VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus

M.Tech Microelectronics and Control Systems (EMS)

Eligibility: Bachelor's degree in Engineering or Technology in

(a)Electrical and Electronics Engineering (b) Electronics and Communication Engineering

(c) AMIE in appropriate branch

(i) GATE: EE, EC

(Effective from Academic year 2016-17)

BOARD OF STUDIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

January 2017

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2016-17
M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)

I SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EEE11	Applied Mathematics	04	--	03	20	80	100	4
2	16EMS12	Analysis of Linear Systems	04	--	03	20	80	100	4
3	16EMS13	VLSI Design	04	--	03	20	80	100	4
4	16EMS14	Embedded Systems	04	--	03	20	80	100	4
5	16EMS15X	Elective -1	03	--	03	20	80	100	3
6	16EMSL16	Microelectronics and Control Laboratory - I	-	3	03	20	80	100	2
7	16EMS17	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of I semester: 22

Elective -1

Course Code under 16EMS15X	Title
16EMS151	Nonlinear Systems
16EMS152	Process Control and Instrumentation
16EMS153	Control Systems for HVAC
16EMS154	Nanotechnology for Microelectronics and Optoelectronics

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SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)

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II SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS21	Industrial Control Technology - 1	04	--	03	20	80	100	4
2	16EMS22	Optimal Control Theory	04	--	03	20	80	100	4
3	16EMS23	High Speed VLSI Design	04	--	03	20	80	100	4
4	16EMS24	CAD Tools For VLSI Design	04	--	03	20	80	100	4
5	16EMS25X	Elective - 2	03	--	03	20	80	100	3
6	16EMSL26	Microelectronics and Control Laboratory - II	-	3	03	20	80	100	2
7	16EMS27	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of II semester: 22+ 22 = 44

Elective -1

Course Code under 16EMS25X	Title
16EMS251	Low Power VLSI Design
16EMS252	Robust Control Theory
16EMS253	Digital System Design with VHDL
16EMS254	Real Time Approach to Process Control

Note: Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

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III SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	--	--	--	25	--	25	20
2	16EMS32	Report on Internship	--	--	--	25	--	25	
3	16EMS33	Evaluation and Viva-Voce of Internship	--	--	--	--	75	75	
4	16EMS34	Evaluation of Project phase -1	--	--	--	50	--	50	1
TOTAL			--	--	--	**100**	**75**	**175**	**21**

Number of credits completed at the end of III semester: 22+ 22 + 21 = 65

Note:
Internship of 16 weeks shall be carried out during III semester.
Major part of the Project work shall also be carried out during the III semester in consultation with the Guide/s.

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SCHEME OF TEACHING AND EXAMINATION - 2016-17

M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)

CHOICE BASED CREDIT SYSTEM (CBCS)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS41	Industrial Control Technology - 2	04	--	03	20	80	100	4
2	16EMS42X	Elective - 3	03	--	03	20	80	100	3
3	16EMS43	Evaluation of Project phase - 2	--	--	--	50	-	50	3
4	16EMS44	Evaluation of Project and Viva-Voce	--	--	03	--	100 + 100	200	10
		TOTAL	**07**	**--**	**09**	**90**	**360**	**450**	**20**

Number of credits completed at the end of IV semester: 22+ 22 + 21 + 20 = 85

Elective -1

Course Code under 16EMS42X	Title
16EMS421	Industrial Control - Software and Routines
16EMS422	Digital System Design with FPGA
16EMS423	Microelectronic Fabrication
16EMS424	Reset Control Systems

Note: 1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.
b. External Examiner shall carry out the evaluation for 100 marks.
c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.
d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
APPLIED MATHAMATICS (Core Course)			
Course Code	16EEE11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- The objectives of this course is to acquaint the students with principles of advanced mathematics through linear algebra, transform methods for differential equations, calculus of variations and linear and non-linear programming, that serve as an essential tool for applications of electrical engineering sciences. ■

Module-1		**Teaching Hours**
Numerical Methods: Solution of algebraic and transcendental equations- iterative methods based on second degree equation – Muller method(no derivation), Chebyshev method. Fixed point iteration method (first order), acceleration of convergence- Δ^2 - Aitken's method. System of non-linear equations – Newton-Raphson method. Complex roots by Bairstow's method. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying	
Module-2		
Numerical Solution of Partial Differential Equations: Classification of second order equations, parabolic equations-solution of one dimensional heat equation, explicit method, Crank-Nicolson method. Hyperbolic equations- solution of one dimensional wave equation and two-dimensional Laplace equation by explicit method. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying	
Module-3		
Linear Algebra: Vector spaces, linear dependent, independence, basis and dimension, elementary properties, examples. **Linear Transformations**: Definition, properties, range and null space, rank and nullity, algebra of linear transformations-invertible, singular and non-singular transformations, representation of transformations by matrices. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding	
Module-4		
System of linear algebraic equations and Eigen value problems: Iterative methods - Gauss-Seidal method, SOR method, Eigen value problems – Gerschgorian circle theorem, Eigen values and Eigen vectors of real symmetric matrices -Jacobi method. **Interpolation:** Hermite interpolation, spline interpolation, numerical solution of differential equations – Numerov method. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EEE11 APPLIED MATHAMATICS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		Teaching Hours
Optimization: Linear programming- formulation of the problem, general linear programming problem, simplex method, artificial variable technique, Big M-method. **Graph Theory:** Basic terminologies, types of graphs, sub graphs, graphs isomorphism, connected graphs-walks, paths, circuits, connected and disconnected graphs, operations on graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, applications to electrical circuits. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing.	

Course outcomes:

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

1. Employ numerical techniques in order to achieve more accurate values in the computation of roots of algebraic and non-linear equations.
2. Utilize analytical and numerical schemes to solve partial differential equations applicable to engineering problems.
3. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
4. Apply standard iterative methods to compute Eigen values and solve ordinary differential equations.
5. Employ linear and non-linear programming techniques in simulation of network systems and optimization of electrical circuits.

Graduate Attributes (As per NBA):

Critical Thinking, Problem Solving, Research Skill, Usage of Modern Tools.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Linear Algebra and its Applications	David C.Lay et al	Pearson	5th Edition,2015
2	Numerical methods in Engineering and Science (with C, C++ & MATLAB)	B.S.Grewal	Khanna Publishers	2014
3	Graph Theory with Applications to Engineering and Computer Science	Narsingh Deo	PHI	2012
4	Numerical Methods for Scientific and Engineering Computation	M. K. Jain et al	New Age International	9th Edition, 2014
5	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition,2015
6	Linear Algebra	K.Hoffman et al	PHI	2011
7	**Web links:**1. *http://nptel.ac.in/courses.php?disciplineId=111* 2. *http://www.class-central.com/Course/math(MOOCs)* 3.*www.wolfram.com*			

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
ANALYSIS OF LINEAR SYSTEMS (Core Course)			
Course Code	16EMS12	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To model Continuous and Discrete time system in state space
- To solve the continuous and discrete time system state space models.
- To assess the controllability and observability of state space models in the continuous and discrete time domains.
- Understand the concepts of state feedback techniques. ■

Module		Teaching Hours
Module-1		
State space Representation of Continuous Time Systems: Introduction, concepts of state, consistency conditions, State space representation using physical variables, phase variables, canonical variables. Eigen values, Eigen vectors, state equations for dynamic systems, Non-uniqueness of state model, state diagrams- state diagrams for continuous time state models. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-2		
State Space Representation of Discrete Time Systems: Digital control system, quantizing and quantization error, Data acquisition and conversion, Impulse sampling and data hold, pulse transfer function, State space representation of discrete time systems, State diagrams - state diagrams for discrete time state models. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-3		
Solution of State Equations: Introduction, Existence and Uniqueness of solution to continuous time state equations, Solution of Linear time invariant continuous time state equations – Evaluation of matrix exponential, series evaluation, Evaluation using symmetry transformation, Evaluation using Cayley- Hamilton technique, Evaluation using Inverse Laplace transformation. Solution of Discrete time state equations – Z transform approach, Pulse transfer function matrix, Discretization of continuous time state space equations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-4		
Controllability and Observability of Systems: Introduction, General Concept of Controllability, General Concept of Observability, Controllability Tests For Continuous Time Systems – Time Invariant Case, Observability Tests For Continuous Time Systems – Time Invariant Case, Controllability and Observability of Discrete Time Systems – Time Invariant Case Controllability and Observability of State Model in Jordan Canonical Form. Loss of Controllability and Observability due to Sampling. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-5		
Model Control: Introduction, Controllable and Observable Companion Forms – Single Input /Single Output Systems, Effect of State feedback on Controllability and Observability, Pole Placement by State Feedback- Single Input Systems, Stabilizability, Full Oder Observer, Reduced Order Observer, Deadbeat Observer. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS12 ANALYSIS OF LINEAR SYSTEMS (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Provide a state variable models for Continuous and discrete time systems.
- Solve the State equations to provide a solution and analyze them in both continuous and discrete time domains.
- Assess the controllability and observability of state space models developed.
- Apply the concepts of state feedback techniques in controlling the systems. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Modern Control System Theory	M Gopal	New Age International	2012 Reprint
2	Discrete Time Control Systems	Ogata K	PHI	2^{nd} Edition, 2016

