Semester II

SI. No.	Course Code	Course Title	Hours/ week			Total Credits	Theory Marks		Practical Marks
			L	T	P		ESE Marks	Internal Marks	
1.	M201	Advanced Microcomputer System Design	3	0	0	3	70	30	0
2.		Elective - 2	3	0	0	3	70	30	0
3.	M202	Mechatronics	3	0	0	3	70	30	0
4.	M203	Robotics and Machine Vision	3	0	0	3	70	30	0
5.	M204	Embedded OS and RTOS	3	0	0	3	70	30	0
6.		Elective - 3	3	0	0	3	70	30	0
7.	ML201	Advanced Microcomputer System Design Laboratory	0	0	2	1	40	10	50
8.	ML202	Mechatronics Laboratory	0	0	2	1	40	10	50
9.		Elective – 2 Laboratory	0	0	2	1	40	10	50
		Total	18	0	6	21	540	210	150

Elective - 2	
M205	ASIC and SOC
M206	Mixed Signal System Design
Elective - 3	
M207	Embedded Applications in Power Conversion
M208	Control System Design
Elective – 2 Laboratory	
ML205	ASIC and SOC
ML206	Mixed Signal System Design

Second Semester

Course Code	**M201**
Course Title	**Advanced Microcomputer System Design**
Credits	**3-0-0:3**
Pre-requisutes	**Nil**

Objective:

- The objective is to impart the concepts and architecture of Embedded systems and to make the students capable of designing Embedded systems. To achieve this, the architecture and programming of Industry popular 32-bit Microcontroller, ARM Cortex is covered in detail.

Syllabus:

- Embedded Concepts, Architecture of embedded systems, ARM Architecture, Cortex-M3 Basics, Exceptions, Instruction Sets, NVIC, Interrupt Behavior, Cortex-M3/M4 Programming, Exception Programming, Memory Protection Unit and other Cortex-M3 features, STM32L15xxx ARM Cortex M3/M4 Microcontroller Memory and Peripherals, Development & Debugging Tools.

Course Outcome:

- After successful completion of the course, students should be able to:
    - Understand the Embedded Concepts and Architecture of Embedded Systems
    - Understand the architecture and programming of Industry standard 32-bit popular ARM Cortex Microcontroller
    - Select a proper Microcontroller for a particular application
    - Understand the usage of the development and debugging tools.

TEXT BOOKS:

1. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc.
2. Andrew N Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide - Designing and Optimizing System Software”, 2006, Elsevier.

REFERENCES:

1. Steve Furber, “ARM System-on-Chip Architecture”, 2nd Edition, Pearson Education
2. Cortex-M series-ARM Reference Manual
3. Cortex-M3 Technical Reference Manual (TRM)
4. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
5. David Seal “ARM Architecture Reference Manual”, 2001 Addison Wesley, England; Morgan Kaufmann Publishers
6. STM32L152xx ARM Cortex M3 Microcontroller Reference Manual
7. ARM Company Ltd. “ARM Architecture Reference Manual– ARM DDI 0100E”

8. ARM v7-M Architecture Reference Manual (ARM v7-M ARM).
9. Ajay Deshmukh, "Microcontroller - Theory & Applications", Tata McGraw Hill
10. Arnold. S. Berger, "Embedded Systems Design - An introduction to Processes, Tools and Techniques", Easwer Press
11. Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 1st Edition, Pearson Education
12. P.S Manoharan, P.S. Kannan, "Microcontroller based System Design", 1st Edition, Scitech Publications

Course Plan:

Modules (Theory)	No. of Hours	ESE marks
Module 1: Embedded Concepts Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software architecture, Application Software, Communication Software, Development and debugging Tools. ARM Architecture Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture.	10	25
Module 2 Overview of Cortex-M3 Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions. Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus. Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call. NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency	13	25

Module 3 Cortex-M3/M4 Programming: Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. Exception Programming: Using Interrupts, Exception/ Interrupt Handlers, Software Interrupts, Vector Table Relocation. Memory Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication	10	25
Module 4 Cortex-M3/M4 Microcontroller STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development & Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc.	9	25

