M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)
## VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION FOR
#### M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)
##### (2014-16)

### I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching Hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for</th>
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<th>Credits</th>
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<tr>
<td>14MAT11</td>
<td>Applied Mathematics</td>
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<td>14 EMS 12</td>
<td>Analysis of Linear Systems</td>
<td>4</td>
<td>2</td>
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<td>14 EMS 13</td>
<td>VLSI Design</td>
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<td>14 EMS 16</td>
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<td>3</td>
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## Elective – I

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<tr>
<th>Subject Code</th>
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<tbody>
<tr>
<td>14EMS151</td>
<td>Nonlinear Systems</td>
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<tr>
<td>14EMS152</td>
<td>Process Control and Instrumentation</td>
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<tr>
<td>14EMS153</td>
<td>Artificial Neural Networks</td>
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<td>Subject Code</td>
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<tr>
<td>14EMS21</td>
<td>Optimal Control Systems</td>
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<tr>
<td>14EMS22</td>
<td>Modern Power Electronics- I</td>
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<tr>
<td>14EMS23</td>
<td>Hardware Description Languages</td>
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<tr>
<td>14EMS24</td>
<td>CAD Tools for VLSI Design</td>
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<tr>
<td>14EMS25X</td>
<td>Elective-II</td>
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<tr>
<td>14EMS26</td>
<td>Microelectronics and Control Laboratory - II</td>
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<tr>
<td>14EMS27</td>
<td>Seminar</td>
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<tr>
<td></td>
<td>**Project Phase-I (6 week Duration)</td>
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** Between the II Semester and III Semester, after availing a vacation of 2 weeks.

**Elective – II**

<table>
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<tr>
<th>Subject Code</th>
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<tr>
<td>14EMS251</td>
<td>Mixed Mode VLSI Design</td>
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<tr>
<td>14EMS252</td>
<td>Low Power VLSI Design</td>
</tr>
<tr>
<td>14EMS253</td>
<td>Discrete Control Systems and Multi Variable Control</td>
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### III Semester: INTERNSHIP

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<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>Credit Based</th>
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<tr>
<td>14EMS31</td>
<td>Seminar/Presentation on Internship (After 8 weeks from the date of commencement)</td>
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<td>Report on Internship</td>
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## IV Semester

<table>
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<td>High Speed VLSI Design</td>
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<td>14EMS42X</td>
<td>Elective-III</td>
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<td>14EMS43</td>
<td>Evaluation of Project Phase – II</td>
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<tr>
<td>14EMS44</td>
<td>Evaluation of Project work – III</td>
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<td>25 --</td>
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<tr>
<td>14EMS45</td>
<td>Evaluation of Project Work and Viva-voce</td>
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<td><strong>50 400</strong></td>
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**Grand Total (I to IV Sem.) : 2400 Marks**

: 94 Credits

## Elective – III

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
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<tbody>
<tr>
<td>14EMS421</td>
<td>Digital System Design with FPGA</td>
</tr>
<tr>
<td>14EMS422</td>
<td>Modern Power Electronics - II</td>
</tr>
<tr>
<td>14EMS423</td>
<td>Advanced Digital Signal Processing and Applications</td>
</tr>
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</table>
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalise the topic of dissertation.

2) Project Phase – II: 16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.

3) Project Phase – III: 24 weeks duration in IV Semester. Evaluation shall be taken up during the middle of IV Semester. At the end of the semester Project Work evaluation and Viva-Voce Examinations shall be conducted.


   Marks of Evaluation of Project:

   • The I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university (Out of two external examiners at least one should be present).

Numerical Solution of Partial Differential Equations: Classification of second order equations, parabolic equations- solution of one dimensional heat equation, explicit method, Crank-Nicolson method and Du Fort-Frankel method, hyperbolic equations- solution of one dimensional wave equation.


Optimization: Linear programming- formulation of the problem, graphical method, general linear programming problem, simplex method, artificial variable technique -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 of graphs.

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.

