SCHEME OF TEACHING

M.Tech (Digital Electronics and Communication)

I Semester

S. No	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC11	Advanced Engineering Mathematics	PCC	2	1	0	3	4
2.	MLC12	Advanced Digital Communication	PCC	3	0	0	3	3
3.	MLCExx	Elective 1	PEC	4	0	0	4	4
4.	MLCExx	Elective 2	PEC	4	0	0	4	4
5.	MLCExx	Elective 3	PEC	3	0	0	3	3
6.	RM116	Research Methodology and IPR	MCC	3	0	0	3	3
7.	MLCL13	Advanced Digital Communication Laboratory	PCCL	0	0	1	1	2
8.	MLCL14	Digital System Design Laboratory	PCCL	0	0	1	1	2
Total				**19**	**1**	**2**	**22**	**25**

II Semester

S. No	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC21	Wireless Communication	PCC	3	1	0	4	5
2.	MLC22	Advanced Embedded Systems	PCC	4	0	0	4	4
3.	MLCExx	Elective 4	PEC	4	0	0	4	4
4.	MLCExx	Elective 5	PEC	4	0	0	4	4
5.	MLCExx	Elective 6	PEC	4	0	0	4	4
6.	MLCL23	Advanced Embedded Systems Laboratory	PCCL	0	0	1	1	2
7.	MLCL24	Advanced Signal and Image Processing Laboratory	PCCL	0	0	1	1	2
Total				**19**	**1**	**2**	**22**	**25**

III Semester

S. No	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC31	Multimedia Communication	PCC	3	1	0	4	4
2.	MLCExx	Elective 7	PEC	4	0	0	4	4
3.	MLC32	Internship/Industrial Training	INT	0	0	4	4	4
4.	MLC33	Project Work – I	PW	0	0	4	4	4
Total				**7**	**1**	**8**	**16**	**16**

IV Semester

S. No	Course Code	Course Title	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MLC41	Project Work – II	PW	0	0	20	20	20
Total				**0**	**0**	**20**	**20**	**20**

List of Electives

S. No	Course Code	Course Name	Credits			
			L	T	P	Total
1.	MLCE01	Antenna Theory and Design	4	0	0	4
2.	MLCE02	Digital System Design with HDL	3	0	0	3
3.	MLCE03	Digital VLSI Design	4	0	0	4
4.	MLCE04	Advanced Signal and Image Processing	4	0	0	4
5.	MLCE05	MEMS	4	0	0	4
6.	MLCE06	Machine Learning and Deep Learning	4	0	0	4
7.	MLCE07	Internet of Things (IoT)	4	0	0	4
8.	MLCE08	Advanced Computer Networks	4	0	0	4
9.	MLCE09	Error Control Coding	4	0	0	4
10.	MLCE10	Optical Communication Networks	4	0	0	4
11.	MLCE11	ASIC Design	4	0	0	4
12.	MLCE12	Advanced Computer Architecture	4	0	0	4

ADVANCED ENGINEERING MATHEMATICS	
Course Code: MLC11 **Pre-requisites: Engineering Mathematics** **Course Coordinator: Dr. K. Indira**	**Credits: 2:1:0** **Contact Hours: 28L+14T**
Unit – I	
Solving Linear Equations: Systems of Linear Equations**,** Row reduced and Echelon forms, Vector Equations, The Matrix Equation, Solution Sets of Linear Systems, Linear Independence, Introduction to Linear Transformation , Matrix of a Linear Transformation, Inverses, Partitioned matrices, Matrix Factorization and Determinants	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https:// nptel.ac.in/courses/111106051
Unit – II	
Vector Spaces: Vector spaces and Subspaces, Null Spaces, Column Spaces and Linear Transformation, Linear Independent Sets: Bases, Coordinate Systems, The dimension of a Vector Space, Rank, Change of basis **Eigen Values and Eigen Vectors:** Eigen values, Eigen vectors and diagonalization, Eigen vectors and linear transformations	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https:// nptel.ac.in/courses/111106051
Unit – III	
Orthogonality: Inner Product, Length and Orthogonality, Orthogonal Sets, Orthogonal Projections, Gram – Schmidt Process, Least Squares Problems, Inner Product Spaces **Symmetric Matrices and Quadratic Forms:** Diagonalization of symmetric matrices, Quadratic forms , Constrained Optimization, Singular Value Decomposition(SVD)	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https:// nptel.ac.in/courses/111106051
Unit – IV	
Random Variables: Introduction, Distribution functions, Discrete Random Variables and Probability Mass function (PMF), Continuous Random Variable and Probability Density Function (PDF), Mean and Variance **Special Distributions**: Bernoulli, Binomial, Poisson, Uniform, Exponential and Normal Distributions **Multiple Random variables**: Introduction, Joint CDF/PMF/PDF, Covariance and Coefficient.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117105085
Unit – V	
Random Processes: Definitions, Ensemble Average**s ,** Gaussian Processes, Stationary Processes, Autocovariance and Autocorrelation Matrices, White Noise, Power Spectrum, Filtering Random Processes, Spectral Factorization	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://onlinecourses.nptel.ac.in/noc20_ee53/preview
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. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling' John Wiley & Sons, Inc., 2002.
4. Henry Stark, John W. Woods, "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Prentice Hall, 2002.
5. Peyton Z. Peebles, "Probability Random Variables and Random Signal Principles", 4th Edition, TMH, 2007.
6. Hwei P, HSU, 'Theory and Problems on Probability, Random Variables and Random Processes, TMH,2010.