Course Code	**M202**
Course Title	**Mechatronics**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- To understand how by digital electronics control the mechanical systems (both linear and rotary motions for various applications) with the help of various sensors and transducers for modern automation that includes programmable automation like PLC, CNC Machine Tools, Industrial Robots, etc

Syllabus:

- Introduction to Mechatronics, Elements of Mechatronics: Sensors and transducers (Position and velocity) – Limit switches, Encoders, resolvers, Inductosyns, Drives and Mechanism, Control Systems, PID controllers, PLCs, Hydraulic systems, Pneumatic systems, Magnetic actuators, CNC machines and Mechatronic systems.

Course Outcome:

- After successful completion of the course, students should be able to:
    - Able to understand conversion of rotary motion conversions from rotary to linear and control of position and velocity
    - Understand the functioning and working principles of various digital/optical sensors (position and velocity), actuators, motors, etc
    - Understand the various mechanisms in modern equipment to control mechanical motions by digital electronics
    - Understand and program the CNC (Computer Numerical Control) Machine Tools
    - Understand the controls system of Industrial robots and CNC Machines

REFERENCES:

1. Lawrence J. Kamm, Understanding electromechanical engineering:an introduction to mechatronics, PHI
2. Robert H. Bishop, Mechatronic systems, sensors, and actuators : fundamentals and modeling, Taylor and Francis
3. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi
4. Boucher, T. O., Computer automation in manufacturing - an Introduction, Chapman and Hall.
5. Robotics for Engineers, By, Yoram Koren, McGraw Hill

Course Plan:

Modules (Theory)	**No. of Hours**	**% ESE marks**

Module 1 Introduction to mechatronics. Mechatronics in manufacturing, products and design. Mechatronic Elements- Data conversion devices, sensors (limit switches, encoders – optical, electrical - resolvers, inductosyn (digital scales), micro-sensors, transducers, signal processing devices, relays, contactors and timers. Drives and mechanisms- Drives: stepper motors, servo drives. BLDC Motors, Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.	14	36
Module 2 Microprocessors, microcontrollers, PID controllers, and PLCs. Hydraulic systems: flow, pressure and direction control valves, solenoid vales, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.	14	36
Module 3 Electro Magnetic actuators, Introduction to CNC machines tools and NC part programming basics. Introduction to Industrial Robots, Micro-Electro Mechanical Systems (MEMS). Design examples of mechatronic systems used in factory/plant automation	11	28

Course Code	**M203**
Course Title	**Robotics and Machine Vision**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- To introduce the concepts of Industrial Robots and Machine Vision and Image Processing techniques for industrial applications.

Syllabus:

- Classification and Structure of Robotic Systems, Kinematics Analysis and Coordinate Transformations, Machine Vision, Industrial Robots, Image Processing Techniques and Transformations, Basic Machine Vision Processing Operators – Monadic one Point Transformations, Edge Enhancement Techniques and Image Analysis, Thresholding, Pattern Matching and Edge Detection, Back-Propagation Algorithm**.**

Course Outcome:

- After successful completion of the course, students should be able to:
  - Get a clear idea of the Image processing and analysis techniques used in Machine Vision for industrial application

TEXT BOOKS:

1. Machine Vision and Digital Image Processing, by Louis J. Galbiati, Jr. Prentice Hall, Englewood Cliffs, New Jersy.`
2. Robotics for Engineers, By, Yoram Koren, McGraw Hill.