REFERENCE BOOKS

M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)  
SEMESTER - I  
ANALYSIS OF LINEAR SYSTEMS  

<table>
<thead>
<tr>
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<th>IA Marks</th>
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<td>Number of Practical Hours/week</td>
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<td>Number of Tutorial Hours/week</td>
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<tr>
<td>Total No. of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
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</table>

Continuous Time Systems: SISO, MIMO system Analysis-Solution-Impulse response matrix, conversion of transfer functions to canonical state variable models, Eigen values, Eigen vectors, solution of state equation, Controllability, Observability  


REFERENCE BOOKS:
MOS Transistor Theory: n MOS / p MOS transistor, threshold voltage equation, body effect, MOS device design equation, sub threshold region, channel length modulation, mobility variation, tunneling, punch through, hot electron effect MOS models, small signal AC characteristics, CMOS inverter, $\beta_n / \beta_p$ ratio, noise margin, static load MOS inverters, differential inverter, transmission gate, tristate inverter, BiCMOS inverter.

CMOS Process Technology: Lambda based design rules, scaling factor, semiconductor technology overview, basic CMOS technology, p well / n well / twin well process, current CMOS enhancement (oxide isolation, LDD, refractory gate, multilayer inter connect) , circuit elements, resistor, capacitor, interconnects, sheet resistance & standard unit capacitance concepts delay unit time, inverter delays, driving capacitive loads, propagate delays, MOS mask layer, stick diagram, design rules and layout, symbolic diagram, mask feints, scaling of MOS circuits.

Basics of Digital CMOS Design: Combinational MOS logic circuits introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, transmission gate, sequential MOS logic circuits - introduction, behavior of bi-stable elements, SR latch circuit, clocked latch and flip flop circuits, CMOS D latch and triggered flip flop, dynamic logic circuits - introduction, principles of pass transistor circuits, voltage boot strapping synchronous dynamic circuits techniques, dynamic CMOS circuit techniques.

CMOS Analog Design: Introduction, single amplifier, differential amplifier, current mirrors, band gap references, basis of cross operational amplifier.

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

REFERENCE BOOKS

Custom Single Purpose Processor design: Combinational, Sequential, RT Level designs, Optimizing.

General Purpose Processor: Software Development Environment, GPP Design.

Application Specific Instruction Set Processor: Introduction to 8051, Architectural features, Instruction list and basic programming, Introduction to DSP, Architecture and features of any TMS processor.


Memory: ROM & RAM and their variants Composing Memory, Memory Hierarchy and Cache, Advanced RAM, Memory Management Unit.

Interfacing: Communication basic, Interfacing method, Interrupts, DMA, Arbitration, Multi Bus Architecture.


Microprocessor Interfacing: Shared data problem, Interrupt Latency.

RTOS: Software Architecture Review, Introduction to RTOS, Task, States, Data, Semaphore.

RTOS Services: Mailboxes, Queues, Pipes, Timer Functions, Events, Memory Management.

RTOS Example: Review of one RTOS.

ARM: Architecture and features of ARM processor, Modes of operation of ARM 7TDMI.

REFERENCE BOOKS
Introduction: Nonlinear phenomena, types, characteristics, methods of analysis of nonlinear systems, piecewise (Local) linearization.

Phase-Plane Analysis: Introduction, general second order linear systems singular (Equilibrium) points-classification and trajectories, multiple singular points and evaluation of type, sketching phase plane portrait for linear/nonlinear systems-isocline method, delta method, Pells’ method, limit cycles-prediction of existence and classification.

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, Nyquist stability criteria, analysis of nonlinear systems using describing function method-evaluation of existence of limit cycle and calculation for magnitude and frequency of oscillation, dual input describing function, sub harmonic and jump phenomena.

Lyapunov’s Method: Introduction, sign definiteness, Sylvester’s criteria, notion of stability-definitions, direct method, generation of Lyapunov function for linear and nonlinear systems-Krasovskii’s method, variable gradient method, Lure’s criteria, Popov’s method, circle criteria and its application, BIBO stability Relay control analysis, Hamels&Tsypkin loci, introduction to sliding mode control and its applications.

REFERENCE BOOKS

Introduction to Process Control: Objectives and benefits, classification of control strategies, process control & block diagrams, analog & digital control.

Mathematical Modeling: Principles, dynamic vs steady state models, general model principles, models of processes.