Course Outcomes (COs):

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

1. Apply row reduction and echelon forms to Solve Systems of Linear Equations (POs: 1, 3, 4)
2. Explain the significance of Vector Spaces, Eigen Values and Eigen Vectors (POs: 1, 3, 4)
3. Apply the Gram-Schmidt process to construct an orthonormal set of vectors in an inner product space. (POs: 1, 3, 4)
4. Analyze different random variables and their statistical parameters (POs: 1, 3, 4)
5. Classify various random processes and analyze the nature of output random process of a LTI systems (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED DIGITAL COMMUNICATION	
Course Code: MLC12 **Pre-requisites: Digital Communication** **Course Coordinator: Dr. T. D. Senthilkumar**	**Credits: 3:0:0** **Contact Hours: 42 L**
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.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104099 ➢ https://nptel.ac.in/courses/117104115
Unit – II	
Digital Communication Through Band-Limited Channels: Optimum receiver for channels with ISI and AWGN. Linear equalization – peak distortion criterion, MSE criterion, Decision feedback equalization.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://www.nptelvideos.com/video.php?id=538&c=5 ➢ https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-ec12/
Unit – III	
Adaptive Equalization: Adaptive linear equalizer – zero-forcing algorithm, LMS algorithm. Adaptive decision-feedback equalizer, RLS algorithm for adaptive equalization.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://www.nptelvideos.com/video.php?id=538&c=5 ➢ https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-ec12/
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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104099 ➢ https://nptel.ac.in/courses/117104115
Unit – V	
Spread Spectrum Signals for Digital Communications: Direct sequence spread spectrum signals – error rate performance, effect of pulsed interference. Frequency hopped spread spectrum signals – performance in an AWGN channel.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104099 ➢ https://nptel.ac.in/courses/117104115
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, 2012.
3. Andrew J. Viterbi, “CDMA: Principles of Spread Spectrum Communications”, Prentice Hall, USA, 1995.

Course Outcomes (COs):

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

1. Analyze the performance of band- and power-limited signals in the AWGN channel 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. Analyze the performance of DSSS and FH spread spectrum systems (POs:1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED DIGITAL COMMUNICATION LABORATORY	
Course Code: MLCL13 **Pre-requisites:** **Course Coordinator: Dr. Sujatha B &** **Dr. T D Senthilkumar**	**Credits: 0:0:1** **Contact Hours: 14P**

List of Experiments	
1.	Experimental studies of radiation pattern of Micro strip Yagi-Uda and Dipole antennas.
2.	Determination of the modes transit time, electronic timing range and sensitivity of klystron source
3.	Determination of the modes transit time, electronic timing range and sensitivity of klystron source.
4.	Calculate the directivity and gain of Horn antenna from the radiation pattern.
5.	Experimental studies of radiation pattern of Micro strip Patch antenna.
6.	Calculate the antenna parameters of different types of antenna using Software/Simulation tool
7.	Write a simulation code to 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.	Write a simulation code to compute Bit Error Rate (BER) for different digital modulation scheme 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 TMH, 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, Third Indian Reprint, 2010.

Web links and Video Lectures (e-Resources):

1. https://www.iitk.ac.in/mimt_lab/vlab/index.php
2. https://www.mathworks.com/help/comm/ug/bit-error-rate-analysis-techniques.html

Course Outcomes:

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

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. Analyze the performance of the digital modulation receivers in fading channel (POs: 1, 3, 4, 5)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Weekly evaluation of laboratory manuals/records after the conduction of every experiment	30	CO1, CO2, CO3, CO4, CO5
Practical test	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination:	50	CO1, CO2, CO3, CO4, CO5

DIGITAL SYSTEM DESIGN LABORATORY	
Course Code: MLCL14 **Pre-requisites: Digital Electronics** **Course Coordinator: Dr. Rajendra Prasad P**	**Credits: 0:0:1** **Contact Hours: 14P**
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.	4-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.	Stepper motor and DC motor interface
9.	DAC interface
Using System Verilog code, simulate the following	
10.	Full subtractor using structural modeling
11.	Flip Flops(D,SR,T,JK)
12.	4-bit synchronous/asynchronous counters, synchronous arbitrary counter