REFERENCES:

1. Robotics and Image Processing – an Introduction, by Janakiraman P. A., Tata McGraw Hill, New Delhi
2. Digital Image Processing and Computer Vision by Robert J.Schalkoff, John Wiley & Sons Inc.
3. Industrial Robotics – Technology, Programming and Applications, by Mikell P. Groover, Mitchell Wein, Roger N. Nagel and Nicholas G. Odlrey, McGraw Hill International Edistion.
4. Handbook of Image Processing Operators by Klette, Reinhard & Zamperoni, Piero; John Wiley & Sons Inc
5. Image Processing, Analysis And Machine Vision by Sonka, Milan Et Al
6. Industrial Robotics by Hodges, Bernard, Jaico Publishing House, Delhi
7. Introductory Computer Vision on Image Processing by Adrian Low, McGraw Hill International Editions**.**

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 - Industrial Robots: Basic Concepts of Robotics, Classification and Structure of Robotic Systems Kinematics Analysis and Coordinate Transformations, Industrial Applications of Robots, and Programming	10	25
Module 2 - Introduction Machine Vision: Principles of Machine Vision, Vision and factory automation, Human Vision Vs. Machine Vision, Economic Considerations, Machine Vision – System Overview, Image acquisition – Illumination, Image formation and Focusing, Image Detection – Introduction, Types of Cameras; Image Processing and Presentation.	13	25
Module 3 - Image Processing Techniques and Transformations: Fundamental Concepts of Image Processing, Pixel, Pixel Location. Gray Scale, Quantizing Error and Measurement Error and Histograms. Basic Machine Vision Processing Operators – Monadic one Point Transformations: Identity operator, Inverse Operator, Threshold operator and other operators viz: Inverted Threshold operator, Binary Threshold operator, Inverted Binary Threshold Operator, Gray Scale Threshold and Inverted Gray Scale Threshold Operators; Dyadic Two Point Transformations –Image Addition, Image Subtracting, Image Multiplication; Convolution and Spacial Transformations	10	25
Module 4 - Edge Enhancement Techniques and Image Analysis: Introduction, Digital Filters – Low pass and High Pass filters; Edge Engancement Operators – Laplacian, Roberts Gradient, Sobel and other Local operators. Image Analysis: Thresholding, Pattern Matching and Edge Detection, Back-Propagation Algorithm.	9	25

Course Code	**M204**
Course Title	**Embedded OS and RTOS**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- The objective of the subject is to provide understanding of the techniques essential to the design and implementation of device drivers and kernel internals of embedded operating systems.
- This syllabus provides the students with an understanding of the aspects of the Real-time systems and Real-time Operating Systems and to provide an understanding of the techniques essential to the design and implementation of real-time embedded systems.

Syllabus:

- Embedded OS Internals, Overview of POSIX APIs, Kernel, Linux Device Drivers, Basics of RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Realtime scheduling, Task Creation, Intertask Communication, I/O Systems, Cross compilers, debugging Techniques, Creation of binaries & porting stages for Embedded Development board.

Course Outcome:

- After successful completion of the course, students should be able to:
  - Understand the Embedded Real Time software that is needed to run embedded systems
  - Understand the open source RTOS and their usage.
  - Understand the VxWorks RTOS and realtime application programming with it.
  - Build device driver and kernel internal for Embedded OS & RTOS.

TEXT BOOKS:

1. Essential Linux Device Drivers, Venkateswaran Sreekrishnan
2. Writing Linux Device Drivers: A Guide with Exercises, J. Cooperstein
3. Real Time Concepts for Embedded Systems – Qing Li, Elsevier

REFERENCES:

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill
2. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK
3. Software Design for Real-Time Systems: Cooling, J E Proceedings of 17the IEEE Real-Time Systems Symposium December 4-6, 1996 Washington, DC: IEEE Computer Society

4. Real-time Systems – Jane Liu, PH
5. Real-Time Systems Design and Analysis : An Engineer's Handbook: Laplante, Phillip A
6. Structured Development for Real - Time Systems V1 : Introduction and Tools: Ward, Paul T & Mellor, Stephen J
7. Structured Development for Real - Time Systems V2 : Essential Modeling Techniques: Ward, Paul T & Mellor, Stephen J
8. Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques: Ward, Paul T & Mellor, Stephen J
9. Embedded Software Primer: Simon, David E.