Behavior of Process Control Systems: Dynamic Behavior of 1st and 2nd order systems, standard process inputs, response of first and second order systems


Control System Instrumentation: Temperature measurement using IC temperature sensor, RTD & thermocouple, measurement of strain, force, displacement, weight, flow, liquid level and pressure.

Signal conditioning & transmission: 4-20mA current transmitter for LVDT, signal conditioning for low level DC & AC signals, concept of shielding, grounding & EMI.

REFERENCE BOOKS


REFERENCE BOOKS

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 characteristics
6. Verification of Sampling Theorem
7. Design and verification of FIR filter
8. State estimation using Pole placement method
9. Study of MATLAB FIS Toolbox
10. Control system application using FIS Tool box.
The aim of the seminar is to inculcate self-learning, face audience, enhance communication skill, involve in group discussion and present his ideas. Each student, under the guidance of a Faculty, is required to

i) Choose a topic of his/her interest relevant to the Course of Specialization

ii) Carryout literature survey, organize the subject topics in a systematic order

iii) Prepare the report with own sentences

iv) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities

v) Present the seminar topic at least for 20 minutes orally and/or through power point slides

vi) Answer the queries and involve in debate/discussion lasting for about 10 minutes

vii) 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 shall be awarded by a committee consisting of at least two staff members based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report.
Introduction: Static and dynamic optimization, parameter optimization.


Pontryagin’s Maximum Principle: Theory, application to minimum time, energy and control effort problems, and terminal control problem.

Dynamic Programming: Belaman’s principle of optimality, multistage decision processes, application to optimal control.

Linear Regulator Problem: Matrix Riccati equation and its solution, tracking problem, computational methods in optimal control, application of mathematical programming, singular perturbations, practical examples.

REFERENCE BOOKS
**Introduction:** Review of line commutated converters, inverters, and voltage control & power factor improvement.

**Power Devices:** BJT, MOSFET, IGBT and GTOs – operating characteristics and gate drive requirements and circuits.

**Switched Mode Rectifier:** Various power circuit configurations & wave shaping techniques. Single phase and three phase circuit configurations.

**Inverters:** Voltage source inverters - single phase & six step inverters, voltage control & PWM strategies, and implementation aspects, modification of power circuit for four quadrant operation.

**Current Source Inverters:** Single phase and three-phase power circuit configuration and analysis.

**Load Commutated Inverters:** Principle of operation, modification of power circuit configuration for low frequency operation, phase controllers. Function & types of snubber circuits, snubber for diode and thyristors, overvoltage snubber, turn-on snubber, GTO snubber, electrically isolated drive circuits, cascade-connected drive circuits.

**REFERENCE BOOKS**

| M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS) |
| SEMESTER - II |
| HARDWARE DESCRIPTION LANGUAGES |
| Subject Code | 14EMS23 | IA Marks | 50 |
| No. of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Number of Practical Hours/week | 02 | Number of Tutorial Hours/week | -- |
| Total No. of Lecture Hours | 52 | Exam Marks | 100 |

**Digital system design:** Process hardware simulation, Hardware Description Languages (HDLs), hardware synthesis, structure of HDL module, styles of descriptions, structural description, components, delay models.

**Introduction to VHDL:** Identifiers, dataflow descriptions, operators, expressions and signal assignment.

**Behavioral descriptions:** PROCESS statements, if-else statements, case, loops, data objects, data types, Packages, procedure and functions, Generate statements, block statements, generics, configuration, guarded statement.

**Verilog introduction:** Hierarchical modeling concept, basic concept, data types, modules and ports, gate level modeling. Stimulus.

**Data flow modelling:** expressions, continuous assignment, delays, operator types, behavioral modeling structured procedures, Procedural assignment, Delay based timing control, Event based timing control, conditional statements, loops, sequential and parallel blocks.

**Tasks and functions:** Useful modeling techniques, Timing and delays, switch level modeling.

Introduction to Advanced VHDL and MIXED HDL. Examples

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**REFERENCE BOOKS**

5. Samir Palnitkar, “verilog HDL a guide to digital design and synthesis” Pearson Education Asia, 2001
High level Synthesis: VLSI Design Cycle, physical design cycle, design style, CDFG representation, partitioning algorithms, Partitioning, problem formulation, Design style specific partitioning problem, classification of partitioning algorithms, group migration algorithms- Clustering growth, hierarchical clustering, Kernighan-Lin algorithm, Simulated annealing & evolution, other partitioning algorithms.