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.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/108105113
2. https://nptel.ac.in/courses/117103064
3. https://nptel.ac.in/courses/117106086
4. https://nptel.ac.in/courses/117106114
5. https://nptel.ac.in/courses/106105165
6. https://nptel.ac.in/courses/108103179

Course Outcomes (COs):

1. Design and model complex combinational circuits using HDL at behavioral, structural and RTL levels. (POs: 1, 3, 4, 5)
2. Enumerate 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. Illustrate 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)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Weekly evaluation of laboratory manuals/records after the conduction of every experiment	30	CO1, CO2, CO3, CO4, CO5
Practical test	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination:	50	CO1, CO2, CO3, CO4, CO5

WIRELESS COMMUNICATION	
Course Code: MLC21 **Pre-requisites: Advanced Digital Communication** **Course Coordinator: Dr. T. D. Senthilkumar**	**Credits: 3:1:0** **Contact Hours: 42L+14T**
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.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104115
Unit – II	
Diversity: Introduction, Micro-diversity, Macro-diversity and simulcast, Combination of Signals, Error Probability in fading channels with diversity reception, Transmit diversity	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://www.nptelvideos.com/video.php?id=538&c=5
Unit – III	
Capacity of Wireless Channels: AWGN channel capacity, Linear time invariant Gaussian channels, Capacity of fading channels	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117105132
Unit – IV	
Spatial Multiplexing for 5G Wireless Communications: Receive diversity, Spatial multiplexing and channel modeling, Multiplexing capability of MIMO channels, Physical modeling of MIMO channels, Modeling MIMO fading channels.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104115
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.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117104115
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):	

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

1. Define 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 spatial multiplexing for MIMO channels. (POs: 1, 3, 4)
5. Discuss the performance of MIMO receiver architecture. (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED EMBEDDED SYSTEMS	
Course Code: MLC22 **Pre-requisites:** **Course Coordinator: Dr. Lakshmi Shrinivasan**	**Credits: 4:0:0** **Contact Hours: 56 L**
Unit – I	
Introduction to Embedded System: Core of Embedded systems, memories & communication protocols **Embedded Systems Design and Development Hardware Software Co-Design and Program Modeling:** Fundamental issues in the Hardware Software Co-Design, Computational models in the embedded system design: Data Flow-Graph/Diagram (DFG) Model, Control Data Flow Graph / Diagram (CDFG), State machine model with examples. Sequential program model, unified modeling language (UML) building blocks with examples, Life Cycle Models.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106105159 ➢ https://nptel.ac.in/courses/108105057
Unit – II	
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 **Technical Overview ARM Cortex –M4:** Processor type, architecture, block diagram, memory System, Interrupt and exception support, instructions, features of ARM Cortex –M4 **Low Power and System Control Features:** Low power features, using WFI and WFE instructions in programming	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106105193 ➢ https://nptel.ac.in/courses/108102045
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. **Fault Exceptions and Fault Handling:** Overview of faults Causes of faults, enabling fault handlers and fault status and address registers	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106105193 ➢ https://nptel.ac.in/courses/117106111
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 techniques, how to Choose an RTOS.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108105057
Unit – V	
The Embedded System Development Environment: Embedded Firmware design approaches and development, the Integrated Development Environment (IDE), Types of Files Generated on Cross-compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging and Boundary Scan	

• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108105057 ➢ https://nptel.ac.in/courses/117101004

References:

1. Joseph Yiu, "The definitive guide to ARM Cortex – M3 and Cortex- M4 processors", 3rd edition, NEWNES, An imprint of Elsevier Inc, 2014.
2. Shibu. K. V, "Introduction to Embedded Systems", 1st edition, Tata McGraw Hill Education Private Ltd., 2009.
3. James K Peckol, "Embedded Systems: A Contemporary Design Tool", 2nd edition, John Wiley & Sons, Inc., 2019
4. Rajkamal, "Embedded Systems, Architecture, Programming and Design", 3rd edition, Tata McGraw Hill Education Pvt., Ltd., 2012
5. Frank Vahid, Tony Givargis, "Embedded System Design - A Unified Hardware/ Software
6. Introduction", new edition Edition, John Wiley & Sons, 2002

Course Outcomes (COs):

