsibilities of the engineering profession*

Program Outcomes (POs)

PO1: ***Development of Solutions:*** *An ability to independently carry out research/investigation and development work to solve practical problems*

PO2: ***Technical Presentation Skills:*** *An ability to write and present a substantial technical report/document*

PO3: ***Analyze Complex Systems:*** *A practical ability and theoretical knowledge to design and analyze complex electronics based and/or communication systems*

PO4: ***Develop Novel Designs:*** *An ability to apply their in-depth knowledge in electronics and communications domain to evaluate, analyze and synthesize existing and novel designs*

PO5: ***Team Work and Project Management:*** *An ability to effectively participate as a team member and develop project management skills necessary for a professional environment*

CURRICULUM COURSE CREDITS DISTRIBUTION

Semester	Professional Courses – Core (Theory & Lab) (PC-C)	Professional Courses – Electives (PC-E)	Technical Seminar (TS)	Project Work/Internship (PW/IN)	Credits in a semester
First	10	12	2		**24**
Second	10	12	2		**24**
Third	4	4		10	**18**
Fourth				22	**22**
Total	**24**	**28**	**4**	**32**	**88**

SCHEME OF TEACHING

(Batch 2019 – 2021)

I SEMESTER

SI. No.	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC11	Advanced Engineering Mathematics	PS-C	3	1	0	4	5
2.	MLC12	Advanced Digital Communication	PS-C	3	1	0	4	5
3.	MLCExx	Elective 1	PS-E	4	0	0	4	4
4.	MLCExx	Elective 2	PS-E	4	0	0	4	4
5.	MLCExx	Elective 3	PS-E	4	0	0	4	4
6.	MLCL13	Advanced Digital Communication Laboratory	PS-C	0	0	1	1	2
7.	MLCL14	Digital System Design Laboratory	PS-C	0	0	1	1	2
8.	MLC15	Technical Seminar I	TS	0	0	2	2	4
			Total	**18**	**2**	**4**	**24**	**30**

II SEMESTER

SI. No.	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC21	Wireless Communication	PS-C	4	0	0	4	4
2.	MLC22	Advanced Embedded Systems	PS-C	4	0	0	4	4
3.	MLCExx	Elective 4	PS-E	4	0	0	4	4
4.	MLCExx	Elective 5	PS-E	4	0	0	4	4
5.	MLCExx	Elective 6	PS-E	4	0	0	4	4
6.	MLCL23	Advanced Embedded Systems Laboratory	PS-C	0	0	1	1	2
7.	MLCL24	Signal and Image Processing Laboratory	PS-C	0	0	1	1	2
8.	MLC25	Technical Seminar II	TS	0	0	2	2	4
			Total	**20**	**0**	**4**	**24**	**28**

III SEMESTER

SI. No.	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC31	Error Control Coding	PC-C	4	0	0	4	4
2.	MLCExx	Elective 7	PC-E	4	0	0	4	4
3.	MLC32	Internship/Industrial Training	IN	0	0	4	4	8
4.	MLC33	Project Work – I	PW	0	0	6	6	12
			Total	**8**	**0**	**10**	**18**	**28**

IV SEMESTER

SI. No.	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC41	Project Work – II	PW	0	0	22	22	44
			Total	**0**	**0**	**22**	**22**	**44**

LIST OF ELECTIVES

Sl. No.	Course Code	Course Title	Credits			
			L	T	P	Total
1.	MLCE01	Antenna Theory and Design	4	0	0	4
2.	MLCE02	Digital System Design using HDL	4	0	0	4
3.	MLCE03	Optical Communication and Networking	4	0	0	4
4.	MLCE04	Advanced Signal and Image Processing	4	0	0	4
5.	MLCE05	MEMS and Nano Electronics	4	0	0	4
6.	MLCE06	Advanced Computer Networks	4	0	0	4
7.	MLCE07	Internet of Things	4	0	0	4
8.	MLCE08	Broadband Wireless Networks	4	0	0	4
9.	MLCE09	CMOS VLSI Circuits	4	0	0	4
10.	MLCE10	Communication System Design using DSP	4	0	0	4
11.	MLCE11	RF and Microwave Circuit Design	4	0	0	4
12.	MLCE12	Simulation, Modeling and Analysis	4	0	0	4
13.	MLCE13	Software Defined Radio	4	0	0	4
14.	MLCE14	Data Compression	4	0	0	4

ADVANCED ENGINEERING MATHEMATICS

Course Code: MLC11 **Credits: 3:1:0**

Prerequisites: Engineering Mathematics **Contact Hours: 70**

Course Coordinator: Sadashiva V. Chakrasali

UNIT – I

Solving Linear Equations: Introduction, geometry of linear equations, solution sets of linear systems, Gaussian elimination, matrix notation, inverses, partitioned matrices, matrix factorization and determinants

Vector Spaces: Vector spaces and subspaces, linear independence, rank, basis and dimension, linear transformation, change of basis

UNIT – II

Eigen values and Eigen Vectors: Eigen values, Eigen vectors and diagonalization, Eigen vectors and linear transformations

Orthogonality: Orthogonal vectors and subspaces, projections, orthogonal bases and Gram – Schmidt orthogonalization

UNIT – III

Orthogonality: Least Squares problems, Inner product spaces, Diagonalization of symmetric matrices, quadratic forms and SVD.

Random Variables: Discrete and continuous random variables, cumulative distribution function (CDF), probability mass function (PMF), probability density function (PDF), Conditional PMF/PDF, expected value, variance functions of a random variable, expected value of the derived random variable.

UNIT – IV

Random Variables: Multiple random variables, joint CDF/PMF/PDF, functions of multiple random variables, multiple functions of multiple random variables, independent/uncorrelated random variables, sums of random variables, moment generating functions.

Random Processes: Introduction to random processes, specification of random processes, n^{th} order joint PDFs, independent increments, stationary increments, Mean and correlation of random processes, stationary, wide sense stationary and ergodic processes.

UNIT – V

Random Processes: Poisson counting process, Wiener process, Markov process.

Filtering Random Processes: Random processes as inputs to linear time invariant systems: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise.

References:

1. Strang. G, "Linear Algebra and its Applications", 4th Edition, Cengage Learning, 2014.
2. David C. Lay, "Linear Algebra and its Applications", 3rd Edition, Pearson Education, 2013.
3. Henry Stark and John W. Woods, "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Prentice Hall, 2002.
4. Peyton Z. Peebles, "Probability, Random Variables and Random Signal Principles", 4th Edition, TMH, 2007.

Course Outcomes (COs):

1. Employ linear system and vector space concepts in signal processing and communication. (POs: 1, 3, 4)
2. Apply eigen values, eigen vectors, diagonalization and SVD in signal processing applications. (POs: 1, 3, 4)
3. Analyze different random variables and their statistical parameters. (POs: 1, 3, 4)
4. Illustrate the nature of multiple random variables. (POs: 1, 3, 4)
5. Classify various random processes and analyze the nature of output random process of LTI systems. (POs: 1, 3, 4)

ADVANCED DIGITAL COMMUNICATION

Course Code: MLC12 **Credits: 3:1:0**

Pre requisites: Digital Communication **Contact Hours: 70**

Course Coordinator: T. D. Senthilkumar

UNIT – I

Optimum Receivers for AWGN Channel: Waveform and vector AWGN channels, Optimal detection and error probability for band-limited and power-limited signaling.

Digital Communication through Fading Multipath Channel: Frequency-nonselective slowly fading channel, Diversity techniques for fading multipath channel, Signaling over frequency-selective slowly fading channel.

UNIT – II

Digital Communication through Band-Limited Channels: Optimum receiver for channels with ISI and AWGN, Linear equalization – peak distortion criterion, MSE criterion, Performance of the MSE equalizer, Decision feedback equalization.

UNIT – III

Adaptive Equalization: Adaptive linear equalizer – zero-forcing algorithm, LMS algorithm, Adaptive decision-feedback equalizer, RLS algorithm for adaptive equalization.

UNIT – IV

Multichannel and Multicarrier Systems: Multichannel digital communications in AWGN channels, Orthogonal frequency division multiplexing – modulation and demodulation in an OFDM system, FFT algorithm implementation of an OFDM system, bit and power allocation in multicarrier modulation

UNIT – V

Spread Spectrum Signals for Digital Communications: Direct sequence spread spectrum signals – error rate performance, effect of pulsed interference, excision of narrowband interference, Frequency hopped spread spectrum signals – performance in an AWGN channel, performance in partial-band interference.

