Curriculum and Syllabus

M.Tech

In

ELECTRONICS DESIGN AND TECHNOLOGY

NATIONAL INSTITUTE OF ELECTRONICS AND INFORMATION TECHNOLOGY, AURANGABAD

Department of Electronics and Information Technology

Vision of Department of Electronics and Information Technology

To be the leader in the development of industry oriented quality education and training and be the country's premier Institution in the field of Information, Electronics and Communications Technology (IECT).

Mission of Department of Electronics and Information Technology

Identifying the needs of modern engineering & technology education and providing Quality Technical Education leading to Academic Excellence, creativity and innovation in the areas of Electronics and Information Technology

Programme Educational Objectives (PEOs) and Programme Outcomes (POs): PG Course in Electronics Design and Technology

Programme Educational Objectives (PEOs)

SI No.	Programme Educational Objectives (PEO)
PEO 1	To bring an innovative, entrepreneurial spirit along with excellence in teaching, learning and research to develop leaders in IT and Electronics.
PEO 2	To generate and keep update Industry-ready quality professionals with knowledge-based skill set in IECT and allied fields.
PEO 3	To maintain close links with Industries, R&D and Academic Institutions to promote electronics, IT and industrial design culture.
PEO 4	To develop entrepreneurs, experts and designers, carry out R&D and provide Industrial Consultancy in IECT

Programme Outcomes (POs) & Programme Specific Outcomes (PSOs) of M.Tech.in Electronics Design and Technology

SI. No.	Programme Outcome (PO)
PO 1	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations
PO 2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions
PO 3	Demonstrate a knowledge and understanding of contemporary technologies, their applications and limitations, contemporary research in the broader context of relevant fields.

PSO 1	The ability to adapt for rapid changes in tools and technology with an understanding of societal and ecological issues relevant to professional engineering practice through life-long learning
PSO 2	Excellent adaptability to function in multi-disciplinary work environment, good interpersonal skills as a leader in a team in appreciation of professional ethics and societal responsibilities.

Scheme of M.Tech Programme in ELECTRONICS DESIGN and TECHNOLOGY

(With Effect from the Academic Year 2021 onwards)

Semester I

SI. No.	Course Code	Course Title	Hours/ week			Total Credits	Theory Marks		Practical Marks
			L	T	P		ESE Marks	Internal Marks	
1.	M101	Industrial Design of Electronic Equipment	1	0	0	1	30	20	0
2.	M102	Advanced Digital System Design	3	0	0	3	70	30	0
		Elective - 1	3	0	0	3	70	30	100
3.	M103	Electromagnetic Compatibility	3	0	0	3	70	30	0
4.	M104	Electronic Packaging	3	0	0	3	70	30	0
5.	M105	Design for Manufacturability	3	0	0	3	70	30	0
6.	ML101	Industrial Design of Electronic Equipment Laboratory	0	0	6	3	70	30	100
7.	ML102	Advanced Digital System Design Laboratory	0	0	2	1	40	10	50
8.		Elective – 1 Lab	0	0	2	1	40	10	50
Total			16	0	10	21	530	220	200
Elective - 1									
M106		Machine Learning							
M107		Networking and IOT							
Elective – 1 Lab									
ML106		Machine Learning Laboratory							
ML107		Networking and IoT Laboratory							

Examination Pattern

- **Theory Subject**
  - Internal Continuous Assessment: 30 / 20 marks

    Internal continuous assessment is in the form of periodical tests, seminars or a combination of both whichever suits best. There will be two tests per subject. The assessment details are to be announced to the students, right at the beginning of the semester by the teacher.

    Test 1- 15 marks

    Test 2- 15 marks

    Total – 30 marks

    End Semester Examination: 70 marks
- **Laboratory Subject**

Laboratory Experiments & Viva Voce	:	10 Marks
Final Internal Test	:	40 Marks
Total	:	50 Marks

- **Project Work and Seminar**
  - Seminar shall be evaluated by the evaluation committee based on the relevance of topic, content depth and breadth, communication skill, question answering etc on the power point presentation of the topic by the student.