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
VLSI DESIGN (Core Course)			
Course Code	16EMS13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To study in detail the basic processing details and the characteristics of MOS transistors.
- To discuss techniques to optimize combinational circuits for lower delay, alternate CMOS logic configurations or circuit families.
- To discuss sequential circuits and designing of bot static and dynamic sequential circuits.
- To design and analyze CMOS power and differential amplifiers.
- To Design and analyze the current mirrors as both bias elements and signal processing components and CMOS Op Amps. ■

Module-1		**Teaching Hours**
MOS Transistor Theory: MOS Transistors, CMOS Fabrication and Layout, Long – Channel I-V Characteristics, C-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics, Pitfalls and Fallacies. **CMOS Processing Technology:** Introduction, CMOS Technologies, Layout Design Rules, CMOS Process Enhancements. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Combinational Circuit Design: Introduction, Circuit Families, Circuit Pitfalls, More Circuit Families, Silicon-on-Insulator Circuit Design, Subthreshold Design, Pitfalls and Fallacies, Historical Perspective. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Sequential Circuit Design: Introduction, Sequencing Static Circuits, Circuit Design of Latches and Flip-flops, Static Sequencing Element Methodology, Sequencing Dynamic Circuits, Synchronizers, Wave Pipelining, Pitfalls and Fallacies, Case study■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Single Stage Amplifiers: Basic Concepts, Common – Source Stage, Source Follower, Common – Gate Stage, Cascode Stage, Choice of Device Models. **Differential Amplifiers:** Single – Ended and Differential Operations, Basic Differential Pair, Common – Mode Response, Differential Pair with MOS Loads, Gilbert Cell. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Passive and Active Current Mirrors: Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors. **Operational Amplifiers:** General Considerations, One – Stage Op Amps, Two – Stage Op Amps, Gain Boosting, Comparison, Common – Mode Feedback, Input Range Limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS13 VLSI DESIGN (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Explain in detail the basic processing details and the characteristics of MOS transistors.
- Optimize combinational circuits for lower delay, discuss alternate CMOS circuit families.
- Design both static and dynamic sequential circuits.
- Design and analyze CMOS power and differential amplifiers.
- Design and analyze the current mirrors as both bias elements and signal processing components and CMOS Op Amps. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Money Harris	Pearson	4th Edition, 2015
2	Design of Analog CMOS Integrated Circuits	Behzad Razavi	Mc Graw Hill	31st Reprint, 2015

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
EMBEDDED SYSTEMS (Core Course)			
Course Code	16EMS14	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To impart knowledge of embedded systems with suitable examples, explanation of process, classification of embedded systems.
- To explain the processor architecture, memory organization, communication with processor and interrupt services.
- To explain the program modeling concepts, inter-process communication and synchronization of processes. ■

Module-1		Teaching Hours
Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems – on –chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design of Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skill required for an Embedded System Designer. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Processor Architecture and Memory Organisation: 8051 Architecture, Real world Interfacing, Introduction to Advanced Architecture, Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory – Types, Memory – Maps and Addresses, Processor Selection, Memory Selection. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Devices and Communication Buses, Interrupt Services: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Device Protocols – Parallel Communication Network Using ISA,PCI, PCI –X and Advanced Protocols. **Device Drivers and Interrupts Service Mechanisms:** Programmed – I/O Busy – wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing Mechanism, Direct Memory Access. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding	
Module-4		
Program Modelling concepts: Program Models, DFG Models, State Machine Programming Models for Event – controlled Program Flow, Modelling of Multiprocessor Systems, UML Modelling. **Interprocess Communication and Synchronization of Processes, Threads and Tasks:** Multiple Processes in an Application, Multiple Threads in an Application, Tasks, Task Status, Task and Data, Clear – cut Distention Between Functions, ISRS and Tasks by their Characteristics, Concept of Semaphores, Shared Data, Interprocess Communication, Signal Function, Semaphore Functions, Message Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC Functions. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) 16EMS14 EMBEDDED SYSTEMS (Core Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-5		**Teaching Hours**
Real - Time Operating Systems: OS Services, Process Management, Timer Functions, Event Functions, Memory management, Device, File and IO Subsystems Management , Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real – time Operating Systems, Basic Design Using an RTOS, Rtos Task Scheduling Models, Interrupt Latency and Response of the task as performance Metrics, OS Security Issues. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

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

- Describe embedded system, recognize the classification of embedded systems and design process in embedded system.
- Describe processor architecture and memory organization.
- Communicate with processor using serial and parallel devices with the processor and explain interrupt services mechanism. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Embedded Systems: Architecture, Programming and Design	Raj Kamal	Mc Graw Hill	2nd Edition,2014

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
NONLINEAR SYSTEMS (Elective Course)			
Course Code	16EMS151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- Understand the concepts of Non Linear Systems.
- Understand the concepts of Phase Plane Analysis concepts.
- Understand the concepts of Lyapunov stability technique.
- Understand the Describing function method. ■

Module-1		Teaching Hours
Nonlinear Systems: Introduction to Nonlinear systems, Behavior of Nonlinear Systems- Frequency –Amplitude dependence, Jump resonance, Sub- harmonic oscillations, Frequency entrainment, Limit Cycles, Asynchronous quenching. Common Physical Non-linearities, Classification of nonlinearities, methods of analysis of nonlinear systems Definition of describing function, Linearization of nonlinear system. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Describing Function Method: Introduction, assumptions and definition, evaluation of describing function for functions like x2, x3,|x|x and common nonlinearities like relay, saturation, dead zone, hysteresis, backlash and a combination of these, Analysis of nonlinear systems – Concept of enclosure, stable and unstable limit cycles, Review of polar plot and Nichols Plot, Evaluation of existence of limit cycle and calculation of magnitude and frequency of oscillation. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Phase-Plane Analysis: Introduction to phase plane and phase trajectory, Singular points –evaluation, classification and trajectories, Stability analysis of nonlinear system using phase trajectories, Limit cycles in phase portrait, Construction of phase trajectories - Analytical method, Isocline method, Delta method, and Pell's method. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Lyapunov Stability: Stability Definitions, Some Preliminaries, Lyapunov's Direct Method, Stability of Linear Systems, Lyapunov's Linearization Method, The Lur'e Problem, Krasovskii;s method of stability assessment, Variable gradient method of stability assessment. Stability assessment of discrete time systems.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Stability Assessment in the Frequency Domain: Circle criteria and its application, Popov's method. **Sliding mode control:** Introduction An overview of classical sliding mode control, introductory example, Dynamics in sliding mode – Linear Systems, Nonlinear Systems, Chattering Problems, Reachability Condition, Applications of Sliding mode control.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS151 NONLINEAR SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Identify the nonlinearity present in a system and explain the behavior of nonlinear system.
- Evaluate the describing function for the nonlinearity present in the system and assess the performance of the system using it.
- Analyze the nonlinear system using the Phase Plane Analysis.
- Define the stability of a system and assess the stability using Lyapunov Stability method.
- Assess the stability of nonlinear system using circle criterion and Popov's stability criterion and apply sliding mode control to the linear and nonlinear systems. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module. ■

Text/Reference Books

1	Advanced Control Theory	A.NagoorKani	RBA Publications	2nd Edition, 2009
2.	Nonlinear Systems Analysis	M. Vidyasagar	PHI	2nd Edition. 2002
3	Non Linear Systems	H. K. Khalil	Pearson	2015
4.	Sliding Mode Control in Engineering	Wilfrid Perruquetti & Jean Pierre Barbot	Marcel Dekker	2002

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
PROCESS CONTROL AND INSTRUMENTATION (Elective Course)			
Course Code	16EMS152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To introduce the concepts of process control, the elements in the building blocks, the units for physical measurements, the use of basic electrical and analog electronic circuits
- To provide digital concepts to their applications, measurement of pressure and level in process control.
- To discuss the instruments and sensors for measurement of flow of fluids, temperature and heat, position, force and light.
- To discuss Humidity measuring devices, regulators, valves, motors and the use of PLC for sequential logic control and continuous control.
- To discuss various methods of analog and digital signal conditioning, process control, the terminology used, and the various methods of implementation of the controller functions and the documentation for alarm and trip systems. ■

Module-1		**Teaching Hours**
Introduction to Process Control: Introduction, Process Control, Definition of the Elements in a Control Loop, Instrumentation and Sensors, Control System Evaluation, Analog and Digital Data, Process Facility Considerations. **Units and Standards:** Introduction, Basic Units, Units Derived from Base Units, Standard Prefixes, Standards. **Basic Electrical Components:** Introduction, Circuits with R, L, and C, RC Filters, Bridge Circuits. **Analog Electronics:** Introduction, Analog Circuits, Types of Amplifiers, Amplifier Applications. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Digital Electronics: Introduction, Digital Building Blocks, Converters, Data Acquisition Devices, Basic Processor. **Microelectromechanical Devices and Smart Sensors:** Introduction, Basic Sensors, Piezoelectric Devices, Microelectromechanical Devices, Smart Sensors Introduction. **Pressure:** Introduction, Pressure Measurement, Measuring Instruments, Application Considerations. **Level:** Introduction, Level Measurement, Application Considerations. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Flow: Introduction, Fluid Flow, Flow Measuring Instruments, Application Considerations. **Temperature and Heat:** Introduction, Temperature and Heat, Temperature Measuring Devices, Application Considerations. **Position, Force, and Light:** Introduction, Position and Motion Sensing, Force, Torque, and Load Cells, Light. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
4Humidity and Other Sensors: Humidity, Density and Specific Gravity, Viscosity, Sound, pH Measurements, Smoke and Chemical Sensors. **Regulators, Valves, and Motors:** Introduction, Pressure Controllers, Flow Control Valves, Power Control, Motors, Application Considerations.		**08**