References:

1. John G. Proakis and Masoud Salehi, “Digital Communications”, 5th Edition, McGraw Hill, 2008.
2. M. K. Simon, S. M. Hinedi and W. C. Lindsey, “Digital Communication Techniques”, Prentice Hall India, 1995.

3. Andrew J. Viterbi, “CDMA: Principles of Spread Spectrum Communications”, Prentice Hall, USA, 1995.

Course Outcomes (COs):

1. Analyze the performance of band and power limited signals in AWGN and fading channel. (POs: 1, 3, 4)
2. Apply equalization techniques to minimize the effect of inter symbol interference. (POs: 1, 3, 4)
3. Compare the performance of different adaptive equalization algorithms. (POs: 1, 3, 4)
4. Employ multicarrier and multichannel modulation in modern wireless communication systems. (POs: 1, 3, 4)
5. Appreciate the performance of DSSS and FH spread spectrum systems. (POs: 1, 3, 4)

ADVANCED DIGITAL COMMUNICATION LABORATORY

Course Code: MLCL13 **Credits: 0:0:1**

Pre requisites: Microwaves and Digital Communication **Contact Hours: 28**

Course Coordinator(s): Sujatha B and T. D. Senthilkumar

LIST OF EXPERIMENTS

Antennas

1. Experimental studies of radiation pattern of microstrip Yagi-Uda and dipole antennas
2. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas
3. Calculate the directivity and gain of Horn antenna from the radiation pattern
4. Experimental studies of radiation pattern of microstrip patch antenna
5. (a) Measure the S-parameters of an antenna using Network Analyzer
   (b) Study the characteristics of transmission line using Network Analyzer
6. Calculate the antenna parameters of different types of antenna using Software/Simulation tool

Digital Communication

7. Analyze the performance of Quadrature Amplitude Modulation (QAM) and M-ary Phase Shift Keying (PSK) scheme in AWGN channel, and compare the results with theoretical results
8. Compute Bit Error Rate (BER) for different digital modulation schemes in frequency-flat and slowly varying fading channel
9. Bit error rate analysis of digital communication receivers with Maximal Ratio Combining (MRC) receive diversity in frequency-flat and slowly varying fading channel
10. Bit error rate analysis of digital communication receivers with Equal Gain Combining (EGC) receive diversity in frequency-flat and slowly varying fading channel
11. Simulation of Direct Sequence Spread Spectrum (DSSS) techniques
12. Conduct an experiment for (a) Measurement of numerical aperture and attenuation loss in analog fiber optic link (b) voice and data multiplexing using optical fiber

References:

1. John D Kraus, Ronald J Marhefka, Ahmad S Khan, “Antennas”, 4th Edition, Tata McGraw Hill, 2006.
2. Constantine. A. Balanis, “Antenna Theory Analysis and Design”, 2nd Edition, John Wiley, 1997.
3. J. G. Proakis and M. Salehi, “Contemporary Communication Systems using MATLAB”, PWS Publishing Company, 2007.

4. T. S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Prentice Hall of India, 3rd Indian Reprint, 2010.

Course Outcomes:

1. Plot the radiation pattern of different types of antennas. (POs: 1, 3, 4,5)
2. Determine the parameters like gain, beam width and directivity of antennas. (POs: 1, 3, 4, 5)
3. Design an antenna array and find the various parameters like directivity and gain by plotting the radiation pattern using software/simulation tool. (POs: 1, 3, 4, 5)
4. Analyze the performance of the digital modulation receivers in AWGN channel. (POs: 1, 3, 4, 5)
5. Inspect the performance of the digital modulation receivers in fading channel. (POs: 1, 3, 4, 5)

DIGITAL SYSTEM DESIGN LABORATORY

Course Code: MLCL14 **Credits: 0:0:1**

Prerequisites: Digital Electronics **Contact Hours: 28**

Course Coordinator: S. L. Gangadharaiah

LIST OF EXPERIMENTS

Using Verilog code design, simulate and synthesize the following with a suitable FPGA.

1. 8 to 3 programmable priority encoder
2. Full Adder using structural modeling
3. Flip Flops(D,SR,T,JK)
4. 3 bit arbitrary Counter,4 bit binary up/down/up-down counter with synchronous reset, 4 bit Johnson counter, BCD counter
5. Sequential block to detect a sequence(say 11101) using appropriate FSM
6. 8 bit ripple carry adder and carry skip adder
7. 8 bit Carry Select Adder
8. 8 bit Serial, Parallel Multiplier and generate report on area and delay

   Using System Verilog code, simulate the following
9. Full Subtractor using structural modeling
10. Flip Flops(D,SR,T,JK)
11. 3-bit synchronous counters, synchronous arbitrary counters
12. 4-bit asynchronous counters

References:

1. Peter J. Ashenden, "Digital Design: An Embedded Systems Approach using Verilog", Elsevier, 2010.
2. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2010.
3. Stuart Sutherland, "RTL Modeling with System Verilog for Simulation and Synthesis: Using System Verilog for ASIC and FPGA Design", 1st Edition, Create Space Independent Publishing Platform, 2017.

Course Outcomes (COs):

1. Design and model complex combinational circuits using HDL at behavioral, structural and RTL levels. (POs: 1, 3, 4, 5)
2. Design and model complex sequential circuits using HDL at behavioral, structural and RTL levels. (POs: 1, 3 ,4, 5)
3. Develop test benches to simulate combinational and sequential circuits. (POs: 1, 3, 4, 5)
4. Examine how the language infers hardware and helps to simulate and synthesize the digital system. (POs: 1, 3, 4, 5)
5. Implement and analyze the digital systems using FPGAs with respect to speed and area. (POs: 1, 3, 4, 5)

TECHNICAL SEMINAR – I

Course Code: MLC15 **Credits: 0:0:2**

Prerequisites: Nil **Contact Hours: 56**

LIST OF ACTIVITIES

1. Seminar: Research Methods
2. Seminar: Technical Report Writing
3. Source/Ideas for a Research Problem
4. Choosing Research Papers
5. Reading Research Papers
6. Summarizing Research Papers: Written
7. Presenting Research: Oral
8. **REVIEW – I**
9. Critiquing: Oral & Written
10. Detailed analysis of Block Diagrams: Written
11. Detailed Analysis of Block Diagrams: Oral
12. Proposing Technical Solutions: Written
13. Proposing Technical Solutions: Oral
14. **REVIEW – II**

Course Outcomes (COs):

1. Identify a technical problem by performing a comprehensive literature survey. (POs: 1, 2, 3, 4, 5)
2. Compare different solution methods presented in the literature for the technical problem identified. (POs: 1, 2, 3, 4, 5)
3. Predict the impact of various software tools and methods for the identified problem. (POs: 1, 2, 3, 4, 5)
4. Display initial simulation results, showing replication of existing approaches for the identified problem. (POs: 1, 2, 3, 4, 5)
5. Construct a technical block diagram that shows an optimized solution for the identified problem, with respect to existing literature. (POs: 1, 2, 3, 4, 5)

WIRELESS COMMUNICATIONS

Course Code: MLC21 **Credits: 4:0:0**

Prerequisites: Digital Communication **Contact Hours: 56**

Course Coordinator: Sarala S. M.

UNIT – I

Wireless channel: Wireless channel as a linear time-varying system, physical modeling for wireless channels, input/output model of wireless channel, time and frequency response, statistical models. Reflection from a ground plane, Power decay with distance and shadowing.

Point to point communication: Baseband equivalent channel model, Detection in Rayleigh fading channel, Repetition Coding, Orthogonal Frequency Division Multiplexing.

UNIT – II

Diversity: Introduction, Micro-diversity, Macro-diversity and simulcast, Combination of Signals, Error Probability in fading channels with diversity Reception, transmit diversity.

UNIT – III

Capacity of wireless channels: AWGN channel capacity, Linear time invariant Gaussian channels, capacity of fading channels.

UNIT – IV

Antenna diversity: Receive diversity, Spatial multiplexing and channel modeling, multiplexing capability of MIMO channels, physical modeling of MIMO channels, modeling MIMO fading channels.