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 – Embedded OS (Linux) Internals Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming Schedulers and types of scheduling. Interfacing: Serial, Parallel Interrupt Handling Linux Device Drivers: Character, USB, Block & Network	11	25
Module 2 – Open source RTOS Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards, RTOS Issues – Selecting a Real Time Operating System, RTOS comparative study. Converting a normal Linux kernel to real time kernel, Xenomai basics. Overview of Open source RTOS for Embedded systems (Free RTOS/ Chibios-RT) and application development.	12	25
Module 3 – VxWorks / Free RTOS VxWorks/ Free RTOS Scheduling and Task Management – Realtime scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems – General Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver	10	25

for a peripheral		
Module 4 – Case study Cross compilers, debugging Techniques, Creation of binaries & porting stages for Embedded Development board (Beagle Bone Black, Rpi or similar), Porting an Embedded OS/ RTOS to a target board ().Testing a real time application on the board	9	25

Elective - 2	
Course Code	**M205**
Course Title	**ASIC and SOC**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- To understand ASIC Design flow, standard cell design, synthesis and timing
- To understand the design of Logic cell and IO cell.
- Detailed ASIC Backend design flow and automated design flows for complete ASIC Design.
- Fundamentals of the IP Design and SoC Design.
- To understand SoC Verification flow and complexity in SoC verification.

Syllabus:

- Types of ASICs, ASIC Library design, ASIC Construction, System on Chip Design Process, System level design issues- Soft IP vs. Hard IP, Design for Timing Closure-Logic Design Issues, Physical Design Issues; Verification Strategy, On-Chip Buses and Interfaces SoC Verification

Course Outcome:

- After successful completion of the course, students should be able to get:
  - Detailed knowledge of ASIC and SoC Design flow.
  - Detailed understanding of System on Chip Design process.
  - Detailed understanding of complexity in verification and to build SoC Verification environment.

TEXT BOOKS:

1. "SoC Verification-Methodology and Techniques", Prakash Rashinkar, Peter Paterson and Leena Singh. Kluwer Academic Publishers
2. "Reuse Methodology manual for System-On-A-Chip Designs", Michael Keating, Pierre Bricaud, Kluwer Academic Publishers, second edition

REFERENCES:

1. Smith, "Application Specific Integrated Circuits", Addison-Wesley,2006

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 **Types of ASICs** – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell data path logic cells – I/O cells – cell compilers.	10	25
Module 2	13	25

ASIC Library design: Transistors as resistors – parasitic capacitance – logical effort programmable ASIC design software: Design system – logic synthesis – half gate ASIC, ASIC Construction – Floor planning & placement – Routing		
Module 3 **System on Chip Design Process:** A canonical SoC design, SoC Design Flow – Waterfall vs Spiral, Top-Down versus Bottom-Up. Specification requirements, Types of Specifications, System Design Process, System level design issues- Soft IP vs. Hard IP, Design for Timing Closure- Logic Design Issues, Physical Design Issues; Verification Strategy, On-Chip Buses and Interfaces; Low Power, Manufacturing Test Strategies. MPSoCs. Techniques for designing MPSoCs	10	25
Module 4 **SoC Verification:** Verification technology options, Verification methodology, Verification languages, Verification approaches, and Verification plans. System level verification, Block level verification, Hardware/software co-verification, and Static net list verification.	9	25

Elective - 2	
Course Code	**M206**
Course Title	**Mixed Signal System Design**
Credits	**3-0-0: 3**
Pre-requisutes	

Objective:

- To introduce the principles of Analog Mixed Signal System Design.
- Design and Analysis of Complex Digital and Analog CMOS Circuits to provide a foundation for more complicated and advanced Designs.
- To introduce the concept of switched capacitor techniques.

To address practical issues in Analog Mixed Signal System Design

Syllabus:

- PN Junctions, Bipolar Vs Unipolar Devices, MOS Transistor operation, CMOS Logic implementation basics, TG based implementation of multiplexers, de-multiplexers, encoders, decoders, ALU, Comparator, Parity generator, Timer, PWM,SRAM and DRAM,CAM, Analog Sub circuits, Ideal Operational Amplifier, Inverting and Non-inverting configuration Differential amplifier basics, VCO, PLL, Data Converters, DAC, ADC, Over sampling Data Converters.