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) 16EMS152 PROCESS CONTROL AND INSTRUMENTATION (Elective Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-4 (continued)		**Teaching Hours**
Programmable Logic Controllers: Introduction, Programmable Controller System, Controller Operation, Input/output Modules, Ladder Diagrams. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Signal Conditioning and Transmission: Introduction, General Sensor Conditioning, Conditioning Considerations for Specific Types of Devices, Digital Conditioning, Pneumatic Transmission, Analog Transmission, Digital Transmission, Wireless Transmission. **Process Control:** Introduction, Sequential Control, Discontinuous Control, Continuous Control, Process Control Tuning, Implementation of Control Loops. **Documentation and P&ID:** Introduction, Alarm and Trip Systems, PLC Documentation, Pipe and Instrumentation Symbols, P&ID Drawings. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	

Course outcomes:

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

- Explain the concepts of process control, the elements in the building blocks, the units for physical measurements, the use of basic electrical and analog electronic circuits.
- Explain the use of digital concepts to their applications, measurement of pressure and level in process control.
- Explain the use of instruments and sensors for measurement of flow of fluids, temperature and heat, position, force and light.
- Explain use of Humidity measuring devices, regulators, valves, motors and the use of PLC for sequential logic control and continuous control.
- Discuss various methods of analog and digital signal conditioning, process control, the terminology used, and the various methods of implementation of the controller functions and the documentation for alarm and trip systems. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Introduction to Instrumentation, Sensors, and Process Control	William C. Dunn	Artech House	2006

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
CONTROL SYSTEMS FOR HVAC (Elective Course)			
Course Code	16EMS153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss the elements of a control system, the basic types of control action, and the energy sources commonly used for controls and various types of control elements.
- To discuss formation of combinations control elements used for control of HVAC.
- To discuss formation and analysis of complete control system
- To provide better idea of the electrical problems inherent in the design of control diagrams, stability of and the digital control of HVAC control systems.
- To use Psychrometric chart to control design, to study central plant pumping and distribution systems, existing HVAC systems and the tuning of HVAC control loops. ■

Module-1		Teaching Hours
Control Theory and Terminology: Introduction, Elementary Control System, Purposes of Control, Control action, Energy Sources for Control, Systems, Measurement, Symbols and Abbreviations, Psychrometrics, Relationships. **Pneumatic Control Devices:** Introduction, Pneumatic Control Devices, Control Cabinets, Air Supply. **Electric and Electronic Control:** Devices, Electric Control Devices, Electronic Control Devices. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Fluidic Control Devices: Introduction, Wall Attachment Devices, Turbulence Amplifiers, Vortex Amplifiers, Radial Jet Amplifier, Fluidic Transducers, Manual Switches. **Flow Control Devices**: Dampers, Steam and Water Flow, Control Valves. **Elementary Control Systems:** Introduction, Outside Air Controls, Air Stratification, Heating, Cooling Coils, Humidity Control, Dehumidifiers, Static Pressure Control, Electric Heat, Gas-Fired Heaters, Oil-Fired Heaters, Refrigeration Equipment, Fire and Smoke Control, Electrical Interlocks, Location of Sensors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-3		
Complete Control Systems: Introduction, Single-Zone Systems, Multizone Air Handling Systems, Dual-Duct Systems, Variable-Volume Systems, Reheat Systems, Heat Reclaim, Fan-Coil Units, Induction Systems, Unit Ventilators, Packaged Equipment, Other Packaged Equipment, Radiant Heating and Cooling, Radiators and Convectors, Heat Exchangers, Solar Heating and Cooling Systems. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-4		
Electric Control Systems: Introduction, Electric Control Diagrams, Electrical Control of a Chiller, Electrical Control of an Air Handling Unit, Example: A Typical Small Air- Conditioning System, Electric Heaters, Reduced-Voltage Starters, Multispeed Starters, Variable Speed Controllers. **Special Control:** Introduction, Close Temperature and/or Humidity Control, Controlled Environment, Rooms for Testing. **Digital and Supervisory Control Systems:** Introduction, Hard-Wired Systems, Multiplexing Systems, Computer-Based Systems for Monitoring and Control, Benefits of the Computer System, Training for Maintenance and Operation. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) 16EMS153 CONTROL SYSTEMS FOR HVAC (Elective Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-5		**Teaching Hours**
Psychrometrics: Introduction, Psychrometric Properties, Psychrometric Tables, Psychrometric Charts, Processes on the Psychrometric Chart, HVAC Cycles on the Chart, Impossible Processes, Effects of Altitude. **Central Plant Pumping and Distribution Systems:** Introduction, Diversity, Constant Flow Systems, Variable Flow Systems, Distribution Systems, Building Interfaces. **Retrofit of Existing Control Systems:** Introduction, Economic Analysis, Discriminators, Control Modes, Economy Cycle Controls, Single-Zone systems, Reheat Systems, Multizone Systems, Dual-Duct Systems, Systems with Humidity Control, Control Valves and Pumping Arrangements. **Dynamic Response And Tuning:** Introduction, Dynamic Response, Tuning HVAC Control Loops. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	

Course outcomes:

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

- Discuss the elements of a control system, the basic types of control action, and the energy sources used for controls and various types of control elements.
- Discuss formation of combinations control elements used for control of HVAC.
- Discuss formation and analysis of complete control system for specific application.
- Explain and solve the electrical problems inherent in the design of control diagrams, stability of and the digital control of HVAC control systems.
- Use Psychrometric chart to control design, to study central plant pumping and distribution systems, existing HVAC systems and the tuning of HVAC control loops. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Control Systems For Heating, Ventilating, and Air Conditioning	Roger W. Haines	Springer	6th Edition, 2006

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
NANOTECHNOLOGY FOR MICROELECTRONICS AND OPTOELECTRONICS (Elective Course)			
Course Code	16EMS154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To review the present trends in microelectronic and optoelectronic devices, solid state and semiconductor physics and define nanostructures.
- To explain the behavior of electrons in nanostructures and the transport and optical properties of nanostructures.
- To study the transport properties of electrons in magnetic field and integral and fractional quantum Hall effect.
- To study advanced semiconductor devices based on nanostructures and advanced optoelectronic and photonic devices based on quantum heterostructures. ■

Module-1		**Teaching Hours**
Mesoscopic Physics and Nanotechnologies: Trends in nanoelectronics and Optoelectronics, Characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Quantum wells, wires, and dots, Density of states and dimensionality, Semiconductor heterostructures, Quantum transport. **Survey of Solid State Physics:** Introduction, review of quantum mechanics, free electron model of a solid. Density of states function, Bloch theorem, Electrons in crystalline solids, Dynamics of electrons in bands, Lattice vibrations, Phonons. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Review of Semiconductor Physics: Introduction, Energy bands in typical semiconductors, Intrinsic and extrinsic semiconductors, Electron and hole concentrations in semiconductors, Elementary transport in semiconductors, Degenerate semiconductors, Optical properties of semiconductors. **The Physics of Low-Dimensional Semiconductors:** Introduction, Basic properties of two-dimensional semiconductor nanostructures, Square quantum well of finite depth, Parabolic and triangular quantum wells, Quantum wires, Quantum dots, Strained layers, Effect of strain on valence bands, Band structure in quantum wells, Excitonic effects in quantum. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Semiconductor Quantum Nanostructures and Superlattices: Introduction, MOSFET structures, Heterojunctions, Quantum wells, Superlattices. **Electric Field Transport in Nanostructures:** Introduction, Parallel transport, Perpendicular transport, Quantum transport in nanostructures. ■		**08**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Transport in Magnetic Fields and the Quantum Hall Effect: Introduction, Effect of a magnetic field on a crystal, Low-dimensional systems in magnetic fields, Density of states of a 2D system in a magnetic field, The Aharonov–Bohm effect, The Shubnikov–de Haas effect, The quantum Hall Effect.		**08**

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) 16EMS154 NANOTECHNOLOGY FOR MICROELECTRONICS AND OPTOELECTRONICS (Elective Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-4 (continued)		**Teaching Hours**
Optical and Electro-optical Processes in Quantum Heterostructures: Introduction, Optical properties of quantum wells and superlattices, Optical properties of quantum dots and nanocrystals, Electro-optical effects in quantum wells. Quantum confined Stark Effect, Electro-optical effects in superlattices. Stark ladders and Bloch Oscillations. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Electronic Devices Based on Nanostructures: Introduction, MODFETs, Heterojunction bipolar transistors, Resonant tunnel effect, Hot electron transistors, Resonant tunneling transistor, Single electron transistor. **Optoelectronic Devices Based on Nanostructures:** Introduction, Heterostructure semiconductor lasers, Quantum well semiconductor lasers, Vertical cavity surface emitting lasers (VCSELs), Strained quantum well lasers, Quantum dot lasers, Quantum well and superlattice photodetectors, Quantum well modulators. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

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

- Explain the present trends in microelectronic and optoelectronic devices, solid state and semiconductor physics and define nanostructures.
- Explain behavior of electrons in nanostructures and the transport and optical properties of nanostructures.
- Discuss the transport properties of electrons in magnetic field and integral and fractional quantum Hall effect.
- Discuss advanced semiconductor devices based on nanostructures and advanced optoelectronic and photonic devices based on quantum heterostructures.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Nanotechnology for Microelectronics and Optoelectronics	J.M. Martínez-Duart, R.J. Martín-Palma, F. Agulló-Rueda	Elsevier	2006

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M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - I

MICROELECTRONICS AND CONTROL LABORATORY - I

Course Code	16EMSL16	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	40	Exam Marks	80

Credits - 02

Course objectives:

- Simulation of a second order system to study the output and perform state estimation by pole placement method in MATLAB/Scilab.
- To analyze the stability of the systems in time and frequency domains using MATLAB/Scilab.
- To Design and verification of the frequency response of different compensators.
- To evaluate the performance of different controllers in enhancing the system performance.
- To verify the sampling theorem, design and analyze the FIR filters.
- To impart knowledge on FIS toolbox for control system applications. ■

Sl. NO	Experiments
1	Simulation of a typical second order system.
2	Study of system stability by using root locus, Bode plot and Nyquist plot.
3	Frequency response of lag, lead and lag-lead network.
4	Performance characteristics of P, PI, PID controller.
5	DC and AC Servo motor characteristic s.
6	Verification of Sampling Theorem.
7	Design and verification of FIR filter.
8	State estimation using Pole placement method.
9	Study of MALAB FIS Tool box.
10	Control system application using FIS Tool box.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.