UNIT – V

MIMO capacity and multiplexing architectures: V-BLAST architecture, Fast fading MIMO channel, Receiver architectures – Linear de-correlator, Successive cancellation, Linear MMSE receiver, D-BLAST architecture.

References:

1. David Tse, P. Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press New York, USA, 2005.
2. Andreas F. Molisch, "Wireless Communications", Wiley Publications, 2009.
3. William C Y Lee, "Mobile Communication Engineering Theory and Applications", 2nd Edition, McGraw Hill Education, 2008.

Course Outcomes (COs):

1. Defining characteristics of wireless channel strength over time and frequency. (POs: 1, 3, 4)
2. Employ the concept of different diversity techniques to overcome the effect of small scale multi-path propagation. (POs: 1, 3, 4)
3. Demonstrate the impact of channel uncertainty on the performance of diversity combining schemes. (POs: 1, 3, 4)
4. Employ the multiple transmit and multiple receive antennas under suitable channel fading conditions. (POs: 1, 3, 4)
5. Discuss the performance of MIMO receiver architecture. (POs: 1, 3, 4)

ADVANCED EMBEDDED SYSTEMS

Course Code: MLC22 **Credits: 4:0:0**

Prerequisites: Microcontrollers **Contact Hours: 56**

Course Coordinator: Lakshmi Shrinivasan

UNIT – I

Introduction to Embedded System: Core of the embedded System, Memories**,** Communication Interface, Sensors and Actuators.

Typical Embedded System: Washing Machine – Application specific ES, Automotive communication buses.

Introduction to ARM Cortex M Processors: Advantages of the Cortex M processors, applications of the ARM Cortex M processors, Resources for using ARM processors and ARM microcontrollers.

Hardware Software Co-Design and Program Modeling: Fundamental issues in the H/W, S/W Co-Design Computational models in the embedded design: Data Flow-Graph/Diagram (DFG) Model, Control Data Flow Graph / Diagram (CDFG), State machine model with examples. Sequential program model, concurrent/communicating process model, unified modeling language (WML) UML building blocks, UML Tools, Hardware and Software trade-offs typical embedded product design and development approach.

UNIT – II

Technical Overview ARM Cortex M4: Processor type, architecture, block diagram, memory system, Interrupt and exception support, features of ARM Cortex M4 processor.

Low Power and System Control Features: Low power features, using WFI and WFE instructions in programming.

Fault Exceptions and Fault Handling: Overview of faults Causes of faults, enabling fault handlers, fault status registers and fault address registers.

UNIT – III

Architecture of ARM Cortex M4: Introduction to the architecture, Programmer's model, behavior of the application program status register (APSR), Memory system, Instruction set: Cortex M4 specific instructions, barrel shifter, exceptions and interrupts, system control block.

UNIT – IV

Real Time Operating System (RTOS) based Embedded System Design: Operating System basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS

UNIT – V

Embedded System Development Environment: Embedded Firmware design approaches, embedded firmware development languages, the Integrated Development Environment (IDE), Types of Files Generated on Cross-compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging and Boundary Scan.

References:

1. Joseph Yiu, "The definitive guide to ARM Cortex-M3 and Cortex-M4 processors", Elsevier Ltd., 2014.
2. Shibu. K. V. "Introduction to Embedded Systems", Tata McGraw Hill Education Private Ltd., 2009.

Course Outcomes (COs):

1. Identify the basic building blocks and computational models in embedded systems. (POs: 1, 3, 4)
2. Develop the programs using technical knowledge of ARM Cortex M4 for embedded system firmware development. (POs: 1, 3, 4)
3. Describe ARM Cortex M4 various architectural features and its importance. (POs: 1, 3, 4)
4. Appreciate RTOS for real time embedded system design. (POs: 1, 3, 4)
5. Interpret the importance of debugger tools for embedded system design and development. (POs: 1, 3, 4)

ADVANCED EMBEDDED SYSTEMS LABORATORY

Course Code: MLCL23 **Credits: 0:0:1**

Prerequisites: Microcontrollers and OS **Contact Hours: 28**

Course Coordinator: Lakshmi Shrinivasan

LIST OF EXPERIMENTS

Introduction to IDE of ARM Cortex M4

1. Assembly Language Data Transfer programs
2. Factorial of a number generation, largest/smallest number from an given array of N numbers
3. Parity checking (odd or even), Ascending/Descending order of given N numbers

H/W Interfacing Experiments using ARM Cortex M4

4. Design and interface a DC motor speed control and measurement
5. Generation of Sine, triangular and square waveforms using Dual DAC
6. Design and interface a simple elevator system
7. Design and interface a stepper motor for following operations: rotate clockwise, anticlockwise for defined degree of angle
8. Design and interface a simple 3x8 calculator type Keypad module
9. Show how an output interfaced hardware module could be controlled using relay

Programs based on RTOS concepts in Linux environment

10. Introduction to Linux commands and fork() function demo
11. Show IPC using Pipes and FIFO

Model the given embedded system using UML tool

12. Static and dynamic aspects of the system using basic Class and sequence diagram and generate code

References:

1. Joseph Yiu, "The definitive guide to ARM Cortex–M3 and Cortex-M4 processors", Elsevier Ltd., 2014.
2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009.

Course Outcomes (COs):

1. Employ simulation and emulation IDE. (POs: 1, 5)
2. Illustrate the assembly instructions of ARM Cortex M4 with the help of assembly code. (POs: 1, 3, 5)
3. Write, compile and debug RTOS based programs. (POs: 1, 3, 5)
4. Interface and communicate peripheral modules to ARM Cortex M4 microcontroller. (POs: 3, 4, 5)
5. Develop various UML diagrams and models for an embedded system. (POs: 1, 3, 5)

ADVANCED SIGNAL AND IMAGE PROCESSING LABORATORY

Course Code: MLCL24 **Credits: 0:0:1**

Prerequisites: Digital Signal Processing **Contact Hours: 28**

Course Coordinator(s): Maya V. Karki and K. Indira

LIST OF EXPERIMENTS

Programs on Adaptive Filters

1. Estimation of power spectrum of AR, MA and ARMA process
2. Design of lattice predictor of order P
3. Stationary system identification
4. FIR filter model using RLS algorithm
5. FIR filter model using LMS algorithm

Programs on Image Processing

6. Reading and displaying images, applying transformation function: log transform, power law transform, histogram equalization
7. Smoothing and sharpening spatial filters
8. Point, line and edge detection , Boundary detection, Basic Global Thresholding, Ostu's method and Region based segmentation
9. Extracting region and boundaries, chain code representation, Boundary reconstruction using Fourier Descriptor
10. Dilation and Erosion of an image using structuring Element, Labeling Connected Components, Morphological Reconstruction
11. Object recognition using minimum distance, Bayes classifier
12. Object recognition using feed forward Neural Network classifier

References:

1. John G. Proakis and D. Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2006.
2. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing using MATLAB", 2nd Edition, Tata McGraw Hill, 2012.

Course Outcomes (COs):

1. Estimate the power spectral density of a random process. (POs: 1, 4, 5)
2. Design and develop FIR filter model using LMS and RLS algorithm. (POs: 1, 4, 5)
3. Analyze various image pre-processing algorithms. (POs: 1, 4, 5)
4. Apply segmentation algorithms to detect objects. (POs: 1, 4, 5)
5. Develop object recognition algorithms using different classifiers. (POs: 1, 4, 5)

TECHNICAL SEMINAR – II

Course Code: MLC25 **Credits: 0:0:2**

Prerequisites: Nil **Contact Hours: 56**

LIST OF ACTIVITIES

1. Detailed discussion of block diagrams
2. Setting up the Simulation environment
3. Simulation of Results
4. Reproduction of Simulation Results: Written
5. Presentation of Simulation Results: Oral
6. Proposing a Technical block diagram: Written
7. Proposing a Technical block diagram: Oral
8. **REVIEW – I**
9. Design of Experiments
10. Design of Experiments
11. Presentation of Simulation Results: Written
12. Presentation of Simulation Results: Oral
13. Comprehensive report writing
14. **REVIEW – II**

Course Outcomes (COs):

1. Present initial simulation results, replicating existing findings. (POs: 1, 2, 3, 4, 5)
2. Propose a technical block diagram with arguments for improved performance. (POs: 1, 2, 3, 4, 5)
3. Elaborate on the tools required for performing experiments, and justify their appropriateness. (POs: 1, 2, 3, 4, 5)
4. Discuss simulation results and optimized performance metrics. (POs: 1, 2, 3, 4, 5)
5. Compare the advantages and disadvantages of the approach, along with possible future directions. (POs: 1, 2, 3, 4, 5)

ERROR CONTROL CODING

Course Code: MLC31 **Credits: 4:0:0**

Prerequisites: Information Theory and Coding **Contact Hours: 56**

Course Coordinator: Chitra M

UNIT – I

Introduction to Algebra: Groups, Fields, binary field arithmetic, Basic properties of GF (2^m),Construction of Galois Field GF (2^m) and its properties, Computation using Galois filed GF (2^m) arithmetic, Vector spaces and matrices on Galois field.