First Semester

Course Code	**M101**
Course Title	**Industrial Design of Electronic Equipment**
Credits	**1-0-0:1**
Pre-requisutes	**Nil**

Objective

- To understand the various processes and systems to address human needs by creating tangible Electronic Products. To pursue learners with emphasis on learning-by-doing and following a comprehensive process of design, engineering and producing products and systems.

Syllabus

- Product development life cycle – various life cycle models. Aesthetics in a product design. Ergonomics. Design for Reliability – failures and solutions. Design for Manufacturability. PCB design – design rules, Schematics, creating Gerber files, etc. Electrical testing of the system. Familiarizing various tools – Shop bot, 3D printer, Laser cutter, PCB fabrication machine & soldering tools.

Course Outcome:

- After undergoing this course, students will be able to:
  - Design electronic products using user centered design process
  - Develop sketches, virtual and physical appearance models to communicate proposed designs
  - Refine product design considering engineering design & manufacturing requirements and constraints.
  - Make mock-up model and working prototype along with design documentation.

References:

1. V.B. Baru R.G.Kaduskar, Electronic Product Design, Wiley India
2. Tony Ward and James Angus, Electronic Product Design, Chapman & Hall

Internal continuous assessment : 20 marks

Test 1- 20 marks

End Semester Examination: 30 marks

Course Plan:

Modules (Theory)	No. of Hours	ESE marks
Module 1: Product development life cycle – various life cycle models.	13	30

Aesthetics in a product design. Ergonomics. Design for Reliability – failures and solutions. Design for Manufacturability. PCB design – design rules, Schematics, creating Gerber files, etc. Electrical testing of the system. Familiarizing various tools – Shop bot, 3D printer, Laser cutter, PCB fabrication machine & soldering tools		

Course Code	**M102**
Course Title	**Advanced Digital System Design**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- To prepare students for the design of practical digital hardware systems using VHDL. This course covers the basics of digital logic circuits and introduces the student to the fundamentals of combination logic design and then to sequential circuits (both synchronous and asynchronous). Memory systems are also covered. Students will be provided opportunities to synthesize the designs (using both schematic capture and VHDL) for implementation in FPGAs..

Syllabus:

- Introduction to Digital Design, Combinational and Sequential Circuit Design, State machine design, Design of Asynchronous Sequential Circuit, Designing with PLDs, and CPLDs. HDL, Introduction to Synthesis and Synthesis Issues Testing, Fault Modelling and Test Generation, Test generation for combinational logic circuits, Introduction to Design for Testability. FPGAs, Logic blocks, Routing architecture, Design flow technology, Xilinx and Altera FPGA Architecture.

Course Outcome:

- The students will be able to design, simulate, built and debug complex combinational and sequential circuits based on an abstract functional specification and implement the designs on FPGAs.

TEXT BOOKS:

1. Parag K. Lala, "Digital System Design using programmable Logic Devices", Prentice Hall, NJ
2. Geoff Bestock, "FPGAs and programmable LSI; A Designers Handbook", Butterworth Heinemann

REFERENCES:

1. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, “Digital Systems Testing and Testable Design”, John Wiley & Sons Inc.
2. Parag K.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications
3. J. Bhasker, "A VHDL Primer", Addison-Weseley Longman Singapore Pte Ltd.
4. Jesse H. Jenkins, "Designing with FPGAs and CPLDs", Prentice Hall, NJ
5. Fundamentals of Logic Design – Charles H. Roth, 5th ed., Cengage Learning.
6. Kevin Skahill, "VHDL for Programmable Logic", Addison –Wesley
7. Z. Navabi, "VHDL Analysis and Modeling of Digital Systems", McGRAW-Hill
8. Digital Circuits and Logic Design – Samuel C. Lee , PHI
9. Smith, "Application Specific Integrated Circuits", Addison-Wesley

10. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Introduction to Digital Design Combinational Circuit Design, Synchronous Sequential Circuit Design - Mealy and Moore model, State machine design, Analysis of Synchronous sequential circuit, State equivalence, State Assignment and Reduction, Analysis of Asynchronous Sequential Circuit, flow table reduction, races, state assignment, Design of Asynchronous Sequential Circuit, Designing with PLDs – Overview of PLDs – ROMs, EPROMs – PLA – PAL - Gate Arrays – CPLDs and FPGAs, Designing with ROMs - Programmable Logic Arrays - Programmable Array logic, PAL series 16 & 22 – PAL22V10 - Design examples.	12	25
Module 2 VHDL Basics – Introduction to HDL – Behavioral modeling – Data flow modeling – Structural modeling – Basic language elements – Entity – Architecture – Configurations – Subprograms & operator overloading – Packages and libraries – Test Bench – Advanced Features – Model simulation Realization of combinational and sequential circuits using HDL – Registers – Flip flops – counters – Shift registers – Multiplexers – sequential machine –Multiplier – Divider, Introduction to Synthesis and Synthesis Issues.	12	25
Module 3 Testing, Fault Modelling And Test Generation – Introduction to testing – Faults in Digital Circuits – Modelling of faults – Logical Fault Models – Fault detection – Fault Location – Fault dominance – Logic simulation – Test generation for combinational logic circuits – Testable combinational logic circuit design, Introduction to Design for Testability, BST	8	25
Module 4 FPGA - FPGAs - Logic blocks, Routing architecture, Design flow technology - mapping for FPGAs, Xilinx FPGA Architecture, Xilinx XC4000 - ALTERA's FLEX 8000, Design flow for FPGA Design, Case studies: Virtex II Pro.	10	25

Course Code	**M103**
Course Title	**Electromagnetic Compatibility**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- To understand the various techniques for electromagnetic compatibility.
- To understand the need of Electromagnetic compatibility.
- To understand the method of PCB layout and stack up.
- To understand the hazards of ESD and protection against it in equipment design

Syllabus:

- Need for Electromagnetic Compatibility, Two aspects of EMC, Digital circuit power distribution, Radiated emission, Conducted emission, PCB layout and stack up, Electrostatic Discharge (ESD)

Course Outcome:

- Understand basic mitigating techniques in EMC
- Understand shielding mechanisms and electromagnetic coupling.
- Understand the basics and importance of grounding.
- Understand the concept of return path in PCB design.
- Able to apply design considerations for various PCB design.
- Will be able to do PCB layers stacking.
- Understand how to apply proper methods of grounding for ESD protection of device.

REFERENCES:

1. Henry W.Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons
2. Henry W.Ott, Noise Reduction Techniques in Electronic Systems, Second Edition Wiley Interscience Publication
3. Clayton R.Paul, Introduction to Electromagnetic Compatibility, Second Edition , Wiley Interscience Publication
4. V. Prasad Kodali, Engineering Electromagnetic Compatibility-Principles, Measurements, Technologies, and Computer Models Second Edition IEEE Press
5. Ralph Morrison, Grounding and Shielding circuits and interference 5th edition Wiley

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Need for Electromagnetic Compatibility, Two aspects of EMC – Emission and Susceptibility, Radiation and Conduction, Designing for EMC, EMC regulations, designing for Electromagnetic Compatibility.	18	34

Noise and Interference, Typical Noise path, Methods of noise coupling, Non-ideal behavior of electronic components Capacitive and Inductive Coupling, Effect of Shielding on capacitive and inductive coupling, Shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, Shield Transfer Impedance -shielding properties of various cable configurations, coaxial cable and shielded twisted pair, braided shields, ribbon cables, Shield Terminations Safety grounds, signal grounds, single point, multi-point and hybrid grounds, Chassis Grounds, Common Impedance Coupling, Grounding of cable shields, Ground loops and its breaking, Common Mode Choke – Analysis at low and high frequencies, Balancing and Filtering		
Module 2 Digital circuit grounding, internal noise sources, Digital circuit ground noise, minimizing ground impedance and loop area, ground grid, ground plane, Ground plane current distribution, ground plane impedance. Current flow in micro-strip and strip-line routing Digital circuit power distribution- Transient power supply currents, decoupling capacitor design, effective decoupling strategies, decoupling capacitor selection and mounting Radiated emission - Differential mode and common mode radiation – Reasons and controlling methods, Conducted emission – Power line impedance, Line impedance stabilization network, Common mode and differential mode noise sources in SMPS. Power line filters	17	33
Module 3 PCB layout and stack up - General PCB layout Considerations, PCB to chassis ground connections, return path discontinuity, PCB layer stack up, General PCB design procedure, mixed signal PCB layout, Split planes, Ground connection and power distribution, vertical isolation Near fields and far fields, characteristic and wave impedances, shielding effectiveness, absorption and reflection loss, shielding with magnetic material, apertures, conductive gaskets, conductive windows, conductive coating, grounding of shields. Electrostatic Discharge (ESD) -Static generation, human body model, static discharge, ESD protection in equipment design, Transient and Surge Protection Devices, ESD grounding, non-grounded products, software and ESD protection, ESD versus EMC, ESD Testing	17	33