Course outcomes:

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

- At the end of the course the student will be able to:
- Use MATLAB/Scilab to simulate a second order system to study the output and perform state estimation by pole placement method.
- Analyze the stability of the systems in time and frequency domains
- Design and verify the frequency response of different compensators.
- Evaluate the performance of different controllers in enhancing the system performance
- Verify the sampling theorem, design and analyze the FIR filter
- Gain knowledge on FIS toolbox for control system applications. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - I			
SEMINAR			
Course Code	16EMS17	IA Marks	100
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of contact Hours	--	Exam Marks	--
Credits - 01			

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.
Each student, under the guidance of a Faculty, is required to

- Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The Internal Assessment marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman. ■

Marks distribution for internal assessment of the course 16EMS17 seminar:
Seminar Report: 30 marks
Presentation skill:50 marks
Question and Answer:20 marks

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

*** END ***

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2016-17
M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)

II SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS21	Industrial Control Technology - 1	04	--	03	20	80	100	4
2	16EMS22	Optimal Control Theory	04	--	03	20	80	100	4
3	16EMS23	High Speed VLSI Design	04	--	03	20	80	100	4
4	16EMS24	CAD Tools For VLSI Design	04	--	03	20	80	100	4
5	16EMS25X	Elective - 2	03	--	03	20	80	100	3
6	16EMSL26	Microelectronics and Control Laboratory - II	-	3	03	20	80	100	2
7	16EMS27	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**06**	**18**	**220**	**480**	**700**	**22**

Number of credits completed at the end of II semester: 22+ 22 = 44

Elective -1

Course Code under 16EMS25X	Title
16EMS251	Low Power VLSI Design
16EMS252	Robust Control Theory
16EMS253	Digital System Design with VHDL
16EMS254	Real Time Approach to Process Control

Note: Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
INDUSTRIAL CONTROL TECHNOLOGY - 1 (Core Course)			
Course Code	16EMS21	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To discuss three types of industrial control systems; embedded control systems, real time control systems and distributed control systems.
- To discuss three types of industrial control engineering; process control, motion control and production automation.
- To explain the working of field elements of industrial control systems; sensors and actuators.
- To discuss working of transducers and valves used in industrial control systems.
- To discuss application of single-core and multi-core microprocessor units in industrial control systems.
- To discuss application of programmable-logic application specific integrated circuits and devices in industrial control systems. ■

Module		Teaching Hours
Module-1		
Industrial Control Systems: Embedded Control Systems, Real-Time Control Systems, Distributed Control System. **Industrial Control Engineering:** Industrial Process Controls, Industrial Motion Controls, Industrial Production Automation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Sensors and Actuators: Industrial Optical Sensors, Industrial Physical Sensors, Industrial Measurement Sensors, Industrial Actuators. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Transducers and Valves: Industrial Switches, Industrial Transducers, Industrial Valves. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Microprocessors: Single-Core Microprocessor Units, Multicore Microprocessor Units.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Programmable-Logic and Application-Specific Integrated Circuits (PLASIC): Fabrication Technologies and Design Issues, Field-Programmable-Logic Devices, Peripheral Programmable-Logic Devices. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS21 INDUSTRIAL CONTROL TECHNOLOGY - 1 (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Differentiate between different types of industrial control systems; embedded control systems, real time control systems and distributed control systems.
- Explain three types of industrial control engineering; process control, motion control and production automation.
- Explain the need of sensors and actuators used in industrial control systems.
- Explain the working of transducers and valves used in industrial control systems.
- Explain the need of microelectronic components in industrial control systems
- Explain the use of multi-core microprocessors in industrial control systems.
- Describe programmable peripheral I/O ports, programmable interrupt controllers, programmable timers, and CMOS and DMA controllers, the application specific integrated circuits used in industrial control systems. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Advanced Industrial Control Technology	Peng Zhang	Elsevier	2010

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
OPTIMAL CONTROL THEORY (Core Course)			
Course Code	16EMS22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To discuss modeling of systems.
- To discuss state and control constraints.
- To discuss the performance measures used in control problems.
- To explain determination of control function that minimizes the performance measure.
- To explain development of a dynamic program applicable to a class of control problems.
- To explain some basic ideas of the calculus of variations and to relate the analogy of results in calculus and the results of calculus of variations
- To explain application of variational method to optimal control problems.
- To explain Pontryagin's minimum principle. ■

Module-1		Teaching Hours
Introduction: Problem Formulation, State Variable Representation of a System. **The Performance Measure:** Performance Measure for Optimal Control Problems, Selecting a Performance Measure, Selection of a Performance Measure. **Dynamic Programming:** The optimal Control Law, the Principle of Optimality, Application of the principle of Optimality to Decision- Making, Dynamic Programming applied to a Routing Problem, An Optimal Control System, Interpolation. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Dynamic Programming (continued): A Recurrence Relation of Dynamic Programming, Computational Procedure for Solving Control Problems, Characteristics of Dynamic Programming Solution, Analytical Results – Linear Regulator Problems, The Hamilton- Jacobi-Bellman Equation, Continuous Linear Regulator Problem, The Hamilton- Jacobi-Bellman Equation – Some Observations. **The Calculus Of Variations:** Fundamental Concepts, Functions of a Single Function. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3		
The Calculus of Variations (continued): Functionals involving several independent Functions, Piecewise – smooth Externals, Constrained Extrema. **The Variational Approach to Optimal Control Problems:** Necessary Conditions for Optimal Control. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-4		
The Variational Approach to Optimal Control Problems (continued): Linear regulator problem, Pontryagin's Minimum Principle and state Inequality Constraints, Minimum –Time problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) 16EMS22 OPTIMAL CONTROL THEORY (Core Course) (continued) CHOICE BASED CREDIT SYSTEM (CBCS)		
Module-5		**Teaching Hours**
The Variational Approach to Optimal Control Problems (continued): Minimum Control-Effort Problems, Singular Intervals in Optimal Control Problems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

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

- Develop mathematical models for systems using state variables.
- Formulate an optimal control problem with constraints.
- Discuss performance of and performance measures used in control problems.
- Evaluate control function that minimizes the performance measure.
- Explain dynamic programming applicable to a class of control problems.
- Explain basic ideas of the calculus of variations.
- Explain application of variational method to optimal control problems.
- Explain Pontryagin's minimum principle used for optimal control systems. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Optimal Control Theory An Introduction	Donal E Kirk	Dover Publication	2004

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
HIGH SPEED VLSI DESIGN (Core Course)			
Course Code	16EMS23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To discuss various issues, that include parasitic capacitances and inductances, propagation delays, crosstalk, and electromigration-induced failure associated with VLSI interconnections used for high-speed applications. ■

Module-1		Teaching Hours
Preliminary Concepts: Interconnections for VLSI Applications, Copper Interconnections, Method of Images, Method of Moments, Even- and Odd-Mode Capacitances, Transmission Line Equations, Miller's Theorem, Inverse Laplace Transformation, Resistive Interconnection as Ladder Network, Propagation Modes in Micro strip Interconnection, Slow-Wave Mode Propagation, Propagation Delays. **Parasitic Resistances, Capacitances, and Inductances:** Parasitic Resistances: General Considerations, Parasitic Capacitances: General Considerations, Parasitic Inductances: General Considerations, Approximate Formulas for Capacitances. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Parasitic Resistances, Capacitances, and Inductances (continued): Green's Function Method: Using Method of Images, Green's Function Method: Fourier Integral Approach, Network Analog Method, Simplified Formulas for Interconnection Capacitances and Inductances on Silicon and GaAs Substrates, Inductance Extraction Using FastHenry, Copper Interconnections: Resistance Modeling, Electrode Capacitances in GaAs MESFET:Application of Program IPCSGV. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Interconnection Delays: Metal–Insulator–Semiconductor Microstripline Model of an Interconnection, Transmission Line Analysis of Single-Level Interconnections, Transmission Line Analysis of Parallel Multilevel Interconnections, Analysis of Crossing Interconnections, Parallel Interconnections Modelled as Multiple Coupled Microstrips. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Interconnection Delays (continued): Modelling of Lossy Parallel and Crossing Interconnections as Coupled Lumped Distributed Systems, Very High Frequency Losses in Microstrip Interconnection, Compact Expressions for Interconnection Delays, Interconnection Delays in Multilayer Integrated Circuits, Active Interconnections. **Crosstalk Analysis:** Lumped-Capacitance Approximation, Coupled Multiconductor MIS Microstrip line Model of Single-Level Interconnections, Frequency-Domain Modal Analysis of Single-Level Interconnections. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS23 HIGH SPEED VLSI DESIGN (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Crosstalk Analysis: Transmission Line Analysis of Parallel Multilevel Interconnections,Analysis of Crossing Interconnections,Compact Expressions for Crosstalk Analysis,Multiconductor Buses in GaAs High-Speed Logic Circuits. **Electromigration-Induced Failure Analysis:** Electromigration in VLSI Interconnection Metallizations: Overview.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:
At the end of the course the student will be able to:

- Discuss basic techniques and advanced concepts regarding wave propagation in an interconnection, v
- Discuss multilevel, multilayer, and multipath interconnections employed in VLSI applications.
- Discuss copper interconnections and their fabrication techniques.
- Explain numerical techniques that can be used to determine the interconnection resistances, capacitances, and inductances on a high-density VLSI chip.
- Calculate the propagation delays in the single and multilevel parallel and crossing interconnections using numerical algorithms.
- Explain the crosstalk effects in the single and multilevel parallel and crossing interconnections.
- Develop a model of very high speed VLSI circuits for the crosstalk analysis.
- Discuss the degradation of the reliability of an interconnection due to electromigration. ■

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	High-Speed VLSI Interconnections	Ashok K. Goel	Wiley	2007

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - II

CAD TOOLS FOR VLSI DESIGN (Core Course)

Course Code	16EMS24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To give an overview of the VLSI physical design automation field, including VLSI design cycle, physical design cycle, design styles and packaging styles.
- To explain fabrication process, impact of process innovations on physical design.
- To discuss design rules, yield, delay, and fabrication costs involved in the VLSI process.
- To discuss data structures, algorithms involved in the physical design.
- To explain graphs used to model problems in VLSI design and basic algorithms for these graphs.
- To explain partitioning algorithms, their classification, factors considered in partitioning the VLSI circuits.
- To discuss basic algorithms for floor planning and pin assignment.
- To discuss different techniques for placement such as, simulated annealing, simulated evolution, and force-directed.
- To discuss global routing, detailed routing and routing algorithms. ■

Module-1		Teaching Hours
VLSI Physical Design Automation: VLSI Design Cycle, New Trends in VLSI Design Cycle, Physical Design Cycle, New Trends in Physical Design Cycle, Design Styles, System Packaging Styles. **Design and Fabrication of VLSI Devices:** Fabrication Materials, Transistor Fundamentals, Fabrication of VLSI Circuits, Design Rules, Layout of Basic Devices. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Data Structures and Basic Algorithms: Basic Terminology, Complexity Issues and NP-hardness, Basic Algorithms, Basic Data Structures, Graph Algorithms for Physical design.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Partitioning: Problem Formulation, Classification of Partitioning Algorithms, Group Migration Algorithms, Simulated Annealing and Evolution, Other Partitioning Algorithms, Performance Driven Partitioning. **Floorplanning and Pin Assignment:** Floorplanning, Chip planning, Pin Assignment, Integrated Approach. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Placement: Problem Formulation, Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algorithms, Performance Driven Placement. **Global Routing:** Problem Formulation, Classification of Global Routing Algorithms, Maze Routing Algorithms, Line-Probe Algorithms, Shortest Path Based Algorithms, Steiner Tree based Algorithms, Integer Programming Based Approach, Performance Driven Routing. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS24 CAD TOOLS FOR VLSI DESIGN (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Detailed Routing: Problem Formulation, Classification of Routing Algorithms, Single-Layer Routing Algorithms, Two-Layer Channel Routing Algorithms, Three-Layer Channel Routing Algorithms, Multi-Layer Channel Routing Algorithms, Switchbox Routing Algorithms. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

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

- Discuss design automation field including the VLSI design cycle, physical design cycle, design styles and packaging styles.
- Discuss the fabrication process for VLSI devices, process innovations, design rules and costs involved in fabrication process. .
- Explain data structures for layout and algorithms involved in the physical design.
- Explain graphs used to model problems in VLSI design and algorithms for the graphs.
- Explain partitioning, partitioning algorithms, their classification and the factors that must be considered in partitioning the VLSI circuits.
- Discuss algorithms for floorplanning and pin assignment and techniques for placement.
- Discuss global routing, routing algorithms and routing of multi-terminal nets
- Discuss detailed routing, routing algorithms and their classification. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Books

1	Algorithms for VLSI Physical Design Automation	Naveed A. Sherwani	Kluwer Academic Publishers	3rd Edition, 2002

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
LOW POWER VLSI DESIGN (Elective Course)			
Course Code	16EMS251	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain the necessity of low power VLSI, the charging and discharging capacitances, short circuit and leakage currents in CMOS circuits and basic principles of low power design.
- To explain simulation of VLSI chips using modeling techniques to estimate power dissipation.
- To explain probabilistic power analysis for VLSI circuits.
- To discuss the optimization and trade-off techniques that involve power dissipation for digital circuits.
- To explain gate reorganization, signal gating, logic encoding and low power techniques for reduction in power consumption in VLSI circuits.
- Explain power and performance management, switching activity reduction for VLSI circuits.
- To explain the architecture for reduction in the power consumption of VLSI circuits.
- To explain the advanced techniques in the design of VLSI circuits; adiabatic computation, pass transistor logic synthesis and asynchronous circuits. ■

Module-1		**Teaching Hours**
Low Power VLSI Chips: Introduction, Needs for Low Power VLSI Chips, Charging and Discharging Capacitance, Short-circuit Current in CMOS Circuit, CMOS Leakage Current, Static Current, Basic Principles of Low Power Design, Low Power Figure of Merits. **Simulation Power Analysis:** SPICE Circuit Simulation, Discrete Transistor Modelling and Analysis, Gate-level Logic Simulation, Architecture-level Analysis, Data Correlation Analysis in DSP Systems, Monte Carlo Simulation. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Probabilistic Power Analysis: Random Logic Signals, Probability and Frequency, Probabilistic Power Analysis Techniques, Signal Entropy. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Circuit: Transistor and Gate Sizing, Equivalent Pin Ordering, Network Restructuring and Reorganization, Special Latches and Flip-flops, Low Power Digital Cell Library, Adjustable Device Threshold Voltage.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Logic: Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Precomputation Logic. **Special Techniques**: Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing, Low Power Techniques for SRAM. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Architecture and System: Power and Performance Management, Switching Activity Reduction, Parallel Architecture with Voltage Reduction, Flow Graph Transformation. **Advanced Techniques:** Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS251 LOW POWER VLSI DESIGN (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:
At the end of the course the student will be able to:

- Explain the needs for low power VLSI, the charging and discharging capacitances, short circuit and leakage currents in CMOS circuits.
- Explain basic principles of low power design.
- Simulate VLSI chips using modeling techniques to estimate power dissipation.
- Perform probabilistic power analysis for VLSI circuits.
- Discuss the optimization and trade-off techniques that involve power dissipation for digital circuits.
- Explain gate reorganization, signal gating, logic encoding and low power techniques for reduction in power consumption in VLSI circuits.
- Explain power and performance management switching activity reduction and the architecture for reduction in the power consumption of VLSI circuits.
- Explain the advanced techniques in the design of VLSI circuits; adiabatic computation, pass transistor logic synthesis and asynchronous circuits. ■

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Practical Low Power Digital VLSI Design	Gary Yeap	Springer	1998

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
ROBUST CONTROL THEORY (Elective Course)			
Course Code	16EMS252	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To present a broad range of well worked out, theoretical and application studies in the field of robust control system analysis and design that include robust PID, H-infinity, sliding mode, fault tolerant, fuzzy and QFT based control systems.
- To explain the current progress in the field robust control, motivate and encourage new ideas and solutions in the robust control area. ■

Module-1		**Teaching Hours**
Introduction: Systems and Control, Modern Control Theory, Stability, Optimal Control, Optimal Control Approach, Kharitonov Approach, H_∞ and H_2 Control, Applications. **Optimal Control and Optimal Observers:** Optimal Control Problem, Principle of Optimality, Hamilton–Jacobi–Bellman Equation, Linear Quadratic Regulator Problem, Kalman Filter. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Robust Control of Linear Systems: Introduction, Matched Uncertainty, Unmatched Uncertainty, Uncertainty in the Input Matrix. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Robust Control of Nonlinear Systems: Introduction, Matched Uncertainty, Unmatched Uncertainty, Uncertainty in the Input Matrix. **Kharitonov Approach:** Introduction, Preliminary Theorems, Kharitonov Theorem, Control Design Using Kharitonov Theorem. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
H_∞ and H_2 Control: Introduction, Function Space, Computation of H_∞ and H_2 Norms, Robust Control Problem as H_∞ and H_2 Control Problem, H_∞ / H_2 Control Synthesis. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Robust Active Damping: Introduction, Problem Formulation, Robust Active Damping Design, Active Vehicle Suspension System. **Robust Control of Manipulators:** Robot Dynamics, Problem Formulation, Robust Control Design, Simulations. **Aircraft Hovering Control:** Modelling and Problem Formulation, Control Design for Jet-borne Hovering, Simulation. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS252 ROBUST CONTROL THEORY (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Explain properties of linear time-invariant systems including controllability, observability, stability, stabilizability, and detectability.
- Synthesize linear time-invariant systems by pole placement and observer design.
- Discuss optimal control and the Kalman filter.
- Explain H_∞ and H_2 robust control design.
- Use optimal control approach to robust control design of linear and nonlinear systems
- Assess robust control of parametric systems using the Kharitonov theorem.
- Design robust active damper for vibration systems, robust controller for robot manipulators.
- Design controller for Jet-borne Hovering.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Robust Control Design; An Optimal Control Approach	Feng Lin	Wiley	2007