UNIT – II

Linear Block Codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, decoding circuits, Hamming codes, Reed-Muller codes, (24,12) Golay codes, Product codes and interleaved codes, applications.

UNIT – III

Cyclic Codes: Introduction, Generator and parity check polynomials, Encoding using multiplication circuits, Systematic cyclic codes – Encoding using feedback shift register circuits, generator matrix for cyclic code, Syndrome computing and error detection, Meggitt decoder, Error trapping decoding, (23,12) Golay codes, Cyclic hamming codes, Shortened cyclic codes.

UNIT – IV

BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction.

Non-binary BCH Codes: q-ary linear block codes, Primitive BCH codes over GF(q), Reed - Solomon codes, decoding of non-binary BCH and RS codes: Berlekamp - Massey Algorithm, Gorenstein – Zierler Algorithm.

UNIT – V

Majority Logic Decodable Codes& Convolutional Codes: One step majority logic decoding, one step majority logic decodable codes, Two-step majority logic decoding, Multiple-step majority logic decoding.

Convolutional codes: Encoding of convolutional codes, Structural properties, Distance properties, Viterbi decoding algorithm for decoding, soft output Viterbi algorithm, Stack and Fano sequential decoding algorithms, Majority logic decoding, Introduction to LDPC codes, Geometrical structure of LDPC codes, EG-LDPC codes, PG-LDPC codes, applications.

References:

1. Shu Lin and Daniel J. Costello. Jr., "Error Control Coding", 2nd Edition, Pearson Education, Prentice Hall, 2014.
2. Todd K. Moon, "Error Correction Coding: Mathematical Methods and Algorithms", 1st Edition, Wiley Publications, 2005.

Course Outcomes (COs):

1. Apply properties of Galois Field to Groups, Fields, Vector Spaces, row space and sub-spaces. (POs: 1, 3, 4)
2. Describe linear block codes, RM codes, Golay codes in error detection and error correction. (POs: 1, 3, 4)
3. Demonstrate cyclic block codes, cyclic Hamming codes, shortened cyclic codes and (23, 12) Golay codes in error detection and correction. (POs: 1, 3, 4)
4. Illustrate various BCH Codes, RS Codes and other q-ary codes and apply them for error detection and correction. (POs: 1, 3, 4)
5. Construct state tables, state diagrams, code-tree diagram and trellis diagrams for convolutional encoders and employ Viterbi and stack algorithms for decoding. (POs: 1, 3, 4)

INTERNSHIP/INDUSTRIAL TRAINING

Course Code: MLC32 **Credits: 0:0:4**

Prerequisites: Nil

The evaluation of students will be based on an intermediate presentation, along with responses to a questionnaire testing for outcomes attained at the end of the internship. The rubrics for evaluation of the presentation and the questionnaire for the report will be distributed at the beginning of the internship.

Course Outcomes (COs):

1. Analyze the working of complex technical systems/blocks. (POs: 1, 3, 4)
2. Appreciate the use and impact of modern tools on the engineering design cycle. (POs: 1, 3, 4)
3. Participate effectively as a member of a team under the supervision of a manager/mentor. (POs: 5)
4. Understand the importance of professional and ethical behavior in the engineering workplace. (POs: 1, 3, 4)
5. Appreciate the requirements for constant technology updation. (POs: 1, 3, 4)

PROJECT WORK – I

Course Code: MLC33 **Credits: 0:0:6**
Prerequisites: Nil

The students will be evaluated based on two oral presentations during the semester. In the presentations they will have to discuss the results of their literature survey and initial implementations of the design.

Course Outcomes (COs):

1. Choose recent literature published in quality journals, and discuss the implementation details and results obtained therein. (POs: 1, 2, 3, 4, 5)
2. Formulate precise, accurate, and unambiguous objectives for the project, based on study of the literature. (POs: 1, 2, 3, 4, 5)
3. Develop a detailed methodology for achieving the objectives identified for the project, including technical blocks and implementation platforms. (POs: 1, 2, 3, 4, 5)
4. Generate technical documents recording the tasks performed, adhering to professional standards. (POs: 1, 2, 3, 4, 5)
5. Present orally the tasks performed, using appropriate visual and explanatory aids. (POs: 1, 2, 3, 4, 5)

PROJECT WORK – II

Subject code: MLC41 **Credits: 0:0:22**
Prerequisites: Nil

The students will be evaluated based on two oral presentations, in which they will present their proposed solutions to the problem identified, and discuss the implementation details and results obtained.

Course Outcomes (COs):

1. Determine the scope of the study by choosing appropriate assumptions and selecting measurable benchmarks for judging progress/outcomes. (POs: 1, 2, 3, 4, 5)
2. Design a suitable set of experiments that is capable of comprehensively testing the hypotheses proposed as part of this study. (POs: 1, 2, 3, 4, 5)
3. Analyze the results obtained, discuss their validity, and their support of hypotheses proposed. (POs: 1, 2, 3, 4, 5)
4. Generate technical documents recording the tasks performed, adhering to professional standards. (POs: 1, 2, 3, 4, 5)
5. Present orally the tasks performed, using appropriate visual and explanatory aids. (POs: 1, 2, 3, 4, 5)

ELECTIVES

ANTENNA THEORY AND DESIGN

Course Code: MLCE01 **Credits: 4:0:0**

Prerequisites: Field Theory and Microwave Circuits **Contact Hours: 56**

Course Coordinator: Sujatha B

UNIT – I

Antenna fundamental and definitions: Radiation patterns, Directivity and gain, Effective height and aperture, Antenna impedance, Radiation efficiency, Antenna polarization.

Arrays: Array factor for linear arrays, uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Multidimensional arrays and Feeding techniques.

UNIT – II

Resonant Antennas: Dipole antenna (Far field electric and magnetic field components, (Radiation resistance), Yagi-Uda antennas.

Broadband antennas: Travelling wave Wire antennas, Helical antennas – Normal mode helix antenna, Axial mode Helix antenna, Bi-conical antennas, sleeve antenna.

UNIT – III

Frequency independent antennas: Principle of frequency independent antennas, Log-periodic antenna.

Microstrip and Printed Antennas: Feeding methods, Rectangular patch, Circular patch, Resonant frequencies and design, Quality factor, Bandwidth and efficiency.

UNIT – IV

Aperture antennas: Techniques for evaluating gain, Pyramidal Horn Antenna, Reflector antennas – Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.

UNIT – V

Antenna Array Synthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array.

Computational Electromagnetics (CEM) for antennas: Introduction to CEM, The methods of moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations.

References:

1. Warren L. Stutzman, Gary A. Thiele, "Antenna Theory and Design", 2nd Edition, John Wiley and Sons, 2012.
2. Constantine. A. Balanis, "Antenna Theory Analysis and Design", 3rd Edition, John Wiley, 2016.
3. John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas", 4th Edition, Tata McGraw Hill, 2006.

Course Outcomes (COs):

1. Define the parameters of antenna and analyze the uniform excited array antennas. (POs: 1, 3, 4)
2. Design resonant and broad band antennas. (POs: 1, 3, 4)
3. Apply different feeding techniques and design microstrip patch antennas. (POs: 1, 3, 4)
4. Calculate the directivity and gain of parabolic reflectors and explain the feed methods of reflector antennas. (POs: 1, 3, 4)
5. Synthesize antenna beam pattern using different types of distributions and describe the computationally efficient approximations using MOM. (POs: 1, 3, 4)

DIGITAL SYSTEM DESIGN USING HDL

Course Code: MLCE02 **Credits: 4:0:0**

Pre-requisites: Digital Electronics **Contact Hours: 56**

Course Coordinator: Gangadharaiah S L

UNIT – I

Introduction and Methodology: Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology.