Course Outcome:

- After successful completion of the course, students should be able to:
  - Detailed knowledge of static and dynamic behavior of CMOS logic.
  - Detailed understanding of CMOS Digital Subsystem Design.
  - Timing analysis and synchronization of digital design.
  - Basic understanding of Analog circuit building blocks.
  - Detailed understanding of Analog Mixed Signal Circuit Design.
  - Detailed Understanding of Data Converters.

TEXT BOOKS:

1. CMOS Analog Circuit Design, 2nd edition; by: Allen, Phillip E, Holberg , Douglas R, Oxford University Press, (Indian Edition
2. D A John, Ken Martin, Analog Integrated Circuit Design, 1st Edition, John Wiley

REFERENCES:

1. Ken Martin, Digital Integrated Circuit Design, John Wiley
2. Gray Paul R, Meyer, Robert G, Analysis and Design of Analog Integrated Circuits, 3rd edition, John Wiley & Sons.
3. Sedra & Smith, Microelectronics Circuits, 5th Edition, Oxford University Press, (Indian Edition)
4. Jan M. Rabaey, Anantha Chadrakasan, B. Nikolic ,Digital Integrated Circuits – A Design Perspective 2nd Edition, Prentice Hall of India (Eastern Economy Edition).

5. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis & Design,2nd Ed, Tata McGraw Hill

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Introduction PN Junctions, Bipolar Vs Unipolar Devices, MOS Transistor operation, MOS Transistor as a Switch, NMOS ,PMOS and CMOS Switches, CMOS Inverter AC and DC Characteristics, Analog Signal Processing, Example of Analog Mixed Signal Circuit Design	10	25
Module 2 Digital Sub Circuits CMOS Logic implementation basics- Logic gates and Flip flops –Transmission Gates, TG based implementation of multiplexers, de-multiplexers, encoders, decoders. Digital Circuits like ALU, Comparator, Parity generator, Timer, PWM,SRAM and DRAM,CAM	13	25
Module 3 Analog Sub circuits Ideal Operational Amplifier, Inverting and Non-inverting configuration Differential amplifier basics, VCO, PLL, Comparator characteristics, two stage open loop comparator ,Switched capacitor fundamentals, Switched capacitor amplifier	10	25
Module 4 Data Converters DAC : Static &Dynamic Charatersitics,1 Bit DAC, String DAC, Fully Decoded DAC,PWM DAC, Current scaling, voltage scaling DACs ADC : Static &Dynamic Characteristics, Nyquist Criteria , Sample & Hold Circuit ,Quantization error, Concept of over sampling, Counting ADC, Tracking ADC, Successive approximation ADC, Flash ADC, Dual Slope ADC Over sampling Data Converters : Over sampling fundamentals, Delta –Sigma Converter basics, $\Delta\ \Sigma$ Modulator	9	25

Elective - 3	
Course Code	**M207**
Course Title	**Embedded Application in Power Conversion**
Credits	**3-0-0: 3**
Pre-requisutes	

Objective:

- To give the student a foundation in
  - Power converter design considerations
  - Design of controllers for power converters
  - Design considerations for UPS
  - Design considerations for AC and DC drives

Syllabus:

- Power Converters, Practical Converter design considerations, Magnetic components, Design of controllers for Power converters, Interfacing of controller output to power module, Design of UPS, DC Motor Drives, AC Motor Drives

Course Outcome:

- After successful completion of the course, the student will have demonstrated an ability to understand the fundamental concepts of power converter design; apply the design consideration for selection of magnetic components, switching components like MOSFET, IGBT etc, controllers and gate drives; apply the basic equations and design considerations for the design of applications like UPS, AC/DC drives, chargers etc.

TEXT BOOKS

1. Power Electronics; By: Mohan, Underland, Robbins; John Wiley & Sons
2. Simplified design of Switching Power supplies; By: John D Lenk; EDN series for designers.