Logic Synthesis & Verification: Introduction to combinational logic synthesis, binary decision diagram, cube representation, Kernels & co-Kernels, two level synthesis, PLA, PLA folding, ROBDD, ITE graphs, sequential synthesis.

Floor planning & pin assignment: Floor planning, problem formulation, classification of floor planning algorithms – constrained based floorplanning, integer programming based floorplanning, rectangular dualization. Pin Assignment: problem formulation classification, general pin assignment, channel pin assignment.

Placement: Problem formulation, classification, simulation base placement algorithms, simulated annealing, force directed placement other placement algorithms, constraint based floor planning, floor planning algorithms for mixed block & cell design. General & channel pin assignment.


Detailed Routing: problem formulation, classification of routing algorithms, single layer routing algorithms, switchbox routing algorithms.

Over the Cell Routing & via Minimization: Two layers over the cell routers, constrained & unconstrained via minimization.

Compaction: Problem formulation, one-dimensional compaction, two dimension based compaction, hierarchical compaction.

REFERENCE BOOKS
Introduction: To CMOS analog circuits, MOS transistor. DC and AC small signal parameters from large signal model, common source amplifier with resistive load, diode load and current source load, source follower.


Operational Amplifiers: Design of 2 stage op-amp, DC and AC response, frequency compensation, slew rate, offset effects, PSRR, noise, comparator, sense amplifier, sample and hold, sampled data circuits, switched capacitor filters, DAC, ADC, RF amplifier, oscillator, PLL, mixer.

REFERENCE BOOKS
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<tr>
<td>Total No. of Lecture Hours</td>
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<td>Exam Marks</td>
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**Low Power VLSI Chips:** Need, sources of power dissipation on digital integrated circuits. Emerging low power approaches, physics of power dissipation in CMOS devices.

**Device & Technology Impact on Low Power:** Dynamic dissipation in CMOS, transistor sizing & gate oxide thickness, impact of technology scaling, technology & device innovation.

**Power Estimation, Simulation Power Analysis:** SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

**Probabilistic Power Analysis:** Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

**Low Power Design Circuit Level:** Power consumption in circuits, flip flops & latches design, high capacitance nodes, low power digital cells library.

**Logic Level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.

**Low Power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

**Low Power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, zero skew Vs tolerable skew, chip & package co design of clock network.

**Algorithm & Architectural Level Methodologies:** Introduction, design flow, algorithmic level analysis & optimization, architectural level estimation & synthesis.

**REFERENCE BOOKS**

Design of discrete time systems using Transform methods; Stability analysis of closed loop systems in the Z-domain- the jury stability test. Introduction, obtaining discrete time equivalent of continuous time filters, design principles based on a discrete time equivalent of analog controller, transient find steady state response analysis, design based on the root locus method, design based on the frequency response method, Analytical design method.
Multi variable System models, state equations, canonical forms, polynomial matrices, transmission zeroes, Multi variable system analysis, solution of state equations, controllability, stabilizability. Observer theory, Realization of transfer matrices, minimal realization, Multi variable system design, pole placement, decoupling model matching, Inverse Nyquist array, characteristic locus methods.

**REFERENCE BOOKS**

1. Ogata, “Discrete Time Control Systems”.
2. B.C Kuo, “Automatic Control System”.
M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)
SEMESTER - II
MICROELECTRONICS AND CONTROL LABORATORY - II

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<th>Subject Code</th>
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<th>Number of Practical Hours/week</th>
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<td>03</td>
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Note: Cadence Layout software to be used for Schematic and Layout.