Number Basics: Unsigned and Signed Integers, Fixed and Floating-point Numbers.

UNIT – II

Sequential Basics: Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology.

UNIT – III

Memories and Implementation Fabrics: Concepts, Memory Types, Error Detection and Correction.

Implementation Fabrics: ICs, PLDs, Packaging and circuit Boards, Interconnection and signal Integrity.

UNIT – IV

System Verilog Simulation and Synthesis: System Verilog extension to Verilog, RTL and gate level modeling, RTL Synthesis, Subset of System Verilog, System Verilog simulation, Digital Synthesis, Modules, Procedural blocks.

UNIT – V

RTL Modeling Fundamentals: System Verilog Language rules, module, module instances, Hierarchy, Four state data values, Data types, Variable types, Net types, Operators, Continuous Signal Assignments, Procedural Signal Assignments, Modeling Combinational logic and Sequential Logic.

References:

1. Peter J. Ashenden "Digital Design: An Embedded Systems Approach using Verilog", Elsevier, 2010.
2. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2010.
3. Stuart Sutherland, "RTL Modeling with System Verilog for Simulation and Synthesis: Using System Verilog for ASIC and FPGA Design", 1st Edition, Create Space Independent Publishing Platform, 2017.
4. Chris Spear, Greogory J Tumbush, "System Verilog for Verification: A Guide to Learning Test Bench Language Features", Springer, 2012.

Course Outcomes (COs):

1. Apply the concepts of Verilog modeling to design and verify the operations of complex digital logic circuits. (POs: 1, 3, 4)
2. Design and test pipelined storage elements, sequential data path controllers using Verilog. (POs: 1, 3, 4)
3. Employ Verilog modeling to multi-port memories and FIFO data paths and FSMs with respect to integrated circuits. (POs: 1 ,3, 4)
4. Demonstrate the basics of System Verilog to simulate and synthesize digital systems. (POs: 1, 3, 4)
5. Design and model combinational and sequential circuits using System Verilog. (POs: 1, 3, 4)

OPTICAL COMMUNICATION AND NETWORKING

Course Code: MLCE03 **Credits: 4:0:0**

Pre-requisites: Digital Communication **Contact Hours: 56**

Course Coordinator: M. Nagabushanam

UNIT – I

Introduction: Propagation of signals in optical fiber, different losses, nonlinear effects, solitons, optical sources, detectors.

Optical Components: Couplers, isolators, circulators, multiplexers and filters, gratings, interferometers, optical amplifiers,

UNIT – II

Modulation and Demodulation: Signal formats, ideal receivers, Practical detection receivers, Optical preamplifier, Noise considerations, Bit error rates, Coherent detection.

UNIT – III

Transmission System Engineering: System model, power penalty, Transmitter, Receiver, Different optical amplifiers, Dispersion.

Optical Networks: Client layers of optical layer – SONET/SDH, multiplexing, layers, frame structure, ATM functions, adaptation layers, Quality of service and flow control, ESCON, HIPPI.

UNIT – IV

WDM Network Elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design- cost trade-offs, LTD and RWA problems, Routing and wavelength assignment, wavelength conversion.

UNIT – V

Control and Management: Network management functions, management framework, Information model, management protocols, layers within optical layer performance and fault management, impact of transparency.

References:

1. Rajiv Ramswami, K. N. Sivarajan, H.Sasaki "Optical Networks", 3rd Edition, Morgan Kaufman Publishers, 2010.
2. John M. Senior, "Optical Fiber Communications: Principles & Practice", 3rd Edition, Pearson Education, 2009.
3. Gerd Keiser, "Optical Fiber Communication", 3rd Edition, McGraw-Hill, 2000.
4. Govind. P. Agarwal, "Fiber Optic Communication Systems", 3rd Edition, John Wiley, 2002.

Course Outcomes (COs):

1. Demonstrate the function of optical components and light propagation mechanism. (POs: 1, 3, 4)
2. Analyze noise performance in optical communication receivers. (POs: 1, 3, 4)
3. Define signal impairment in optical networks. (POs: 1, 3, 4)
4. Demonstrate the principle of WDM network elements. (POs: 1, 3, 4)
5. Appreciate different network and management protocols in optical networks. (POs: 1, 3, 4)

ADVANCED SIGNAL AND IMAGE PROCESSING

Course Code: MLCE04 **Credits: 4:0:0**

Pre requisites: Digital Signal Processing **Contact Hours: 56**

Course Coordinator: Maya V. Karki

UNIT – I

Linear Prediction & Optimum Linear Filters: Random Signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the Normal Equations, Properties of the Linear Prediction-Error Filters, Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

UNIT – II

Adaptive filters: Applications of adaptive filters, Adaptive direct form FIR filters, The LMS algorithm, Adaptive direct form filters, RLS algorithm.

UNIT – III

Image Pre-processing: Basic intensity transformations, Histogram processing, Smoothing and sharpening spatial filters, Segmentation: Point, line and edge detection, Thresholding, Region based segmentation

UNIT – IV

Representation and Morphological Image processing: Representation: Chain codes, signatures, Boundary segments, Image Boundary descriptors: Some simple descriptors and Fourier descriptor.

Morphological Image Processing: Erosion and dilation, Basic Morphological algorithms: Boundary extraction, hole filling extraction of connected components, Thinning, Thickening, skeletons, Morphological Reconstruction.

UNIT – V

Object Recognition: Patterns and pattern classification. Recognition based on decision theoretic methods: matching, optimum statistical classifiers, neural networks. Structural Methods: matching shape numbers, string matching.

References:

1. John G Proakis and Dimitris K Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2006.
2. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2009.
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Cengage Learning, 2013.

Course Outcomes (COs):

1. Design linear predictors and optimum linear filters. (POs: 1, 3, 4)
2. Implement adaptive filters with LMS and RLS algorithms. (POs: 1, 3, 4)
3. Apply segmentation algorithms to detect and link edges in an image. (POs: 1, 3, 4)
4. Represent and apply morphological algorithms to describe the shape and characteristics of an object. (POs: 1, 3, 4)
5. Demonstrate different object recognition algorithms to detect objects in a scene. (POs: 1, 3, 4)

MEMS AND NANOELECTRONICS

Course Code: MLCE05 **Credits: 4:0:0**

Prerequisites: Semiconductor Theory **Contact Hours: 56**

Course Coordinator: Lakshmi S

UNIT – I

Introduction to MEMS and MEMS devices and systems: Feynman's vision, multi-disciplinary aspects, application areas. Scaling laws in miniaturization, scaling in geometry, electrostatics, electromagnetics.

Micro and Smart Devices and Systems – Principles: Transduction principles in MEMS Sensors: Actuators: different actuation mechanisms - silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, silicon micro-mirror arrays, piezo-electric based inkjet print head, electrostatic comb-driver.

UNIT – II

Micro manufacturing and Packaging: Lithography, thin-film deposition, etching (wet and dry), wafer-bonding, Silicon micromachining: surface, bulk, LIGA process, Wafer bonding process.

Integration and Packaging of MEMS devices: Integration of microelectronics and micro devices at wafer and chip levels, Microelectronic packaging: wire and ball bonding, flipchip, Microsystem packaging examples.

UNIT – III

Electrical and Electronics Aspects of MEMS: Electrostatics, Coupled electro mechanics, stability and Pull-in phenomenon, Practical signal conditioning circuits for microsystems, RF MEMS: Switches, varactors, tuned filters.

UNIT – IV

Introduction to Nanoelectronics: Particles and waves, Wave-particle duality, Wave mechanics, Schrödinger wave equation, Materials for nanoelectronics, Semiconductors, Crystal lattices: Bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and pseudomorphic hetero structures, Inorganic-organic heterostructures, Carbon nanomaterials: nanotubes and fullerenes.

Electron transport in nanostructures: Electrons in traditional low-dimensional structures, Electrons in quantum wells, Electrons in quantum wires, Electrons in quantum dots, Nanostructure devices, Resonant-tunneling diodes, Single-electron-transfer devices, Nano-electromechanical system devices, Quantum-dot cellular automata.

UNIT – V

Fabrication, Measurement and Applications: Fabrication and measurement techniques for nanostructures, Bulk crystal and heterostructure growth, Nanolithography, etching, othermeans for fabrication of nanostructures and nanodevices, Techniques for characterization of nanostructures, Spontaneous formation and ordering of nanostructures, Clusters and nanocrystals.