Course Code	**M104**
Course Title	**Electronic Packaging**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- The course will discuss all the important facets of packaging at three major levels, namely, chip level, board level and system level. Students masters the fundamental knowledge of electronics packaging including packing styles, hierarchy and method of package necessary for various environment. Sensitize students to the multi-disciplinary area and appreciate the role of packaging in electronics product. Provides pathway for further studies in packaging if the students is inclined to do so.

Syllabus:

- Functions of an Electronic Package, IC Assembly, System Packaging, Printed Circuit Board, Board Assembly, Design Reliability, Thermal management for IC and PWB, Electrical Testing and trends in packaging

Course Outcome:

- The student will able to understand distinguish between engineering performance, economic efficiency and to develop cost efficient high performance packaging approaches. As designer point of view cost efficiency and high performance are very important. It is going to be very difficult to build high performance at low cost; but, a good packaging engineer will strive to achieve these very two extremities in packaging.

REFERENCES:

1. Rao R. Tummala, Fundamentals of Microsystem PackagingMcGraw Hill
2. Richard K. Ulrich &William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEE Press
3. Rao R. Tummala, MadhavanSwaminathan, Introduction to System-on-Package (SOP), McGraw-Hill

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Functions of an Electronic Package, Packaging Hierarchy, Driving Forces on Packaging Technology. Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging. Electrical Anatomy of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference.	12	31
Module 2	16	41

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging. Different types of IC packages – DIP, QFP etc. Systems Packaging – MCM / SoC/ SiP/ SoP. Discrete, Integrated and Embedded Passives. Printed Circuit Board – Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards. Board Assembly – Surface Mount Technology, Through-Hole Technology, Process Control and Design challenges.		
Module 3 Design for Reliability – Fundamentals, Induced failures. Thermal Management for IC and PWBs, Cooling Requirements, Electronic cooling methods. Electrical Testing – System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability. Trends in packaging.	11	28

Course Code	**M105**
Course Title	**Design for Manufacturability**
Credits	**3-0-0: 3**
Pre-requisutes	**Nil**

Objective:

- The objective of course is identifying the manufacturing constraints that influence the design of parts and part systems.
- Students will be introduced to the Design for Manufacturability (DFM) methodology, and will be motivated to understand infeasible or impractical designs.
- To introduce emerging trends in PCB Design and manufacturing
- To explain design considerations for various PCB circuits like Analog, Digital and high-speed circuit.
- To introduce design rule check in PCB design

Syllabus:

- Product Life cycle, Need for different DFM techniques for different companies, DFM softwares, Design consideration for different types of PCBs, Manual verification

Course Outcome:

- Students will be able to understand the recent trends in DFM.
- Students will get to know the need for DFM in industry.
- Students will get exposure to PCB designs tools in software.
- Students will be able to differentiate between designer and manufacturer.
- Students will get familiar with design considerations for high-speed PCB designs and will be able to implement it wherever required.
- Students will be able to manually find out
- Students will get the knowledge of thermal profiling during SMD/PTH process.