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

1. Identify the basic building blocks, software & hardware 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 various architectural features and importance of ARM Cortex M4. (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)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED EMBEDDED SYSTEMS LABORATORY	
Course Code: MLCL23 **Pre-requisites:** **Course Coordinator: Dr. Lakshmi Shrinivasan**	**Credits: 0:0:1** **Contact Hours: 14P**
List of Experiments	
Introduction to IDE for ARM processor family	
1.	Assembly language based data transfer programs.
2.	Factorial of a given number and largest/smallest number from a given array of N numbers.
3.	Ascending/Descending order of given N numbers and Parity checking (even or odd)
Hardware Interfacing Experiments using ARM Cortex M4	
4.	Design and Interface a DC motor speed control and measurement.
5.	Generation of Sine, triangular and square waveform using Dual DAC.
6.	Design and Interface a stepper motor for following operations: rotate clockwise, anticlockwise for defined degree of angle.
7.	Design and Interface simple elevator system.
8.	Design and Interface a simple 3 x 8 calculator type Keypad module.
9.	Show how an output interfaced H/W 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 Inter Process Communication (IPC) using Pipes, FIFO, Semaphore, Message Queues and Mutex.
Model the given embedded system using UML tool	
12.	The static aspects of the system using basic class, use case and sequence diagram with code generation.

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.
3. James K Peckol, "Embedded Systems: A Contemporary Design Tool", 2nd edition, John Wiley & Sons, Inc., 2019

Web links and Video Lectures (e-Resources):

1. https://a.impartus.com/ilc/#/course/289735/703

Course Outcomes:

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

1. Use simulation and emulation IDE (POs – 1, 5)
2. Know 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)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Weekly evaluation of laboratory manuals/records after the conduction of every experiment	30	CO1, CO2, CO3, CO4, CO5
Practical test	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination:	50	CO1, CO2, CO3, CO4, CO5

ADVANCED SIGNAL AND IMAGE PROCESSING LABORATORY	
Course Code: MLCL24 **Pre-requisites:** **Course Coordinator:**	**Credits: 0:0:1** **Contact Hours: 14P**
List of Experiments	
1.	Estimation of power spectrum of AR, MA, and ARMA process
2.	Design of lattice predictor of order p
3.	Stationary system identification
4.	Generation of spectrogram of speech signal
5.	FIR filter model using RLS algorithm
6.	FIR filter model using LMS algorithm
7.	Reading and displaying images, applying transformation function: log transform, power law transform, histogram equalization
8.	Smoothing and sharpening spatial filter
9.	Point, line and edge detection, Boundary detection, Basic global thresholding, Otsu's method and Region based segmentation
10.	Extracting region and boundaries, Chain code representation, Boundary reconstruction using Fourier Descriptor
11.	Dilation and Erosion of an image using structuring element, Labelling connected components, Morphological reconstruction
12.	Object recognition using minimum distance, Bayes classifier
13.	Object recognition using feed forward network classifier

References:

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

Web links and Video Lectures (e-Resources):

Course Outcomes:

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

1. Estimation of power spectral density of random processes. (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)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Weekly evaluation of laboratory manuals/records after the conduction of every experiment	30	CO1, CO2, CO3, CO4, CO5
Practical test	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination:	50	CO1, CO2, CO3, CO4, CO5

MULTIMEDIA COMMUNICATION	
Course Code: MLC31 **Pre-requisites:** **Course Coordinator: Dr. Maya V Karki**	**Credits: 3:1:0** **Contact Hours: 42L+14T**
Unit – I	
Introduction to Multimedia: Introduction, Network and network services, Multimedia sources, Sources and destination services, Applications of multimedia communication networks: Video streaming to multiple users, Video conferencing **Multimedia Software Tools:** Multimedia presentation, Editing and authoring tools in multimedia, Graphics and image data representation, Digital video, Video display interfaces	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – II	
Audio and Image Coding Standards: Architectural overview of audio standards, Psychoacoustic modeling, Time frequency mapping, Quantization, Variable length coding, MPEG audio coding standards, Image compression: Quantization, Transform coding: KLT, DCT and Wavelet transforms, EZW and SPIHT algorithm, Standards: JPEG, JPEG 2000	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – III	
Video Compression and Standards: Basic video compression techniques, Video compression based on motion compensation, Search for motion vectors, H.261, MPEG video coding:1,2,4 and 7, Video coding standards: H.264, H.265	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – IV	
Network Services and Protocols for Multimedia Communication: Local area networks and access Networks, Internet technologies and protocols, Multicast extension, Quality of Service for multimedia communication, Protocols for multimedia transmission and interaction	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – V	
Internet Multimedia Communication: Content multimedia distribution, Broadcast multicast Video-on-demand, Peer-to-peer video streaming with mesh overlays, HTTP based media streaming, Multimedia over wireless and mobile networks: 4G cellular networks and beyond, Multimedia cloud computing	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
References:	

1. Ze Nian Li, Mark S Drew, Jiangchuan Liu, "Fundamentals of Multimedia", 2nd Edition, Springer, 2014.
2. Gerry D Gibson, "Multimedia Communications: Directions and Innovations", Academic Press, 2001.
3. Ranjan Parekh, "Principles of Multimedia", 2nd Edition Tata McGraw Hill, 2013.
4. Fred Halsall, "Multimedia Communications", 1st Edition, Pearson Education, 2011