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
DIGITAL SYSTEM DESIGN WITH VHDL (Elective Course)			
Course Code	16EMS253	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To discuss the design of digital systems, CMO technology, programmable logic and engineering problems of noise margins and fan-out.
- To discuss the principles of Boolean algebra, combinational logic design, timing diagrams and basic number systems.
- To explain modeling of combinational logic and synchronous sequential logic systems in VHDL.
- To explain modeling of sequential logic blocks and complex sequential systems in VHDL.
- To describes event-driven simulation and specific features of a VHDL simulator.
- To discuss synthesis tool for RTL synthesis, fault modeling and design-for-test principles.
- To explain the designing of asynchronous sequential circuits.
- To explain simulation of digital to analog and analog to digital converters using VHDL-AMS simulator. ■

Module-1		Teaching Hours
Introduction: Modern digital design, CMOS technology, Programmable logic, Electrical properties. **Combinational logic design:** Boolean algebra, Logic gates, Combinational logic design, Timing, Number codes. **Combinational logic using VHDL gate models:** Entities and architectures, Identifiers, spaces and comments, Netlists, Signal assignments, Generics, Constant and open ports, Testbenches, Configurations. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Combinational building blocks: Three-state buffers, Decoders, Multiplexers, Priority encoder, Adders, Parity checker, Testbenches for combinational blocks. **Synchronous sequential design:** Synchronous sequential systems, Models of synchronous sequential systems, Algorithmic state machines, Synthesis from ASM charts, State machines in VHDL, VHDL testbenches for state machines. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
VHDL models of sequential logic blocks: Latches, Flip-flops, JK and T flip-flops, Registers and shift registers, Counters, Memory, Sequential multiplier, Testbenches for sequential building blocks. **Complex sequential systems:** Linked state machines, Datapath /controller partitioning, Instructions, A simple microprocessor, VHDL model of a simple microprocessor. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying.	
Module-4		
VHDL simulation: Event-driven simulation, Simulation of VHDL models, Simulation modelling issues, File operations. **VHDL synthesis:** RTL synthesis, Constraints, Synthesis for FPGAs, Behavioural synthesis, Verifying synthesis results. **Testing digital systems:** The need for testing, Fault models, Fault-oriented test pattern generation, Fault simulation, Fault simulation in VHDL. ■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS253 DIGITAL SYSTEM DESIGN WITH VHDL (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5		**Teaching Hours**
Design for testability: Ad hoc testability improvements, Structured design for test, Built-in self-test, Boundary scan (IEEE 1149.1).		**08**
Asynchronous sequential design: Asynchronous circuits, Analysis of asynchronous circuits, Design of asynchronous sequential circuits, Asynchronous state machines, Setup and hold times and metastability. **Interfacing with the analogue world:** Digital to analogue converters, Analogue to digital converters, VHDL-AMS, Phase-locked loops, VHDL-AMS simulators. ■		
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

Course outcomes:

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

- Discuss the design digital systems using VHDL, the technology of CMO integrated circuits programmable logic, engineering problems of noise margins and fan-out.
- Explain the principles of Boolean algebra, combinational logic design, timing, hazards and basic number systems.
- Model combinational logic and synchronous sequential logic systems in VHDL.
- Develop models for sequential logic blocks and complex sequential systems in VHDL.
- Describes idea of event-driven simulation and specific features of a VHDL simulator.
- Discuss synthesis tool for RTL synthesis, fault modeling and design-for-test principles.
- Design asynchronous sequential circuits.
- Explain simulation of digital to analog and analog to digital converters using VHDL-AMS simulator.■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Ethics, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Digital System Design with VHDL	Mark Zwoli´nski	Pearson	2^{nd} Edition, 2004

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
REAL TIME APPROACH TO PROCESS CONTROL (Elective Course)			
Course Code	16EMS254	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To give an overview of process control.
- To introduce the instrumentation used in the process control.
- To explain basics of single input – single output systems, Feedback control, the elements of control loops, system dynamics including capacitance and dead time, and system modeling.
- To highlight the various PID control modes and provide a framework for understanding control-loop design and tuning.
- To introduce advanced control configurations including feed-forward, cascade, and override control.
- To explain practical rules of thumb for designing and tuning the more common control loops found in industry.
- To explain control of distillation columns.
- To introduce the concept of multiple loop controllers and issues relating to the plant-wide control problem. ■

Module-1		Teaching Hours
Control, simulation and Process control hardware fundamentals: Control, Simulation, Control system components, Primary elements, Final control elements. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Fundamentals of single input−single output systems: Open-loop control, Disturbances, Feedback control overview, Feedback control: a closer look, Process attributes: capacitance and dead time, Process dynamic response, Process modelling and simulation. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Basic control modes: On−off control, Proportional (P-only) control, Integral (I-only) control, Proportional plus integral (PI) control, Derivative action, Proportional plus derivative (PD) controller, Proportional integral derivative (PID) control, Choosing the correct controller, Controller hardware. **Tuning feedback controllers:** Quality of control and optimisation, Tuning methods. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Advanced topics in classical automatic control: Cascade control, Feedforward control, Ratio control, Override control (auto selectors). **Common control loops:** Flow loops, Liquid pressure loops, Liquid level control, Gas pressure loops, Temperature control loops, Pump control, Compressor control, Boiler control. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS254 REAL TIME APPROACH TO PROCESS CONTROL (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-5	Teaching Hours
Distillation column control: Basic terms, Steady-state and dynamic degrees of freedom, Control system objectives and design considerations, Methodology for selection of a controller structure, Level, pressure, temperature and composition control, Optimizing control, Distillation control scheme design using steady-state models, Distillation control scheme design using dynamic models. **Using steady-state methods in a multi-loop control scheme:** Variable pairing, The relative gain array, Niederlinski index, Decoupling control loops, Tuning the controllers for multi-loop systems, Practical examples. **Plant-wide control:** Short-term versus long-term control focus, Cascaded units, Recycle streams, General considerations for plant-wide control. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

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

- Discuss process control and the instruments used in the process control
- Explain basics of single input – single output systems, Feedback control, elements of control loops, system dynamics including capacitance and dead time, and system modeling.
- Discuss various PID control modes.
- Understand control-loop design and tuning.
- Explain advanced control configurations including feed-forward, cascade, and override control.
- Explain thumb rules for designing and tuning the more common control loops found in industry.
- Control distillation columns.
- Explain the concept of multiple loop controllers and issues relating to the plant-wide control problem. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	A Real-Time Approach to Process Control	William Y. Svrcek	Wiley	2nd Edition, 2006

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
MICROELECTRONICS AND CONTROL LABORATORY - II			
Course Code	16EMSL26	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	40	Exam Marks	80
Credits - 02			

Course objectives:

- To develop Verilog code for verification of the functionality of CMOS inverter, buffer, transmission gate, Boolean expressions, adders, flip-flops and shift registers.
- To draw the transfer characteristics of CMOS inverter and compute noise margins, critical input and output.
- To design Mod-16 synchronous and asynchronous counters, draw truth table and waveform diagram. ■

Sl. NO	Experiments
Note: Cadence Layout software to be used for Schematic and Layout.	
1	(i)Verify the function of CMOS inverter by Verilog code. (ii) Draw the voltage transfer characteristics to determine critical input and output voltages and low and high noise margins.
2	Write a Verilog code for a buffer and verify its functionality.
3	Write a Verilog code for a Transmission gate and verify its functionality.
4	Using the Verilog code verify the functionality of a Boolean expression using Basic gates like NAND, NOR, AND, XOR.
5	Design a 16 bit parallel adder (carry select, carry look ahead adder and ripple carry adder) using Verilog code and verify its functionality. Compare the area and power utilisation.
6	Write a Verilog code for a 3 input Boolean expression using 8:1 multiplexor and verify its functionality.
7	Design the following Flip flops using Verilog code and verify the functionality: SR flip flop, D flip flop, T flip flop, JK flip-flop.
8	Write a Verilog code for a universal shift register and verify its functionality.
9	Design a MOD-16 Synchronous counter using synchronous reset. Draw the truth table and waveform diagram.
10	Design a MOD-16 Asynchronous counter using T-flip flop. Draw the truth table and waveform diagram.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

Course outcomes:

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

- Write Verilog code to verify the functionality of CMOS inverter and buffer.
- Write Verilog code to verify the functionality of Basic gates, transmission gates and universal shift register.
- Write Verilog codes for verifying the functionality of 3 input Boolean expression using 8:1 multiplexer.
- Determine critical input and output voltages of CMOS inverter and noise margins of CMOS inverter.
- Use Verilog code to design a 16 bit parallel adder, flip flops.
- Design MOD -16 synchronous counter using synchronous set.
- Design MOD -16 asynchronous counter using T – flip flop. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Modern Tool Usage, Individual and Team work, Communication.