REFERENCES

1. Design of magnetic components for switched mode power converters; By L Umanad, S.R Bhat; Wiely Eastern ltd.
2. MOSFET& IGBT Designers manual, International Rectifier
3. UPS design guide, International Rectifier

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Power Converters: Power converter system design. Isolated and Non-isolated dc-dc converters. Inverters with square and sinusoidal output. PWM switching – unipolar and bipolar, sine PWM	10	25

Practical Converter design considerations: Power semiconductor devices – Power Diodes, BJT, MOSFET, IGBT. MOSFET & IGBT – Ratings, SOA, Switching characteristics, Gate Charge, Paralleling devices. Dos and Don’ts of using Power MOSFETs, Gate drive characteristics & requirements of power MOSFETs and IGBT modules. Design of turn on and turn off snubbers. Magnetic components: Design of high frequency transformer, design of Inductors, design of CTs.		
Module 2 Design of controllers for Power converters: Micro controllers and DSP based controllers for power conversion. Peripheral interfacing - ADC, Keyboard, LCD display, PWM generation. Design of PWM bridge controller based on low end and high-end controllers. Interfacing of controller output to power module. Designs based on dedicated gate driver ICs. Design of isolated gate drives.	13	25
Module 3 Design of UPS: Online, off line UPS. Operation & design criteria of AC switch, Operation & design criteria of battery charger, operation & design criteria of inverter, active PFC circuits. Thermal design of power converters.	10	25
Module 4 DC Motor Drives: Design of adjustable speed DC motor drives, speed control of a separately excited motor, design of closed loop control, design chopper controlled DC motor drive, design of four quadrant chopper. AC Motor Drives: Design of 3 phase PWM VSI inverter, design of v/f control for induction Motor, design of open loop and closed loop control. Vector control of AC motors, space vectors, vector control strategy for induction motor.	9	25

Elective - 3	
Course Code	**M208**
Course Title	**Control System Design**
Credits	**3-0-0:3**
Pre-requisutes	

Objective:

- To introduce state space models, Digital control systems and Digital controllers.

Syllabus:

- Review of basic elements of analog control systems, Digital control systems and Digital controllers

Course Outcome:

- After the successful completion of course student will be able to:
  - Understand state space models
  - Understand the working of Digital Control systems and Digital controllers.

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Review of basic elements of analog control systems- classical control techniques –transfer function approach- PID controller design. State-Space Models - Controllability and state transfer - Observability and state estimation – Pole Placement– State feedback approach.	12	25
Module 2 Digital control systems -Sampling and reconstruction of signals – z transforms - pulse transfer function and analysis of digital control systems - discretization methods - Cascade and feedback compensation from continuous data controllers- Dead beat controller design	12	25
Module 3 (15hours): Digital controllers - Root locus, Bode plot, Nyquist plot methods- Design of Digital PID controller –state space analysis of digital control systems - Observers and their use in state-feedback loops -Observer-based controllers - controllability and observability under discretization. Controller realization structures - canonical forms - Effects of finite word length on controllability and closed loop pole placement- Case studies	15	25

Course Code	**ML201**
Course Title	**Advanced Microcomputer System Design Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- To make the students familiar with the programming of 32-bit Microcontrollers and also to make them interface to the external embedded world for data acquisition etc.

Syllabus:

- ARM Assembly Programming, Embedded C Programming on ARM Cortex M3/M4 Microcontroller, ARM Cortex M3/M4 Programming with CMSIS, Peripheral Interfacing

Course Outcome:

- After successful completion of the lab, students will be capable of programming and interfacing details of building Microcontrollers based Embedded Systems.

REFERENCES:

1. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
2. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.
3. David Seal “ARM Architecture Reference Manual”, 2001 Addison Wesley, England; Morgan Kaufmann Publishers
4. Andrew N Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide - Designing and Optimizing System Software”, 2006, Elsevier.
5. Steve Furber, “ARM System-on-Chip Architecture”, 2nd Edition, Pearson Education.
6. Cortex-M series-ARM Reference Manual
7. Cortex-M3 Technical Reference Manual (TRM)
8. ARM Company Ltd. “ARM Architecture Reference Manual– ARM DDI 0100E”
9. STM32L152xx ARM Cortex M3 Microcontroller Reference Manual
10. ARM v7-M Architecture Reference Manual (ARM v7-M ARM).