Course Outcomes (COs):

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

1. Appraise basics of multimedia communication and multimedia software tools. (POs: 1, 3, 4)
2. Illustrate different audio and image coding standards. (POs: 1, 3, 4)
3. Elaborate on video compression based on motion compensation and MPEG video coding. (POs: 1, 3, 4)
4. Appreciate various network services and protocols for multimedia communication. (POs: 1, 3, 4)
5. Employ internet technologies for multimedia content distribution. (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ANTENNA THEORY AND DESIGN	
Course Code: MLCE01 **Pre-requisites:** **Course Coordinator: Dr. Sujatha B**	**Credits: 4:0:0** **Contact Hours: 56 L**
Unit – I	
Antenna fundamentals 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.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – II	
Resonant Antennas: Dipole antenna (Far field electric and magnetic field components, Radiation resistance), Yagi-Uda antenna. **Broadband antennas:** Travelling wave Wire antennas, Helical antennas – Normal mode helix antenna, Axial mode Helix antenna, Bi-conical antennas, sleeve antenna.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – III	
Frequency independent antennas: Principle of frequency independent antennas, Log-periodic antenna. **Micro-strip and Printed Antennas:** Feeding methods, Rectangular patch, Circular patch, Resonant frequencies and design.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – IV	
Aperture antennas: Pyramidal Horn Antenna, Reflector antennas – Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, offset parabolic reflectors, Dual reflector antennas, Feed antennas for reflectors, Feed antennas used in practice.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
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, Dolph Chebyshev linear array method to reduce side lobe narrow main beam synthesis. **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	

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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):

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

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 micro-strip patch antennas (POs: 1, 3, 4)
4. Design the directivity and gain of parabolic reflector and explain the feed methods of reflector antennas (POs: 1, 3, 4)
5. Synthesize antenna beam pattern using different types of distributions and describe computationally efficient approximations using MOM (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

DIGITAL SYSTEM DESIGN with HDL	
Course Code: MLCE02 **Pre-requisites:** **Course Coordinator: Dr. Rajendra Prasad P**	**Credits: 3:0:0** **Contact Hours: 42 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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117108040 ➢ https://nptel.ac.in/courses/117105080
Unit – II	
Sequential Basics: Storage elements, Counters, Sequential data paths and control, Clocked synchronous timing methodology	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117106092 ➢ https://nptel.ac.in/courses/117106086
Unit – III	
Memories and Implementation Fabrics: Concepts, Memory types, Error detection and correction, ICs, PLDs, Packaging and circuit boards, Interconnection and signal integrity	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117106109 ➢ https://nptel.ac.in/courses/117106114
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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108103179 ➢ https://nptel.ac.in/courses/106105165
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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106105165 ➢ https://nptel.ac.in/courses/108103179
References:	
1. Peter J. Ashenden, "Digital Design: An Embedded Systems Approach using Verilog", Elsevier, 2010. 2. 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. 3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2010.	

4. Chris Spear, Greogory J Tumbush, "System Verilog for Verification – A Guide to Learning Test Bench Language Features", Springer, 2012.

Course Outcomes (COs):

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

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

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

DIGITAL VLSI DESIGN	
Course Code: MLCE03 **Pre-requisites:** **Course Coordinator:**	**Credits: 4:0:0** **Contact Hours: 42 L**
Unit – I	
Introduction to CMOS circuits: MOS transistors, CMOS combinational logic gates, multiplexers, latches and flip-flops, CMOS fabrication and layout, VLSI design flow.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106106089 ➢ https://nptel.ac.in/courses/117101004
Unit – II	
MOS transistor theory: Ideal I-V and C-V characteristics, non-ideal I-V effects, CMOS Inverter, DC transfer characteristics, Switch level RC delay models.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106106089 ➢ https://nptel.ac.in/courses/117101004
Unit – III	
CMOS technologies: Layout design rules, CMOS process enhancement, Technology related CAD issues. **Circuit characterization and performance estimation:** Delay estimation, Logical effort and transistor sizing	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106106089
Unit – IV	
Power: Introduction, Dynamic power, Static power, Power dissipation, Low power architectures.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106106089
Unit – V	
Combinational circuit design: Static CMOS, Ratioed circuits, Cascode voltage switch logic, Dynamic circuits, Pass transistor circuits.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/106106089
References:	
1. Neil H E Weste, David Harris, "CMOS VLSI Design: A System Perspective", 4th Edition, Pearson Education, 2014. 2. Jan Rabaey, B. Nikolic, A. Chadrakasan," Digital Integrated Circuits: A Design Perspective", 2nd Edition, Pearson,2016 3. Wayne Wolf, "Modern VLSI Design: System on Silicon", 3rd Edition, PHI, 2008. 4. Douglas A Pucknell, Kamran Eshraghian, "Basic VLSI Design", 3rd Edition, PHI, 2009.	
Course Outcomes (COs):	
At the end of the course, students will be able to: 1. Analyse the theory behind CMOS digital integrated circuits. (POs:1, 3, 4) 2. Design CMOS inverters with specified noise margin and propagation delay. (POs:1, 3, 4)	