Applications: Injection Lasers: Quantum cascade lasers, Single photon sources, Biological tagging, Optical memories, Coulomb blockade devices, Photonic structures, QWIPs.

References:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. K. Aatre, "Micro and Smart Systems", 1st Edition, Wiley India, 2010.
2. T R Hsu, "MEMS and Microsystems Design and Manufacturing", 2nd Edition, Tata McGraw Hill, 2008.
3. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2011.
4. George W. Hanson, "Fundamentals of Nanoelectronics", Pearson Education India, 2009.

Course Outcomes (COs):

1. Analyze scaling laws and operation of various practical MEMS systems. (POs: 1, 3)
2. Describe various fabrication techniques and packaging methods for MEMS devices. (PO: 3)
3. Identify the electronics and RF aspects of MEMS systems. (POs: 3, 4)
4. Recognize the distinguishing aspect of nanoscale devices and systems. (PO: 3)
5. Examine the basic science behind the design and fabrication of nano scale systems and their applications. (PO: 3)

ADVANCED COMPUTER NETWORKS

Course Code: MLCE06 **Credits: 4:0:0**

Prerequisites: Computer Communication Networks **Contact Hours: 56**

Course Coordinator: Flory Francis

UNIT – I

Local Area Networks: Ethernet - Physical layer, MAC, LLC, LAN **i**nterconnection, Token ring, Physical layer, MAC, LLC, FDDI

Switching: Introduction, circuit switching, packet switching, multicasting

Scheduling: Introduction, requirements, choices, performance bounds, best effort techniques, Naming and addressing.

UNIT – II

Traffic Management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling.

Control of Networks: Objectives and methods of control, routing optimization in circuit and datagram networks, Markov chains, Queuing models in circuit and datagram networks.

UNIT – III

Congestion and flow control: Window congestion control, rate congestion control, control in ATM Networks, flow control model, open loop flow control, closed loop flow control.

UNIT – IV

Cryptography: Introduction, Symmetric Ciphers, Block Cipher structure, DES, AES cipher, Principles of Public-Key Cryptosystems, RSA algorithm.

UNIT – V

Hash Functions and Message Authentication: One way hash functions using symmetric block algorithms and public key algorithms, Message authentication codes, hash functions, Digital signature algorithm

References:

1. J. Walrand and P. Varaya, "High Performance Communication Networks", 2nd Edition, Morgan Kaufmann Publisher Inc, 2005
2. S. Keshav "An Engineering Approach to Computer Networking", 1st Edition, Pearson Education, 2006.
3. Leon-Garcia, and I. Widjaja, "Communication Networks: Fundamental Concepts and Key Architectures", 2nd Edition, TMH, 2003.
4. William Stallings, "Cryptography and Network Security: Principles and Practice", 6th Edition, Pearson Education Inc., 2014.

Course Outcomes (COs):

1. Describe the basic networking, data switching and scheduling techniques of networks. (POs: 1, 3)
2. Analyze various network traffic management and control techniques. (POs: 1, 3, 4)
3. Discuss the congestion and flow control. (POs: 1, 3)
4. Illustrate working of symmetric and public key ciphers. (POs: 1, 3, 4)
5. Elaborate on the importance of hash functions and message authentication codes. (POs: 1, 3, 4)

INTERNET OF THINGS

Course Code: MLCE07 **Credits: 4:0:0**

Prerequisites: Computer Networks **Contact Hours: 56**

Course Coordinator: Lakshmi S.

UNIT – I

Introduction & Concepts: Definition and Characteristics of IoT, Things in IoT, IoT Protocols, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, IoT levels and deployment templates, IoT and M2M, SDN and NFV for IoT, IoT system management with NETCONFIG – YANG

UNIT – II

Developing Internet of Things: IoT Platform design methodology, Specifications: Requirements, Process, Domain, Information, Services, Level, Functional, Operational, Integration, Application Development

Python Language: Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date and Time Operations, Classes, Python packages of interest for IoT

UNIT – III

IoT Physical Devices and End Points: Basic building blocks of an IoT Device, Raspberry Pi, Linux on Raspberry Pi, Raspberry Pi Interfaces: Serial, SPI, I2C

Programming Raspberry Pi with Python: Controlling LED, Interfacing Switch, Interfacing Light Sensor

UNIT – IV

Cloud and Data Analytics: Introduction to cloud storage models and communication APIs

Web Application Framework: Django, Web Services for IoT, Sky Net Messaging Platform, Data Analytics for IoT, Apache: Hadoop, Oozie, Storm, Real-Time Data Analysis, Tools for IoT

UNIT – V

IoT Case Studies: Home Automation: Smart Lighting, Home Intrusion Detection; Cities: Smart Parking Environment: Weather Monitoring System, Weather Reporting Bot, Air Pollution Monitoring, Forest Fire Detection; Agriculture – Smart Irrigation, IoT Printer, IOT in Automobiles: Intelligent Transportation and the Connected Vehicle, Vehicular Ad-hoc Networks (VANETs)

References:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", University Press, 2015.
2. Pethuru Raj, Anupama C Raman, "The Internet of things: Enabling Technologies, Platforms, and Use Cases Description", Taylor & Francis, CRC Press, 2017.
3. Daniel Minoli "Building the Internet of Things with IPV6, John Wiley & Sons, 2013.

Course Outcomes (COs):

1. Describe the OSI Model for the IoT/M2M systems. (POs: 1, 3)
2. Learn basics of design, integration and applications of IoT models. (POs: 1, 3)
3. Acquire the knowledge of basic blocks of an IoT devices using Raspberry Pi. (PO: 3)
4. Understand cloud storage models and web services for IoT. (PO: 3)
5. Appraise with various case studies. (POs: 1, 3, 4)

BROADBAND WIRELESS NETWORKS

Course Code: MLCE08 **Credits: 4:0:0**

Prerequisites: Computer Communication Networks **Contact Hours: 56**

Course Coordinator: Flory Francis

UNIT – I

WiMAX genesis and framework: IEEE 802.16 standard from 802.16-2004 to 802.16e, WiMAX forum, WiMAX forum working groups, WiMAX forum white papers, WiMAX products certification, WiMAX certified products, Predicted products and deployment evolution, Product types, Products and deployment Timetable, Other 802.16 Standards, Korean Cousin: WiBro.

Protocol layers and topologies: Protocol Layers of WiMAX, Convergence Sub layer (CS),Medium Access Control Common Part Sub layer (MAC CPS), Security Sub layer, Physical Layer, Single Carrier (SC) and OFDM, Network Management Reference Model, WiMAX Topologies.

UNIT – II

Frequency utilization and system profiles: Cellular concept, Sectorisation, Cluster size considerations, Handover, WiMAX system profiles.

WiMAX physical layer: OFDM transmission, Basic Principle: Use the IFFT Operator, Time domain and Frequency domain OFDM considerations, OFDM symbol parameters, Physical Slot (PS), Peak-to-Average Power Ratio (PAPR), OFDMA and its variants, Subcarrier permutations in WiMAX OFDMA PHY.802.16 transmission chains.

UNIT – III

WiMAX MAC and QoS: CS layer, MAC function and frames, MAC addresses and MAC frames, MAC header format, MAC sub-headers and special payloads, Fragmentation, Packing and Concatenation, Basic, Primary and Secondary Management Connections, User data and MAC Management Messages, TLV encoding in the 802.16 standard, TLV encoding sets, Automatic Repeat Request (ARQ), ARQ feedback format, Hybrid ARQ (HARQ), Scheduling and link adaptation.

UNIT – IV

Multiple access and burst profile: Duplexing – FDD,TDD mode, Transmission of downlink and uplink subframes, OFDM PHY uplink and downlink subframe, OFDMA PHY frame, frame duration, Preambles, Maps of Multiple Access: DL-MAP and UL-MAP, DL-MAP message, UL-MAP message, OFDMA PHY UL and DL MAP Messages, Burst profile usage: DCD Message and DIUC Indicator, Burst profile selection thresholds, DCD (Downlink Channel Descriptor) message, Transmission of the DCD message, DIUC values, UCD (Uplink Channel Descriptor) message and UIUC indicator, Mesh frame, Network control subframe, Schedule control subframe

Uplink bandwidth allocation and request mechanisms: Types of uplink access grant request, Contention based focused bandwidth request in OFDM PHY.