REFERENCES:

1. Michael Orshansky, Sani Nassif, Duane Boning, Design for Manufacturability And Statistical Design: Constructive Approach, Springer
2. Chiang, Charles, Kawa, Jamil, Design for Manufacturability and Yield for Nano-Scale CMOS
3. R S Khandpur, Printed Circuit Boards, Tata McGraw-Hill

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Product Life cycle – Introduction, Growth, Mature and Saturation, Product life cycle management, What is DFM, Need of DFM – Higher Quality, Lower Cost, Faster Time to market,	13	33

better Yield etc. Designer vs manufacturer. Need for different DFM techniques for different companies – Different applications, Different manufactures, Different equipment and processes. Development of DFM rules, Design Guidelines, exceptions. Simple assembly process vs complex and expensive components, Simple component manufacture vs complex manufacturing process, Simple and inexpensive design vs expensive and complex service and support.		
Module 2 DFM softwares. Emerging manufacturing trends, Lead free design, standard design processes, Certifications. Over view of Design for Testability, Design for Assembly, Design for serviceability, Design for reliability etc. PCB Design and manufacturing process. Design considerations for different types of PCBs – Single layer PCBs, Multilayer PCB, Flexible PCB etc. Design considerations for PCBs for different applications – digital circuits, Analog circuits, High speed circuits, Power circuits etc. Layout rules and parameters. Design rule checks – Signal layer checks, Power/Ground checks, Solder mask check, Drill check etc.	13	33
Module 3 Manual verification – Thermal design, plane split width, isolation, PCB thickness etc. Automated processes, Through Hole vs SMT technologies. Thermal profiling during SMD/PTH assembly. Case studies to understand DFM from design, manufacturing and Assembly Miniaturization and increased complexity of VLSI circuits Functional Yield, Parametric Yield, Reliability, Yield Loss Modules, Yield analysis Higher Yield Cells, Spacing and Width of interconnect wires, Redundancy in the design, Fault Tolerant vias, generation of yield optimized cells, layout compaction, wafer mapping optimization, planarity fill, statistical timing.	13	34

Elective - 1	
Course Code	**M106**
Course Title	**Machine Learning**
Credits	**3-0-0: 3**
Pre-requisutes	**Any object oriented programming language**

Objective:

- The objective of the Machine Learning course is to introduce the basic concepts and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.

Syllabus:

- Python, Introduction to NumPy, Data Manipulation with Pandas, Visualization with Matplotlib, Machine Learning Algorithms.

Course Outcome:

- After completion of course, students would be able:
  - To review some common Machine Learning algorithms and their limitations.
  - To apply common Machine Learning algorithms in practice and implementing the same.
  - To perform experiments in Machine Learning using real-world data.

Textbooks:

1. Python Data Science Handbook by Jake VanderPlas (O'reilly publication)
2. Hands on Machine Learning with Scikit Learn and Tensorflow' by Aurélien Géron (O'reilly publication)
3. Neural Networks and Deep Learning by Michael Neilson

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 Launching Jupyter Notebook, Help and Documentation in Python, Keyboard shortcuts in IPython Shell, IPython Magic Commands, Input and Output History, IPython and Shell commands, Errors and Debugging, Profiling and Timing Code		
Module 2 Understanding Data types in Python, The Basics of NumPy array, Computation on NumPy arrays, Aggregations: Min, Max, Computation on arrays, Comparison Mask and Boolean Logic, Fancy Indexing, Sorting Arrays and Structured Data		

Module 3 Introducing Pandas Object, Data Indexing and Selection, Operating on data in pandas, Handling missing data, Hierarchical Indexing, Combining datasets, Aggregation and grouping, Pivot tables, Vectorized string operation, Working with time series, High-performance pandas		
Module 4 General Matplotlib tips, Simple line plots and scatter plots, Visualizing errors, Density and Contour plots, Histogram, binnings and density, Customizing plot legends and colorbars, Multiple Subplots, Text and annotations, 3D plotting in matplotlib, geographic data with basemap, visualization with seaborn		
Module 5 Introducing Scikit Learn, Hyperparameters and Model validation, Feature Engineering, Naïve Bayes classification, linear regression, Support vector machine, decision tree and random forest, Principal Component analysis, manifold learning, K-means clustering, Gaussian mixed model, Kernel density estimation.		