3. Employ different performance metrics to predict the performance of VLSI circuits. (POs: 1, 3, 4)
4. Apply low power concepts in VLSI Design. (POs: 1, 3, 4)
5. Implement the logic circuits using MOS and CMOS technology. (POs: 1, 3, 4, 5)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5

ADVANCED SIGNAL AND IMAGE PROCESSING	
Course Code: MLCE04 **Pre-requisites:** **Course Coordinator:**	**Credits: 4:0:0** **Contact Hours: 56 L**
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 normal equations, Properties of linear prediction – Error filters, Lattice and ARMA Lattice-Ladder Filters, Wiener filters for filtering and prediction	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – II	
Adaptive filters: Applications of adaptive filters, Linear Predictive Coding (LPC) of speech signal, Adaptive direct form FIR filters, LMS algorithm, Adaptive direct form filters, RLS algorithm	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
References:	
1. John G Proakis, Dimitris G Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2006. 2. Rafael C Gonzalez, 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):
At the end of the course, students will be able to: 1. Design linear predictors and optimum linear filters. (POs: 1,3,4) 2. Design 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. Apply different object recognition algorithms to detect objects in a scene. (POs:1,3,4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

MEMS	
Course Code: MLCE05 **Pre-requisites:** **Course Coordinator: Dr. Lakshmi S**	**Credits: 4:0:0** **Contact Hours: 56 L**
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, and 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.	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108106165 ➢ https://archive.nptel.ac.in/courses/108/108/108108113/
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,	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108106165 ➢ https://archive.nptel.ac.in/courses/108/108/108108113/
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.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/108106165
Unit – IV	
Introduction to Nanoelectronics: Particles and waves- Wave-particle duality- Wave mechanics- Schrödinger wave equation, 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.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/118102003
Unit – V	
Fabrication and measurement techniques for nanostructures- Bulk crystal and hetero structure growth, Nanolithography. **Measurement and Applications of Nano devices:** Techniques for characterization of nanostructures, Injection Lasers: Quantum cascade lasers, Single photon sources. Optical memories, Coulomb blockade devices, Photonic structures	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://www.digimat.in/nptel/courses/video/117108047/L01.html
References:	

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

Course Outcomes (COs):

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

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. (POs – 3)
3. Identify the electronics and RF aspects of MEMS systems. (POs - 3, 4)
4. Recognize the distinguishing aspect of nanoscale devices and systems. (POs – 3)
5. Examine the basic science behind the design and fabrication of nano scale Systems and their applications. (POs- 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

MACHINE LEARNING AND DEEP LEARNING	
Course Code: MLCE06 **Pre-requisites:** **Course Coordinator: Dr. K. Indira**	**Credits: 4:0:0** **Contact Hours: 56 L**
Unit – I	
Introduction: What is machine learning, Example machine learning applications **Supervised Learning:** Learning a class from examples, VC dimension, PAC learning, Noise, Learning multiple classes, Regression, Model selection and generalization **Bayesian Decision Theory:** Classification, Losses and Risks, Discriminant functions, Association Rules	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://onlinecourses.nptel.ac.in/noc22_cs29/preview
Unit – II	
Parametric Methods: Maximum likelihood estimation, Evaluating an estimator, Bayes estimator, Parametric classification, Regression, Tuning model capacity Dimensionality Reduction: Subset Selection, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA)	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://onlinecourses.nptel.ac.in/noc22_cs29/preview
Unit – III	
Unsupervised Learning: Clustering: k–Means Clustering, EM algorithm, Hierarchical Clustering, **Decision Trees:** Univariate Trees: Classification and Regression trees	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://onlinecourses.nptel.ac.in/noc22_cs29/preview
Unit – IV	
Multilayer Perceptrons: Perceptron, Training a perceptron, Learning Boolean functions, Multilayer perceptrons, Backpropagation algorithm, Training procedures, Dimensionality reduction	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117105084 ➢ https://nptel.ac.in/courses/108108148
Unit – V	
Deep Neural Networks: Deep feed forward networks, regularization for deep learning, Optimization for training deep models, Convolutional networks	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢ https://nptel.ac.in/courses/117105084
References:	
4. Ethem Alpaydin, "Introduction to Machine Learning", 3rd Edition, PHI Learning Pvt. Ltd, 2015 5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017. 6. Christopher Bishop, "Pattern Recognition and Machine Learning", CBS Publishers &Distributors, 2010. 7. Tom Mitchell, "Machine Learning", McGraw Hill, 1997. 8. Michael Nielsen, "Neural Networks and Deep Learning", 2019.	
Course Outcomes (COs):	