UNIT – V

Radio resource management: Radio engineering consideration for WiMAX systems, Radio resource management procedures, Advanced antenna technologies in WiMAX, Multicast Broadcast Services (MBS), Multi-BS access MBS, MBS frame.

WiMAX architecture: Need for a standardised WiMAX, High-level architecture requirements, Network reference model, Network functionalities.

References:

1. Loutfi Nuyami, "WiMAX Technology for Broadband Access", John Wiley, 2007.
2. Yan Zhang, Hsia-Hwa Chen, "Mobile WiMAX", Aurobech Publications, 2008.

Course Outcomes (COs):

1. Identify different protocols and topologies in wireless networks. (POs: 1, 3)
2. Discuss cellular concepts and physical layer specifications of WiMAX. (POs: 1, 3)
3. Describe the MAC layer responsibilities and its frame format. (POs: 1, 3)
4. Employ various multiple access techniques for efficient spectrum allocation and utilization. (POs: 1, 3)
5. Describe the functional blocks of WiMax architecture and RF resource management. (POs: 1, 3)

CMOS VLSI CIRCUITS

Course Code: MLCE09 **Credits: 4:0:0**

Prerequisites: Digital Design **Contact Hours: 56**

Course Coordinator: M. Nagabushanam

UNIT – I

MOS Transistor Theory: n MOS/p MOS transistor, threshold voltage equation, body effect, MOS device design equation, sub threshold region, Channel length modulation. mobility variation, Tunneling, punch through, hot electron effect MOS models, small signal AC Characteristics, CMOS inverter, βn / βp ratio, noise margin, static load MOS inverters, differential inverter, transmission gate, tristate inverter, BiCMOS inverter.

UNIT – II

CMOS Process Technology: Semiconductor Technology overview, basic CMOS technology, p well / n well / twin well process. Current CMOS enhancement (oxide isolation, LDD, refractory gate, multilayer inter connect), Circuit elements, resistor, capacitor, interconnects, sheet resistance & standard unit of capacitance concepts delay unit time, inverter delays, driving capacitive loads, RC delay Line, Super Buffers, propagation delays, MOS mask layout, stick diagram, design rules and layout, symbolic diagram, masking, scaling of MOS circuits.

UNIT – III

Basics of Digital CMOS Design: Combinational MOS Logic circuits-Introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, Transmission Gate. Sequential MOS logic Circuits- Introduction, Behavior of Bi-stable elements, SR latch Circuit, clocked latch and Flip Flop Circuits, CMOS D latch and triggered Flip Flop. Dynamic Logic Circuits - Introduction, principles of pass transistor circuits, Dynamic CMOS circuit techniques.

UNIT – IV

Dynamic CMOS and clocking: Introduction, advantages of CMOS over NMOS, CMOS/SOS technology, CMOS/bulk technology, latch up in bulk CMOS, static CMOS design, Domino CMOS structure and design, Charge sharing, Clocking: clock generation, clock distribution, clocked storage elements

UNIT – V

Circuit Simulation: Introduction to circuit simulation, Spice tutorials, Device models, Device characterization, circuit characterization, Simulation mismatches, Monte Carlo simulation

References:

1. Neil H E Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A System Perspective", 3rd Edition, Pearson Education, 2006.
2. Wayne Wolf, "Modern VLSI Design: System on Silicon", 3rd Edition, PHI, 2008.
3. Douglas A Pucknell, Kamran Eshraghian, "Basic VLSI Design", 3rd Edition, PHI, 2009.
4. Sung Mo Kang and Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", 3rd Edition, Tata McGraw-Hill, 2003.

Course Outcomes (COs):

1. Describe basics of CMOS digital integrated circuits. (POs: 3, 4)
2. Discuss the fabrication process in CMOS technologies. (POs: 1, 3, 4)
3. Analyze the switching characteristics of VLSI circuits. (POs: 1, 3, 4)
4. Design and analyze dynamic CMOS circuits. (POs: 1, 3, 4)
5. Elaborate on the circuit simulation process for VLSI circuits. (POs: 1, 3, 4)

COMMUNICATION SYSTEM DESIGN USING DSP

Course Code: MLCE10 **Credits: 4:0:0**

Prerequisites: Analog & Digital Communication **Contact Hours: 56**

Course Coordinator: T. D. Senthilkumar

UNIT – I

Introduction: Digital filters, Discrete time convolution and frequency responses, FIR filters – Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. IIR filters – realization and implementation, FFT and power spectrum estimation: DTFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum.

UNIT – II

Analog modulation scheme: Amplitude Modulation – Theory, generation and demodulation of AM, Spectrum of AM signal, Envelope detection and square law detection, Hilbert transform and complex envelope, DSP implementation of amplitude modulation and demodulation.

DSBSC: Theory, generation of DSBSC, demodulation using coherent detection and Costas loop, Implementation of DSBSC using DSP hardware.

SSB: Theory, SSB modulators, Coherent demodulator, Frequency translation, Implementation using DSP hardware.

UNIT – III

Frequency modulation: Theory, Single tone FM, Narrow band FM, FM bandwidth, FM demodulation, Discrimination and PLL methods, Implementation using DSP hardware.

UNIT – IV

Digital Modulation schemes: PRBS, and data scramblers: Generation of PRBS, Self-synchronizing data scramblers, Implementation of PRBS and data scramblers. RS-232C protocol and BER tester: The protocol, error rate for binary signaling on the Gaussian noise channels, Three bit error rate tester and implementation.

UNIT – V

PAM: PAM theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM.

QAM: Basic QAM transmitter, Constellation examples, QAM structures using pass band shaping filters, Ideal QAM demodulation, QAM experiment. QAM receivers – Clock recovery and other frontend sub-systems, Equalizers and carrier recovery systems.

Experiment for QAM receiver frontend: Adaptive equalizer, Phase splitting, fractionally spaced equalizer. Decision directed carrier tracking, Blind equalization, Complex cross coupled equalizer and carrier tracking experiment, Echo cancellation for full duplex modems: Multicarrier modulation, ADSL architecture, Components of simplified ADSL transmitter, a simplified ADSL receiver, Implementing simple ADSL Transmitter and Receiver.

References:

1. Steven A. Tretter, "Communication System Design using DSP Algorithms with Laboratory Experiments for the TMS320C6713 DSK", Springer, 2008.
2. Vinay Ingle, John Proakis, "Digital Signal Processing using MATLAB", Cengage Learning, 2011.
3. John G. Proakis, Masoud Salehi, Gerhard Bauch, "Contemporary Communication Systems using MATLAB and Simulink", 2^{nd} Edition, Thomson-Brooks/Cole, 2004.

Course Outcomes (COs):

1. Employ C and assembly functions in the implementation of filters and Fourier transforms, using DSP hardware. (POs: 1, 3, 4)
2. Apply amplitude modulation concepts in the DSP implementation of AM/DSB transceiver. (POs: 1, 3, 4)
3. Demonstrate the DSP implementation of frequency modulation scheme. (POs: 1, 3, 4)
4. Analyze the bit error rate performance of the binary modulation receiver. (POs: 1, 3, 4)
5. Illustrate the function of QAM transmitter and receiver hardware .(POs: 1, 3, 4)

RF AND MICROWAVE CIRCUIT DESIGN

Course Code: MLCE11 **Credits: 4:0:0**

Prerequisites: Microwave Circuits **Contact Hours: 56**

Course Coordinator: Sujatha B

UNIT – I

Wave Propagation in Networks: Introduction, Reasons for using RF/Microwaves, Applications, RF waves, RF and Microwave circuit design, Introduction to components basics, Analysis of simple circuit phasor domain, RF impedance matching, Properties of waves, transmission media, Micro strip lines, High frequency parameters, Formulation of S-parameters, Properties, transmission matrix, Generalized S-parameters.

UNIT – II

Passive Circuit Design: Introduction, Smith chart, Scales, Application of Smith chart, Design of matching networks, Definition of impedance matching, Matching using lumped and distributed elements.

Considerations in Active Networks and design of amplifiers, oscillators and detectors: Stability consideration, gain consideration, Noise consideration.

UNIT – III

Linear and Non-linear Design: Introduction, Types of amplifier, Design of different types of amplifiers, Multi-stage small signal amplifiers

Design of Transistor Oscillators: Oscillator versus Amplifier Design. Oscillation Conditions, Design of Transistor Oscillators, Generator Tuning Networks.