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - II			
SEMINAR			
Course Code	16EMS27	IA Marks	100
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of contact Hours	--	Exam Marks	--
Credits - 01			

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The Internal Assessment marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman. ■

Marks distribution for internal assessment of the course 16EMS27 seminar:

Seminar Report: 30 marks
Presentation skill:50 marks
Question and Answer:20 marks

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

*** END ***

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2016-17
M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)

III SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	--	--	--	25	--	25	20
2	16EMS32	Report on Internship	--	--	--	25	--	25	
3	16EMS33	Evaluation and Viva-Voce of Internship	--	--	--	--	75	75	
4	16EMS34	Evaluation of Project phase -1	--	--	--	50	--	50	1
		TOTAL	--	--	--	**100**	**75**	**175**	**21**

Number of credits completed at the end of III semester: 22+ 22 + 21 = 65

Note:
Internship of 16 weeks shall be carried out during III semester.
Major part of the Project work shall also be carried out during the III semester in consultation with the Guide/s.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
SCHEME OF TEACHING AND EXAMINATION - 2016-17
M.Tech MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)

IV SEMESTER

Sl. No	Course Code	Title	Teaching Hours /Week		Examination				Credits
			Theory	Practical/ Field work/ Assignment	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16EMS41	Industrial Control Technology - 2	04	--	03	20	80	100	4
2	16EMS42X	Elective - 3	03	--	03	20	80	100	3
3	16EMS43	Evaluation of Project phase - 2	--	--	--	50	-	50	3
4	16EMS44	Evaluation of Project and Viva-Voce	--	--	03	--	100 + 100	200	10
		TOTAL	**07**	**--**	**09**	**90**	**360**	**450**	**20**

Number of credits completed at the end of IV semester: 22+ 22 + 21 + 20 = 85

Elective -1

Course Code under 16EMS42X	Title
16EMS421	Industrial Control - Software and Routines
16EMS422	Digital System Design with FPGA
16EMS423	Microelectronic Fabrication
16EMS424	Reset Control Systems

Note: 1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee comprising of HoD as Chairman, Guide and Senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.
b. External Examiner shall carry out the evaluation for 100 marks.
c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.
d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
INDUSTRIAL CONTROL TECHNOLOGY - 2 (Core Course)			
Course Code	16EMS41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
Credits - 04			

Course objectives:

- To explain the industrial intelligent controllers necessary for both industrial production control and industrial process control; PLC controllers, CNC controllers, and fuzzy-logic controllers.
- To explain industrial process controllers, including PID controllers, batch process controllers and servo motion controllers.
- To explain industrial motherboards, industrial personal computers, computer peripherals and accessories.
- To introduces the layer model, architectures, components, functions and applications of several primary industrial control networks: CAN, SCADA, Ethernet, Device Net, LAN, and other enterprise networks.
- To explain networking devices, including networking hubs, switches, routers, bridges, gateways, repeaters and key techniques used in these networking devices. ■

Module-1		Teaching Hours
Industrial Intelligent Controllers: PLC (Programmable Logic Control) Controllers, CNC (Computer Numerical Control) Controllers, FLC (Fuzzy Logic Control) Controllers. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Industrial Process Controllers: PID (Proportional-Integral-Derivative) Controllers, BPC (Batch Process Control) Controllers, SMC (Servo Motion Control) Controllers. **Industrial Computers:** Introduction, Industrial Computer Classes and Configurations, Industrial Computer Peripherals and Accessories. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
3Industrial Control Networks: Controller Area Network (CAN), Supervisory Control and Data Acquisition (SCADA) Network, Industrial Ethernet Network, Industrial Enterprise Networks. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Networking Devices: Hubs and Switches, Network Routers, Bridges, Gateways and Repeaters. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Human–machine interfaces: Human–Machine Interactions, User–Machine Interfaces, Industrial Application Examples. **Data Transmission Interfaces:** Data Transmission Basics, Data Transmission I/O Devices, Data Transmission Control Devices. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS41 INDUSTRIAL CONTROL TECHNOLOGY - 2 (Core Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Explain the industrial intelligent controllers necessary for both industrial production control and industrial process control.
- Explain industrial process controllers, including PID controllers, batch process controllers and servo motion controllers.
- Explain industrial motherboards, industrial personal computers, computer peripherals and accessories.
- Discuss the layer model, architectures, components, functions.
- Discuss applications of several primary industrial control networks: CAN, SCADA, Ethernet, DeviceNet, LAN, and other enterprise networks.
- Explain networking devices, including networking hubs, switches, routers, bridges, gateways, repeaters and key techniques used in these networking devices.
- Describe interfaces existing in industrial control systems namely human machine interfaces and data transmission interfaces. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Advanced Industrial Control Technology	Peng Zhang	Elsevier	2010

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
INDUSTRIAL CONTROL - SOFTWARE AND ROUTINES (Elective Course)			
Course Code	16EMS421	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To explain the firmware of a microprocessor chipset.
- To explain all the details of real-time operating systems, which are the platforms needed for a control system to satisfy real-time criteria.
- To explain the distributed operating system, the necessary platform for distributed control systems.
- To explain industrial system operation routines, including the self-test routines at power-on and power-down, installation and configuration routines, diagnostic routines, and calibration routines.
- To discuss the identification principles and techniques for model-based control. ■

Module-1		Teaching Hours
Microprocessor Boot Code: Code Structures, Single-Processor Boot Sequences, Multiprocessor Boot Sequences. **Real-Time Operating Systems:** Introduction, Task Controls, Input /Output Device Drivers.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Real-Time Operating Systems (continued): Interrupts, Memory Management, Event Brokers, Message Queue, Semaphores, Timer. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Distributed Operating Systems: Multiprocessor Operating Systems, Multicomputer Operating Systems, Distributed and Parallel Facilities.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Industrial Control System Operation Routines: Self-Test Routines, Install and Configure Routines, Diagnosis Routines, Calibration Routines.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Industrial Control System Simulation Routines: Modelling and Identification, Simulation and Control, Software and Simulator.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

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

- Explain the Microprocessor boot code, one of the key component of Embedded software for control purpose.
- Explain in detail the real-time operating systems, which are the platforms needed for a control system to satisfy real-time criteria.
- Explain the distributed operating system, the necessary platform for distributed control systems.
- Explain industrial system operation routines, including the self-test routines at power-on and power-down, installation and configuration routines, diagnostic routines, and calibration routines.
- Discuss the identification principles and techniques for model-based control.■

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS421 INDUSTRIAL CONTROL - SOFTWARE AND ROUTINES (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Graduate Attributes (As per NBA):
Engineering Knowledge, Problem Analysis, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Advanced Industrial Control Technology	Peng Zhang	Elsevier	2010

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
DIGITAL SYSTEM DESIGN WITH FPGA (Elective Course)			
Course Code	16EMS422	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To introduce the programmable logic devices, their differing architectures, and their use within electronic system design.
- To explain the terminology used, design methods and tools.
- To discuss programming languages that can be used to develop digital designs for implementation in either a processor or in programmable logic.
- To discuss electronic systems design, the types of solutions that can be developed, and the decisions that will need to be made in order to identify the right technology choice for the design implementation.
- To introduce VHDL as hardware description language to describe digital circuit and system designs in an ASCII text-based format.
- To explain the testing of the electronic system.
- To discuss interfacing of programmable logic to the analogue world and power electronics circuits.
- To explain with a case study the necessity to develop programmable logic–based designs at a high level of abstraction using behavioral descriptions of the system functionality. ■

Module-1		**Teaching Hours**
Programmable Logic: Introduction, Electronic Circuits: Analogue and Digital, Programmable Logic versus Discrete Logic, Programmable Logic versus Processors, Types of Programmable Logic, PLD Configuration Technologies, Programmable Logic Vendors, Programmable Logic Design Methods and Tools, Technology Trends. **Design Languages:** Introduction, Software Programming Languages, Hardware Description Languages, SPICE, System C ^{R}, System Verilog, Mathematical Modelling Tools. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Electronic Systems Design: Introduction, Sequential Product Development Process versus Concurrent Engineering Process, Flowcharts, Block Diagrams, Gajski-Kuhn Chart, Hardware-Software Co-Design, Formal Verification, Embedded Systems and Real-Time Operating Systems, Electronic System-Level Design, Creating a Design Specification, Unified Modelling Language, Reading a Component Data Sheet, Digital Input/Output, Parallel and Serial Interfacing, System Reset, System Clock, Power Supplies, Power Management, Printed Circuit Boards and Multichip Modules, System on a Chip and System in a Package, Mechatronic Systems, Intellectual Property, CE and FCC Markings. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3		
Introduction to Digital Logic Design with VHDL: Introduction, Designing with HDLs, Design Entry Methods, Logic Synthesis. Entities, Architectures, Packages, and Configurations, A First Design, Signals versus Variables, Generics, Reserved Words, Data Types, Concurrent versus Sequential Statements, Loops and Program Control, Coding Styles for VHDL, Combinational Logic Design. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS422 DIGITAL SYSTEM DESIGN WITH FPGA (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		Teaching Hours
Introduction to Digital Logic Design with VHDL (continued): Sequential Logic Design, Memories Unsigned versus Signed Arithmetic - Adder Example. Multiplier Example. **Testing the Design:** Introduction, Integrated Circuit Testing, Printed Circuit Board Testing, Boundary Scan Testing, Software Testing. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Digital-to-Analogue Conversion, and Power Electronics: Introduction, Digital-to-Analogue Conversion, Analogue-to-Digital Conversion, Power Electronics, Heat Dissipation and Heat sinks. Operational Amplifier Circuits. **System-Level Design:** Introduction, Case Study-DC Motor Control. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