1. Cmos Inverter
2. Buffer
3. Transmission gate
4. Basic gates NAND2, NOR2, AND2, XOR2
5. Parallel adder using full adder 4 bit
6. 4:1 multiplexer
7. Flip flops SR latch, D flip flop, T flip flop, JK flip-flop
8. MOD-16 Synchronous counter using synchronous reset
9. MOD-16 Asynchronous counter using T-flip flop
10. Serial in serial out register using D-flip flop
<p>| M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS) |
| SEMESTER - II |
| Subject Code | 14EMS27 | IA Marks | 25 |
| No. of Lecture Hours/Week | -- | Exam Hours | -- |
| Number of contact Hours/week | 03 | Number of Tutorial Hours/week | -- |
| Total No. of Hours | -- | Exam Marks | -- |</p>
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<tr>
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<th>IA Marks Seminar/Presentation</th>
<th>14EMS32 Report on Internship</th>
<th>14EMS33 Internship Evaluation and Viva-voce</th>
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<td>14EMS33 Internship Evaluation and Viva-voce</td>
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<td>14EMS32 Report on Internship</td>
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M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS) SEMESTER - III

<table>
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<th>INTERNSHIP</th>
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<tbody>
<tr>
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</table>
Introduction to high speed digital design: Frequency, time and distance design: Frequency, time and distance, Capacitive and inductive effects, High speed properties of logic gates, Speed and power, wire modeling and transmission line

Signaling convention and circuits: Signaling modes for transmission lines, Signaling over RC interconnect, Driving lossy LC lines, Bi-directional signaling, Terminators, Signaling standards, Chip to chip communications, ESD protection-ESD failure mechanisms, ESD protection devices

Power distribution: Power supply networks, IR drop, Power supply isolation.

Noise sources in digital system: Power supply noise, Cross talk, Inter symbol interference.

Timing convention: Timing fundamentals encoding timing, Open loop synchronous timing, Closed loop timing, Clocking styles, Clock jitter.

Synchronization: Synchronization failure and meta-stability, PLL and DLL clock aligners, Asynchronous clocking techniques.

Clocked and non-clocked logics: Single rail domino logic, Dual rail domino structures, Latched domino structures, Clock pass gate logic, CMOS DCVS LOGIC, non-clocked pass gates families

Latching strategies: Basic latch design and latching, single ended logic and differential logic, Race free latches for pre charged logic, Asynchronous latch techniques

REFERENCE BOOKS
4. EVAN Sutherland, "Logic efforts designing Fast CMOS Circuits" I edition Morgan Kaufman, 2005
M.TECH. MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)
SEMESTER - IV

DIGITAL SYSTEM DESIGN WITH FPGA(ELECTIVE - III)

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<th>Exam Hours</th>
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**Digital Design**: Introduction, hierarchical design, controller(FSM), case study, FSM issues, timing issues, pipe lining, resource sharing, meta stability, synchronization, MTBF analysis, setup/hold time of various types of flip-flops, synchronization between multiple clock domains, reset recovery, proper resets.

**VHDL**: Different models, simulation cycles, process, concurrent and sequential statements, loops, delay models, library, packages, functions, procedures, coding for synthesis, test bench.

**FPGA**: Logic block and routing architecture, design methodology, special resources, Virtex-II, straitix architectures, programming FPGA, constraints, STA, timing closure, case study.

**REFERENCE BOOKS**
3. FPGA Data sheets and application notes.
DC- DC Converters: Principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge & isolated Cuk converters, input & output filter design, multi-output operation of isolated converters.

Modelling: Of the above converters using state averaging techniques, concepts of switch mode inverters, single phase inverters & three phase inverters, resonant inverters, DC link inverters, modified circuit topologies for DC link voltage clamping.

Voltage Control: PWM techniques (sigma, sigma - delta modulation) quasi resonant inverters, series resonant and parallel resonant, application of zero voltage and zero current switching for DC-DC converters (buck & boost).

Linear power supplies, dc-dc converters with electrical isolation, control of switch-mode dc power supplies, protection, power supply specification.

UPS, power line disturbances, power conditioners.


REFERENCE BOOKS
Discrete Time Signals: Sequences; representation of signals on orthogonal basis, sampling and reconstruction of signals.


Design of FIR Digital Filters: Window method, Park-McClellan's method.

Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic approximations, low pass, band pass, band stop and high pass filters, effect of finite register length in FIR filter design, parametric and non-parametric spectral estimation.

Introduction to multi-rate signal processing: Application of DSP to speech and radar signal processing.

REFERENCE BOOKS