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Display “Hello word” message using internal UART of ARM Cortex M3	2	5
2.	Interface and speed Control of the DC Motor using ARM Cortex M3	2	5
3.	Interface a stepper motor and rotate it in clockwise and anticlockwise direction	2	5

4.	Determine a digital output for a given Analog input using Internal ADC of ARM Cortex M3 controller.	2	5
5.	Interface a DAC and generate Triangular and Square waveform susing ARM Cortex M3.	2	5
6.	Interface a 4*4 Keyboard and display the Key code on and LCD using ARM Cortex M3.	2	5
7.	Using the internal PWM module of ARM controller and generate PWM and Vary its duty cycle using ARM Cortex M3.	2	5
8.	Demonstrate the use of an external interrupt to toggle an LED ON/ OFF using ARM Cortex M3.	2	5
9.	Display the HEX digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.	2	5
10.	Interface a simple switch and display its status through Relay, Buzzer and LED.	2	5
11.	Getting started with STM32 ARM cortex M4 board LED blinking using STM32CubeMx.	2	5
12.	Write a program a to show UART loopback using STM32CubeMx.	2	5
13.	I2C Demonstration using light sensor as a slave using STM32CubeMx.	2	5
14.	ADC demonstration using POT with STM32CubeMx.	2	5
15.	DAC demonstration using LED with STM32CubeMx.	2	5
16.	PWM demonstration using LED with STM32CubeMx.	2	5
17.	Accelerometer sensor Demonstration using STM32 ARM controller.	2	5
18.	Demonstrate Buzzer interface using STM32 ARM controller.	2	5
19.	Demonstrate IR Transmission using STM32 ARM controller	2	10

Software used: Keil Microvision IDE, ‘C’ Compiler and Assembler for ARM.

Platforms used: PC, STM32L15xxx ARM Cortex M3/M4 Microcontroller Discovery Kits

Course Code	**ML202**
Course Title	**Mechatronics Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- The objective is to impart the concepts of Mechatronics elements like micro sensors, contactors etc, drives and mechanism, PID controllers and PLCs, Hydraulic and Pneumatic systems, CNC machines and industrial robots

Syllabus:

- Introduction to Mechatronics, Mechatronics Elements, Drives and Mechanism, PID controllers, PLCs, Hydraulic systems, Pneumatic systems, Magnetic actuators, CNC machines and Mechatronic systems.

Course Outcome:

- After successful completion of the course, students should be able to:
  - Understand the concepts of micro-sensors, transducers, signal processing devices, relays, contactors and timers
  - Understand the concepts of stepper motors, servo drives. BLDC Motors, Ball screws, camshafts etc.
  - Understand the working of Hydraulics and pneumatic systems
  - Understand the working of CNC machines, MEMS etc,

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Study and use of PLC instructions	1	10
2.	Study of Timers	1	10
3.	Study of Counters	1	10
4.	Study and use of Analog Input and Analog Output	1	10
5.	Study and use of HMI and PLC	1	10
6.	Double Acting Cylinder Control by Solenoid Valve and PLC	1	10
7.	Hydraulic/ Pneumatic Motor Control by Solenoid Valve and PLC	1	10
8.	Single Acting Cylinder Control by Solenoid Valve and PLC	1	10
9.	Counting of Single Acting Cylinder piston forward movement using Proximity Sensor and PLC	1	10
10.	Counting of Double Acting Cylinder piston forward movement using Limit Switch and PLC	1	10

Elective – 2 Laboratory	
Course Code	**ML205**
Course Title	**ASIC and SOC Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- To make the students familiar with the SPICE programming suing Open source software and also to make them ready to design ASIC System.