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

6. Examine the concepts of various supervised learning algorithms and employ Bayesian learning for classification (POs – 1, 3, 4)
7. Evaluate parametric methods for classification and investigate various dimensionality reduction algorithms (POs –1, 3, 4)
8. Analyse unsupervised learning algorithms and multivariate concepts (POs –1, 3, 4)
9. Appreciate the concepts of deep learning and apply deep feed forward network practical problems (POs – 1,3, 4)
10. Understand Deep Neural Networks and demonstrate how Convolutional Network can be mapped to practical applications (POs – 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

INTERNET OF THINGS (IoT)	
Course Code: MLCE07 **Pre-requisites:** **Course Coordinator: Dr. Suma K V**	**Credits: 4:0:0** **Contact Hours: 56L**
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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – II	
Developing Internet of Things: IoT Platform design methodology, Specifications: Requirements, Process, Domain, Information, Services, Level, Functional, Operational, Integration, Application Development	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
Unit – IV	
Web Application Framework: Django, Web Services for IoT, SkyNet Messaging Platform, **Data Analytics for IoT**: Apache: Hadoop, Oozie, Storm, Real-Time Data Analysis, Tools for IoT	
• Pedagogy/Course delivery tools: • Links: • Links:	➢ Chalk and talk ➢
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.	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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.	

Course Outcomes (COs):
At the end of the course, students will be able to: 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. (POs-3) 4. Understand cloud storage models and web services for IoT. (POs-3) **5.** Appraise with various case studies. (POs-1,3,4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED COMPUTER NETWORKS	
Course Code: MLCE08 **Pre-requisites:** **Course Coordinator: Flory Francis**	**Credits: 4:0:0** **Contact Hours:56L**
Unit – I	
Local Area Networks: Ethernet - Physical layer, MAC, LLC, LAN interconnection, 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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – IV	
Cryptography: Introduction, Symmetric ciphers, Block cipher structure, DES, AES cipher, Principles of public key cryptosystems, RSA algorithm	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
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	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
References:	
1. J. Walrand and P. Varaya, "High Performance Communication Networks", Harcourt Asia (Morgan Kaufmann), 2000. 2. S. Keshav, "An Engineering Approach to Computer Networking", Pearson Education, 1997. 3. Leon-Garcia, and I. Widjaja, "Communication Networks: Fundamental Concepts and Key Architectures", TMH, 2000. 4. William Stallings, "Cryptography and Network Security: Principles and Practice", 6th Edition, Pearson Education Inc., 2014.	

Course Outcomes (COs):
At the end of the course, students will be able to: 1. Describe the basic networking, data switching and scheduling techniques of networks. (POs: 1, 3) MNOP 2. Analyze various network traffic management and control techniques. (POs: 1, 3,4) 3. Discuss congestion and flow control. (POs: 1, 3) 4. Appraise the working for symmetric and public key ciphers. (POs: 1, 3,4) 5. Illustrate the importance of hash functions and message authentication codes. (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ERROR CONTROL CODING	
Course Code: MLCE09 **Pre-requisites:** **Course Coordinator: Chitra M**	**Credits: 4:0:0** **Contact Hours:56L**

Unit – I

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

Unit – V

Majority Logic Decodable 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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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):

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

1. Apply properties of Galois field to groups, fields, vector space, row space and sub-spaces. (POs: 1, 3, 4)
2. Employ linear block codes, RM codes and Golay codes in error detection and 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 BCH, RS and other q-ary coding and decoding algorithms. (POs: 1, 3, 4)
5. Describe convolutional encoders and Viterbi and stack algorithm based decoders. (POs: 1, 3, 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

OPTICAL COMMUNICATION NETWORKS

Course Code: MLCE10 **Pre-requisites:** **Course Coordinator:**	**Credits: 4:0:0** **Contact Hours:56L**

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

Unit – II

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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

• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢

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):
At the end of the course, students will be able to: 1. Demonstrate the function of optical components and light propagation mechanism. (POs: 1, 3, 4) 2. Analyze the 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)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ASIC DESIGN	
Course Code: MLCE11 **Pre-requisites:** **Course Coordinator: Dr. V. Anandi**	**Credits: 4:0:0** **Contact Hours:56L**
Unit – I	
Introduction to ASICs: Full custom, Semi-custom and programmable ASICs, ASIC design flow, **ASIC cell libraries CMOS Logic:** Datapath logic cells: Data path elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path operators, I/O cells	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – II	
ASIC Library Design: Logical effort: Predicting delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages **Programmable ASIC Logic Cells:** MUX as Boolean function generators, Actel ACT: ACT 1, ACT 2 and ACT3 logic modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – III	
Programmable ASIC I/O Cells: Xilinx and Altera I/O Block **Low-level Design Entry:** Schematic entry: Hierarchical design, Netlist screener **ASIC Construction:** Physical Design, CAD Tools **Partitioning:** Goals and objectives, Constructive partitioning, Iterative partitioning improvement, KL and look ahead algorithms	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – IV	
Floor Planning: Goals and objectives, Floor planning tools, Channel definition, I/O and Power planning, Clock planning **Placement:** Goals and objectives, Min-cut placement algorithm, Iterative placement improvement, Physical design flow	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – V	
Routing: Global routing: Goals and objectives, Global routing methods, Back-annotation **Detailed Routing:** Goals and objectives, Measurement of channel density, Left-Edge and Area routing algorithms. Special routing, Circuit extraction and DRC	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
References:	