Course Code	**M107**
Course Title	**Networking and IOT**
Credits	**3-0-0: 3**
Pre-requisutes	

Objective:

- To explore the interconnection and integration of the physical world and the cyberspace. To learn different protocols used in IOT, to learn the concepts of smart city development in IOT, to learn how to analyze the data in IOT.

Syllabus:

- IoT an architectural view, Iot Architecture- State of Art, Networking in IoT.

Course Outcome:

- Able to understand the application areas of IOT
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- Able to understand building blocks of Internet of Things and characteristics.
- Able to design and develop smart city using IOT.
- Able to analyze the data received through sensors in IOT.

Textbooks:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press
2. Peter Waher, Learning Internet of Things, Packt publishing Ltd.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Springer, 2011
4. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Wiley.
5. Vijay Madisetti, Arshdeep Bahga, Internet of Things (A Hands-on-Approach),Orient Blackswan Private Limited, 2015

Course Plan:

Modules (Theory)	No. of Hours	% ESE marks
Module 1 IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management	13	33
Module 2	13	33

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints-Introduction, Technical Design constraints-hardware Data representation and visualization, Interaction and remote control.		
Module 3 IOT Data Link Layer & Network layer Protocols PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), ,Wireless Hart mZ-Wave,Bluetooth Low Energy, Zigbee Smart Energy, -Network Layer-IPv4, IPv6, 6LoWPAN, DHCP, ICMP, RPL, CORPL, CARP. Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT-Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer	13	34

Course Code	**ML101**
Course Title	**Industrial Design of Electronic Equipment Laboratory**
Credits	**0-0-3: 3**
Pre-requisutes	

Objective:

- Understand the need for PCB Design and steps involved in PCB Design and Fabrication process.
- Understand the fundamental of basic electronic components and basic electronic instruments and equipment.
- To understand the various processes and systems to address human needs by creating tangible Electronic Products. To pursue learners with emphasis on learning-by-doing and following a comprehensive process of design, engineering and producing products and systems.

Syllabus:

- The students need to implement the prototype model of an electronic product undergoing different stages of product development life cycle, which include:
    - Requirements/market study/feasibility study
    - Finalizing the Specifications
    - Mechanical design
        - Ergonomics and Aesthetics
    - Hardware Design
        - Component selection
        - Schematic Entry
        - Layout Design
        - PCB manufacturing and assembly
    - Assembly
    - Software Design
    - Testing.

Course Outcome:

- Need and evolution of PCB, types and classes of PCB.
- Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design.
- Understand basic concepts of Fundamental electronic components &instruments value measurements & standard testing procedure.
- Design electronic products using user centered design process.
- Develop sketches, virtual and physical appearance models to communicate proposed designs

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Exercises on sketching and drawing, use of colors.	2	10
2.	Practice use of model making materials and processes.	2	10
3.	To study various IC packages and Create component library with proper dimensions and specifications as per datasheet on Grid paper.	2	10
4.	Practice methods and techniques of prototype making using sheet metal and plastic fabrication	2	10
5.	Design the DC TO DC 5V Voltage regulator circuit using LM317 IC into schematic editor and draw the PCB layout for the same in Autodesk EAGLE software, generate Gerber files for top electrical and bottom electrical.	2	10
6.	To learn the process of generating files (HPGL, ISEL, Excellon) for CNC drilling and milling machine	2	10
7.	To develop the artwork on photo films using photoplotter machine, installation of films on machine and developing of the photo films using developer bath and fixer bath.	2	10
8.	Study the various format settings done in photoplotter machine. Learn about artwork generation software, the concept of importing PCB Gerber file and converting files to photoplotter format.	2	10
9.	Learn about PCB cleaning Process, study the operation and working of PCB brushing machine and perform brushing operation on FR-4 copper clad.	2	10
10.	To learn the process of galvanic plated through hole machine, and study the operation and working of through hole plating machine and perform operations on double sided PCBs.	2	10