Syllabus:

- Introduction to circuit design and SPICE simulations
  - Why do we need circuit design and SPICE simulations?
  - Introduction to basic element in circuit design - NMOS
  - Strong inversion and threshold voltage
  - Threshold voltage with positive substrate potential
- NMOS Resistive region and saturation region of operation
  - Resistive region of operation with small drain-source voltage
  - Drift current theory
  - Drain current model for linear region of operation
  - SPICE conclusion to resistive operation
  - Pinch-off region condition
  - Drain current model for saturation region of operation
- Introduction to SPICE
  - Basic SPICE setup
  - Circuit description in SPICE syntax
  - Define technology parameters
  - Standard technology file
  - First SPICE Simulation
  - SPICE deck for 1.2u Technology node
- SPICE simulation for lower nodes and velocity saturation effect
  - SPICE simulation for lower nodes (250nm)
  - SPICE deck for 250nm Technology node
  - Drain current vs gate voltage for long and short channel device
  - Id-Vgs SPICE deck for 1.2u technology node
  - Id-Vgs SPICE deck for 250nm technology node
  - Velocity variation at lower and higher electric fields
  - Velocity saturation drain current model
- CMOS voltage transfer characteristics
  - MOSFET as a switch
  - Introduction to standard MOS voltage current parameters
  - PMOS NMOS drain current v/s drain voltage
- Voltage Transfer Characteristics - SPICE simulations
  - SPICE deck creation for CMOS inverter
  - SPICE simulation for CMOS inverter
  - SPICE deck for CMOS inverter (W/L)p = (W/L)n

    - SPICE deck for CMOS Inverter (W/L)p = 2.5(W/L)n
- Static behavior Evaluation : CMOS inverter Robustness - Switching Threshold
    - Switching Threshold, Vm
    - Analytical expression of Vm as a function of (W/L)p and (W/L)n
    - Analytical expression of (W/L/)p and (W/L)n as a function of Vm
    - Static and dynamic simulation of CMOS inverter
    - Static and dynamic simulation of CMOS inverter with increased PMOS width
    - Applications of CMOS inverter in clock network and STA
    - Switching threshold quiz
- Static behavior Evaluation : CMOS inverter Robustness - Noise Margin
    - Introduction to noise margin
    - Noise margin voltage parameters
    - Noise margin equation and summary
- Static behavior Evaluation : CMOS inverter Robustness - Power supply variation
    - Smart SPICE simulation for power supply variations

Course Outcome:

- After completion of this lab students can understand various nanometer Physics of MOSFET and SPICE simulation. Students understand the time analysis in brief which is required for the ASIC and SOC design.

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Introduction to circuit design and spice simulation	1	10
2.	Introduction to SPICE	1	10
3.	NGCPICE Simulation for Id-Vgs characteristic NMOS	1	10
4.	NGCPICE Simulation for Id-Vds characteristic NMOS	1	10
5.	NGCPICE Simulation for Id-Vgs characteristic PMOS	1	10
6.	NGCPICE Simulation for Id-Vds characteristic PMOS	1	10
7.	Spice simulation for CMOS Inverter	1	10
8.	Spice simulation for variation in Power Supply	1	10
9.	Study and simulate CMOS VTC	1	10
10.	6T-SRAM cell	1	10

Elective – 2 Laboratory	
Course Code	**ML206**
Course Title	**Mixed Signal System Design Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- To make the students familiar with the simulation and designing of mixed circuit design.

Syllabus:

- Amplifier
- Differential Amplifier
- Current Mirror
- Operational Amplifier
- PLL

Course Outcome:

- After completion of this lab students design and simulate the Mixed Signal Circuits as per the requirement

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	**Design Differential Amplifier**	1	10
2.	Design Current Mirror	1	10
3.	Design of Operational Amplifier	1	10
4.	Design of Current-Controlled Ring Oscillator.	1	10
5.	Design of Phase-Frequency detector	1	10
6.	Design of a PLL	1	10
7.	Design cascading of current mirror	1	10
8.	Design cascode amplifier	1	10
9.	Design Operational Amplifier with output buffer	1	10
10.	Design Schmitt Trigger using NGSPICE	1	10
11.	Design of Voltage Controlled Oscillator using NGSPICE	1	10