UNIT – IV

RF/Microwave Frequency Conversion I: Rectifier and Detector Design: Detector losses, Effect of Matching Network on the Voltage Sensitivity, detector design.

RF/Microwave Frequency Conversion II: Mixer Design: Mixers, Mixer types, Conversion loss for SSB mixers, One-Diode (or Single-Ended) Mixers, Two-Diode Mixers, Four Diode Mixers, Eight-Diode Mixers.

UNIT – V

RF/Microwave Control Circuit Design: Phase shifters, Digital phase shifters, Semiconductor phase shifters, PIN Diode Attenuators

RF and microwave IC design, MICs, MIC materials, Types of MICs, Hybrid verses monolithic MICs,

References:

1. Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education, 2004.
2. Reinhold Ludwig, Pavel Bretchko, "RF Circuit Design Theory and Applications", Pearson Education, 2004.

Course Outcomes (COs):

1. Employ transmission line theory, S-parameters, and Smith chart for microwave circuit analysis. (POs: 3, 4)
2. Design passive microwave matching circuits. (POs: 3, 4)
3. Design microwave amplifiers, oscillators, resonators and micro-strip circuits. (POs: 3, 4)
4. Discuss features of active high-frequency matching networks, detector and mixer devices. (POs: 3, 4)
5. Design microwave ICs and hybrid ICs using MIC materials. (POs: 3, 4)

SIMULATION, MODELING AND ANALYSIS

Course Code: MLCE12 **Credits: 4:0:0**

Prerequisites: Engineering Mathematics **Contact Hours: 56**

Course Coordinator: S. L. Gangadharaiah

UNIT – I

Simulation Modeling: Nature of simulation, System models, discrete event simulation, Single server simulation, Alternative approaches, other types of simulation

UNIT– II

Building Valid, Credible and Detailed Simulation Models: Techniques for increasing model validity and credibility, comparing real world observations

UNIT – III

Selecting Input Probability Distributions: Useful probability distributions, Assessing sample independence, Activity – I, II and III, Model of arrival process.

UNIT – IV

Random Number Generators: Linear congruential, Other kinds, Testing number generators, Random variate generation: Approaches, Continuous random variates, discrete random variates, Correlated random variates

UNIT – V

Output Data Analysis: Statistical analysis for term initiating simulation, Analysis for steady state parameters, Comparing alternative system configuration, Confidence interval, Variance reduction techniques, Arithmetic and control variates.

References:

1. Averill Law, "Simulation Modeling and Analysis", 4th Edition, McGraw Hill, 2007.
2. Jerry Banks, "Discrete Event System Simulation", Pearson Education, 2009.
3. Seila Ceric and Tadikamalla, "Applied Simulation Modeling", Cengage Publishing, 2009.
4. George. S. Fishman, "Discrete Event Simulation", Springer, 2001.
5. Frank L. Severance, "System Modeling and Simulation", Wiley, 2009.

Course Outcomes (COs):

1. Describe the basic concepts in modeling and simulation. (POs: 1, 3, 4)
2. Apply different techniques to increase model validity and credibility. (POs: 1, 3, 4)
3. Choose different probability distributions for simulation and modeling. (POs: 1, 3, 4)
4. Employ random number variates to develop simulation models. (POs: 1, 3, 4)
5. Analyze and test the output data produced by the model. (POs: 1, 3, 4)

SOFTWARE DEFINED RADIO

Course Code: MLCE13 **Credits: 4:0:0**

Prerequisites: Wireless Communication **Contact Hours: 56**

Course Coordinator: T. D. Senthilkumar

UNIT – I

Introduction to Software Radio concepts: Characteristics, benefits and design principles of a software radio.

Radio Frequency Implementation issues: Purpose of the RF front-end, Challenges of receiver design, RF receiver front-end topologies, RF components, Transmitter architecture, Noise and distortion in the RF chain, ADC and DAC conversion.

UNIT – II

Multirate Signal Processing: Sample rate conversion principles, Poly phase filters, Digital filter banks, Timing recovery in digital receivers using digital filters.

UNIT – III

Digital Generation of Signals: Introduction – approaches to direct digital synthesis, analysis of spurious signals, bandpass signal generation, performance of direct digital synthesis system, Hybrid DDS-PLL systems, Generation of random sequences, ROM compression techniques

UNIT – IV

ADC and DAC: Introduction. Parameters of ideal and practical data converters – sampling process, quantization, physical model, transfer characteristics, dynamic range, timing issues, analog bandwidth, power consumption, impact of noise and interference, Techniques to improve data converter performance.

UNIT – V

Digital Hardware: Introduction, Hardware elements, DSP processors – core, architectures, addressing, pipelining, multiprocessing using real-time operating systems, software design cycle, maximizing performance, Field programmable gate arrays, Power management issues.

References:

1. J. H. Reed, "Software Radio", Prentice Hall, 2002.
2. Eugene Grayver, "Implementing Software Defined Radio", Springer, 2013.
3. Joseph Mitola, "Software Radio Architecture", 1st Edition, John Wiley & Sons, 2002.

Course Outcomes (COs):

1. Describe the characteristics and design issues of RF components. (POs: 1, 3, 4)
2. Employ the principles of sampling rate conversion in implementation of digital poly phase filters. (POs: 1, 3, 4)
3. Enumerate the techniques to generate the digital signals for random sequences. (POs: 1, 3, 4)
4. Apply the design principles of data converter to improve its performance. (POs: 1, 3, 4)
5. Appraise the use of DSP processors and FPGA in the implementation of SDR. (POs: 1, 3, 4)

DATA COMPRESSION

Course Code: MLCE14 **Credits: 4:0:0**

Prerequisites: Information Theory and Coding **Contact Hours: 56**

Course Coordinator: Maya V. Karki

UNIT – I

Lossless Compression Techniques: Introduction to lossy and lossless compression, Uniquely Decodable codes, Prefix codes, Kraft McMillan Inequality, Huffman coding, Adaptive Huffman coding, Arithmetic coding, Adaptive Dictionary (LZW) algorithm, Context based compression (The Burrow Wheeler Transform), Applications of lossless compression: text and images.

UNIT – II

Lossy Compression Techniques: Basics of lossless compression**,** scalar quantization: uniform, non-uniform and entropy coded quantization. Vector quantization: LBG algorithm, Tree structured VQ, Structured VQ, Differential encoding: Prediction in DPCM, Adaptive DPCM, Delta Modulation.

UNIT – III

Transform Coding: Transforms–KLT, DCT, DST, DWHT, Quantization and coding of transform coefficients, DWHT entropy coded quantization, Wavelets: multi-resolution analysis and scaling, embedded zero tree coder (EZW), set partitioning in hierarchical trees (SPIHT).

UNIT – IV

Image and Audio Compression Standards: JPEG standard, JPEG 2000 standard, ADPCM in speech coding, G.726 ADPCM, Linear predictive coding, CELP, ADPCM in speech coding, MPEG audio compression.

UNIT – V

Video Compression Techniques: Video compression based on motion compensation, search formotion vectors, H.261, H.263, MPEG – 1 and MPEG- 2, MPEG-4 and MPEG-7 video coding.

References:

1. K. Sayood**,** “Introduction to Data Compression”, 3rd Edition, Harcourt India Pvt. Ltd. & Morgan Kaufmann Publishers, 2006.
2. Z. Li and M.S. Drew, “Fundamentals of Multimedia”, Pearson Education (Asia) Pvt. Ltd., 2004.
3. D. Salomon, “Data Compression: The Complete Reference”, Springer, 2000.

4. N. Jayant and P. Noll, “Digital Coding of Waveforms: Principles and Applications to Speech and Video”, Prentice Hall, 1984.

Course Outcomes (COs):

1. Describe coding and decoding text messages using Huffman, arithmetic and dictionary based methods. (POs: 3, 4)
2. Differentiate between scalar quantizer, vector quantizer and predictive coding. (POs: 1, 3, 4)
3. Apply DCT, DWT, EZW, and SPIHT compression algorithms for images. (POs: 1, 3, 4)
4. Illustrate JPEG, JPEG 2000, CELP and MPEG-1 audio standards. (POs: 1, 3, 4)
5. Enumerate various video coding standards. (POs: 1, 3, 4)