1. M J S Smith, “Application Specific Integrated Circuits”, Pearson Education, 2003.
2. Neil H. E. Weste, David Harris, Ayan Banerjee, “CMOS VLSI Design: A Circuits and Systems Perspective”, 3rd Edition, Addison Wesley/Pearson Education, 2011.
3. Vikram Arkalgud Chandrasetty, “VLSI Design: A Practical Guide for FPGA and ASIC Implementations”, Springer, 2011.
4. Rakesh Chadha, J. Bhasker, “An ASIC Low Power Primer: Analysis, Techniques and Specification”, Springer Publications, 2015.

Course Outcomes (COs):

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

1. Describe the concepts of ASIC design methodology, data path elements and FPGA architectures. (POs: 4)
2. Design data path elements for ASIC cell libraries and compute optimum path delay. (POs: 4)
3. Employ industry synthesis tools to achieve desired objectives. (POs: 1, 2, 3, 5)
4. Design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain physical design flow. (POs: 1, 3, 4)
5. Create floor plan including partition and routing using CAD algorithms. (POs: 4)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5

ADVANCED COMPUTER ARCHITECTURE	
Course Code: MLCE12 **Pre-requisites:** **Course Coordinator: Dr. V. Anandi**	**Credits: 4:0:0** **Contact Hours:56L**
Unit – I	
Parallel Computer Models: State of computing, Classification of parallel computers, Multiprocessors and multicomputer, Multivectors and SIMD computers grain size and latency **Program and Network Properties:** Conditions of parallelism, Data and resource dependencies, Hardware and software parallelism, Program partitioning and scheduling	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – II	
Program Flow Mechanisms: Control flow v/s data flow, Comparisons of flow mechanisms, Performance metrics and measures, Data flow architecture, Demand driven mechanisms **Principles of Scalable Performance:** Parallel processing applications, Speedup performance laws, Scalability analysis and approaches	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – III	
Speedup Performance Laws: Amdhal's law, Gustafson's law, Memory bounded speedup model, Scalability analysis and approaches **Advanced Processors:** Advanced processor technology, Instruction set architectures, CISC scalar processors, RISC scalar processors, Superscalar processors, VLIW architectures	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – IV	
Pipelining: Linear pipeline processor, Nonlinear pipeline processor, Instruction pipeline, Design mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch handling techniques, Branch prediction, Arithmetic pipeline design **Memory Hierarchy Design:** Cache basics and cache performance, Reducing miss rate and miss penalty, Multilevel cache hierarchies, Main memory organization, design of memory hierarchies	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
Unit – V	
Multiprocessor Architectures: Symmetric shared memory architectures, Distributed shared memory architectures, Models of memory consistency, Scalable cache coherence, Design challenges of directory protocols, Memory based directory protocols, Cache based directory protocols. Cache coherence protocols (MSI, MESI, MOESI), Overview of directory based approaches	
• Pedagogy/Course delivery tools: • Links:	➢ Chalk and talk ➢
References:	

1. Kai Hwang, “Advanced Computer Architecture: Parallelism, Scalability, Programmability”, 1st Edition, Tata McGraw Hill, 2003.
2. Kai Hwang, Zu, “Scalable Parallel Computers Architecture” Tata McGraw Hill, 2003.
3. M.J. Flynn, “Computer Architecture, Pipelined and Parallel Processor Design”, Narosa Publishing, 2002.
4. D.A. Patterson, J.L. Hennessy, “Computer Architecture: A Quantitative Approach”, Morgan Kauffmann,2012.

Course Outcomes (COs):

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

1. Illustrate contemporary computer architecture issues and techniques. (POs:1,2)
2. Discuss the role of parallelism in current and future architectures. (POs:3)
3. Analyze the behavior of a processor pipeline for various sequences of instructions. (POs: 3,4)
4. Apply concept of cache and virtual memory for high performance computer architecture. (POs: 1,3,5)
5. Compare different multi-processor architectures and cache coherence protocols. (PO:3)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	**Marks**	**Course outcomes addressed**
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination:	100	CO1, CO2, CO3, CO4, CO5