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

- Discuss programmable logic devices that are available today, their architectures, their use within electronic system design and the terminology used.
- Discuss different programming languages that are used to develop digital designs for implementation in either a processor or in programmable logic.
- Explain designing of electronic systems, the types of solutions that can be developed, and the decisions that will need to be made in order to identify the right technology choice for the design implementation.
- Describe digital circuit and system designs in an ASCII text-based format using VHDL.
- Test the electronic systems for failure mechanisms in hardware and software.
- Interface programmable logic devices to the analogue world.
- Explain with a case study the necessity to develop programmable logic–based designs at a high level of abstraction using behavioral descriptions of the system functionality. ■

Graduate Attributes (As perNBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Ethics, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Digital Systems Design with FPGAs and CPLDs	Ian Grout	Elsevier	2008

<table>
<tr><td colspan="4" align="center">M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV</td></tr>
<tr><td colspan="4" align="center">MICROELECTRONIC FABRICATION (Elective Course)</td></tr>
<tr><td>Course Code</td><td>16EMS423</td><td>IA Marks</td><td>20</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>Exam Hours</td><td>03</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Marks</td><td>80</td></tr>
<tr><td colspan="4" align="center">Credits - 03</td></tr>
</table>

Course objectives:

- To explain the basic processes of fabrication of monolithic integrated –circuit and steps in lithographic process, including mask fabrication, photoresist process and etching.
- To explain the theory of oxide growth, techniques for selective oxidation of silicon, methods to determine the thickness of oxide film and process simulation.
- To explain theoretical and practical aspects of diffusion process and diffusion systems, the characterization of diffused layer sheet resistance and determination of junction depth.
- To explain the process of ion implementation, mathematical modelling of the impurity distributions, and the removal of crystal damage due to implantation process.
- To explain deposition processes, including evaporation, chemical vapour deposition and sputtering.
- To discuss interconnections and the problems associated with making good contacts between metal and silicon.
- To discuss the liftoff process, multilevel metallization, copper interconnects, and Damascene process.
- To discuss testing, die separation, attachment, wire bonding, packages used with integrated circuits and MOS process design.
- To discuss interconnections between fabrication processes, bipolar device design and layout.
- To discuss processes for fabrication of microelectromechanical elements in silicon. ■

<table>
<tr><td colspan="2">Module-1</td><td>Teaching Hours</td></tr>
<tr><td colspan="2">Introduction: Historical Perspective, Overview of Monolithic Fabrication, Metal – Oxide Semiconductor (MOS) Process, Basic Bipolar Process, Safety.
Lithography: The Photolithographic Process, Etching Techniques, Photomask Fabrication, Exposure Systems, Exposure Sources, Optical and Electron Microscopy.
Thermal Oxidation of Silicon: The Oxidation Process, Modelling Oxidation, Factors Influencing Oxidation Rate, Dopant Redistribution during Oxidation, Masking Properties of Silicon Dioxide, Technology of Oxidation, Oxide Quality, Selective Oxidation and Shallow Trench Formation, Oxide Thickness Characterization, Process Simulation. ■</td><td>08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td><td></td></tr>
<tr><td colspan="3">Module-2</td></tr>
<tr><td colspan="2">Diffusion: The Diffusion Process, Mathematical Model for Diffusion, The Diffusion Coefficient, Successive Diffusions, Solid – Solubility Limits, Junction Formation and Characterization, Sheet Resistance, Generation – Depth and Impurity Profile Measurement, Diffusion Simulation, Diffusion Systems, Gettering. ■</td><td>08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td><td></td></tr>
<tr><td colspan="3">Module-3</td></tr>
<tr><td colspan="2">Ion Implantation: Implantation Technology, Mathematical Model for Ion Implantation, Selective Implantation, Junction Depth and Sheet Resistance, Channeling, Lattice, Damage and Annealing, Shallow Implantations.
Film Deposition: Evaporation, Sputtering, Chemical Vapour Deposition, Epitaxy.
Interconnections and Contacts: Interconnections in Integrated Circuits, Metal Interconnections and Contact Technology, Diffused Interconnections, Polysilicon Interconnections and Buried Contacts, Silicides and Multilayer – Contact Technology, The Liftoff Process, Multilevel Metallization, Copper Interconnects and Damascene Process. ■</td><td>08</td></tr>
<tr><td>Revised Bloom's Taxonomy Level</td><td>L_1 – Remembering, L_2 – Understanding.</td><td></td></tr>
<tr><td colspan="3"></td></tr>
</table>

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS423 MICROELECTRONIC FABRICATION (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Module-4		**Teaching Hours**
Packaging and Yield: Testing, Water Thinning and Die Separation, Die Attachment, Wire Bonding, Packages, Flip – Chip and tape – Automated – Bonding Process, Yield. **MOS Process Integration:** Basic MOS Device Considerations, MOS Transistor Layout and Design Rules, Complementary MOS (CMOS) Technology, Silicon on Insulator. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Bipolar Process Integration: The Junction – Isolated Structure, Current Gain, Transit Time, Base Width, Breakdown Voltages, Other Elements in SBC Technology, Layout Considerations, Advanced Bipolar Structure, Other Bipolar Insulation Techniques, BICMOS. **Process for Microelectromechanical Systems (MEMS):** Mechanical Properties of Silicon, Bulk Micromachining, Silicon Etchants, Surface Micromachining, High – Aspect – Ratio Micromachining, Silicon Wafer Bonding, IC Process Compatibility. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Course outcomes:

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

- Explain the basic processes of fabrication of monolithic integrated –circuit and basic steps in lithographic process.
- Discuss the theory of oxide growth, oxide growth processes, factors affecting the growth rate, impurity redistribution during oxidation.
- Explain techniques for selective oxidation of silicon, methods to determine the thickness of oxide film and process simulation.
- Explain theoretical and practical aspects of diffusion process and diffusion systems, the characterization of diffused layer sheet resistance and determination of junction depth.
- Discuss ion implementation technology, mathematical modelling of the impurity distributions, and the removal of crystal damage due to implantation process.
- Explain deposition processes and interconnections.
- Discuss packaging and associated processes with integrated circuits and MOS process integration.
- Discuss bipolar process integration and processes for fabrication of microelectromechanical elements in silicon. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Communication.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Introduction to Microelectronic Fabrication	Richard C Jaeger	Prentice Hall	2nd Edition, 2002

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - IV			
RESET CONTROL SYSTEMS (Elective Course)			
Course Code	16EMS424	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
Credits - 03			

Course objectives:

- To give basics and fundamental design concepts of Reset Control Systems.
- To derive the describing function of reset systems.
- To explain how the reset matrix affects the frequency domain property of HDD system.
- To explain stability analysis of Reset Control Systems.
- To discuss robust stability of RCSs with uncertainties, Quadratic stability and affine quadratic stability for systems with time-varying and constant uncertainties.
- To study robust stability for RCSs with time-delays.
- To study stability of RCSs with discrete-time reset conditions.
- To study stability of RCS with fixed reset time instants both moving horizon optimization and fixed horizon optimization.
- To discuss the application of optimal reset law design to HDD systems and PZT-positioning stage respectively.
- To discuss passivity and finite L2 gain stability of RCSs with conic jump sets. ■

Module-1		**Teaching Hours**
Introduction: Motivation of reset control, Basic concepts of RCSs, Fundamental theory of traditional reset design. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Describing function analysis of reset systems: Sinusoid input response, Describing function, Application to HDD systems. ■		**08**
Revised Bloom's Taxonomy Level	Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-3		
Stability of reset control systems: Preliminaries, Quadratic stability, Stability of RCSs with time-delay, Reset times-dependent stability, Passivity of RCSs.■		**08**
Revised Bloom's Taxonomy Level	Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-4		
Robust stability of reset control systems: Definitions and assumptions, Quadratic stability, Affine quadratic stability, Robust stability of RCS with time-delay, Examples. **RCSs with discrete-time reset conditions:** Preliminaries and problem setting, Stability analysis, A heuristic design method, Application to track-seeking control of HDD systems. ■		**08**
Revised Bloom's Taxonomy Level	Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analyzing.	
Module-5		
Reset control systems with fixed reset instants: Stability analysis, Moving horizon optimization, Optimal reset law design, Application to HDD systems, Application to PZT-positioning stage. **Reset control systems with conic jump sets:** Basic idea, L 2 -gain analysis. ■		**08**
Revised Bloom's Taxonomy Level	Remembering, L_2 - Understanding, L_3 – Applying, L_4 – Analyzing.	

M.TECH MICROELECTRONICS AND CONTROL SYSTEMS (EMS)
16EMS424 RESET CONTROL SYSTEMS (Elective Course) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes:

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

- Explain design concepts of Reset Control Systems.
- Explain the describing function of reset systems and the effects of reset matrix on the frequency domain property of HDD system.
- Perform stability analysis of Reset Control Systems.
- Explain robust stability, Quadratic stability and affine quadratic stability for reset control systems.
- Perform stability study of RCSs with discrete-time reset conditions.
- Perform stability study stability of RCS with fixed reset time instants both moving horizon optimization and fixed horizon optimization
- Discuss the application of optimal reset law design to HDD systems and PZT-positioning stage.
- Discuss passivity and finite L_2 gain stability of RCSs with conic jump sets. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Analysis and Design of Reset Control Systems	Yuqian Guo et al	IET	2015

*** END ***