Laboratory Experiments & Viva Voce	:	20 Marks
Final External Test	:	50 Marks
Internal marks	:	30 Marks
Total	:	100 Marks

Course Code	**ML102**
Course Title	**Advanced Digital System Design Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- This lab is specially designed and developed for modelling of combinational and sequential logic circuits using VHDL/ Verilog and implementation of digital circuits on Xilinx FPGAs. This lab is well provided with equipment Xilinx Vivado 2017 and Altera FPGA Deployment boards. At the end of the lab student will be able to Design Digital Logic circuit modeling using 7 series FPGA and Digital system modelling using VHDL/ Verilog and implementation on Basys3 Board

Syllabus:

- The students need to implement the digital IC on the available and advance development board, which include:
- Finite State Machines
- ALU Design
- Design of all Combination Circuits
- Design of all Sequential Circuits
- Case Study for the latest topics

Course Outcome:

- Students understand the use standard digital memory devices as components in complex subsystems
- Technical knowhow to design simple combinational logic circuits and logic controllers
- Acquire skill set to develop the necessary software for basic digital systems

Course Plan:

SI. No.	Practicals	No. of Hours	% ESE marks
1.	Implement One Bit Full Adder	1	10
2.	Implement Two Input all basic gates	1	10
3.	Implement 32Bit carry ripple adder	1	10
4.	Implement CMOS inverter	1	10
5.	Implement Counters	1	10
6.	Implement Combinational Circuit	1	10
7.	Implement Sequential Circuit	1	10
8.	Implement UART Tx	1	10
9.	Implement UART Rx	1	10
10.	Implement ALU	1	10

Course Code	**ML106**
Course Title	**Machine Learning Lab**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- The objective of the Machine Learning course is to introduce the basic concepts and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.

Syllabus:

- Python, Introduction to NumPy, Data Manipulation with Pandas, Visualization with Matplotlib, Machine Learning Algorithms.

Course Outcome:

- After completion of course, students would be able:
  - To review some common Machine Learning algorithms and their limitations.
  - To apply common Machine Learning algorithms in practice and implementing the same.
  - To perform experiments in Machine Learning using real-world data.

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file	2	10
2.	For a given set of training data examples stored in a .CSV file, implement and Demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.	2	10
3.	Write a program to demonstrate the working of the decision tree based ID3 Algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample	2	10
4.	Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.	2	10
5.	Understating of Linear Regression , Naive Bayes	2	10

	methods		
6.	Understating of Support Vector Machine Tree Models methods	2	10
7.	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.	2	10
8.	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set	2	10
9.	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.	2	10
10.	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.	2	10
11.	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.	2	10
12.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.	2	10

Course Code	**ML107**
Course Title	**Networking and IoT Lab**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- To learn different protocols used in IOT, to learn the concepts of smart city development in IOT, to learn how to analyze the data in IOT.

Syllabus:

- Wifi , BLE, CoAP, MQTT, GATT, Sensor Network

Course Outcome:

- Able to understand the application areas of IOT.
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- Able to understand building blocks of Internet of Things and its characteristics.
- Able to design and develop smart city in IOT.
- Able to analyze the data received through sensors in IOT.

Course Plan:

SI. No.	Practicals	No. of Hours	% ESE marks
1.	Scanning the available SSID's in the range of Wi-Fi.	1	5
2.	Connect to the SSID of choice.	1	5
3.	Demonstration of a peer-to-peer network topology.	1	5
4.	Check the connectivity to any device in the same network.	1	5
5.	Send hello world to TCP server existing in the same network	1	5
6.	Reading Temperature and Relative Humidity value from the sensor.	1	5
7.	Transmitting the measured physical value from the sensor over the air.	1	5
8.	Reading sensor data from sensor and sending into UART.	1	5
9.	BLE beacon: Experiment involves initializing BLE stack, advertising packet/beacon (Eddystone frame format may be used) and starting the advertisement.	1	5
10.	Experiment is to understand BLE GATT protocol and develop profiles based on GATT services.	1	5
11.	Point to point communication of two C-Motes over the radio frequency.	1	5
12.	Multi-point to single point communication of C-	1	5

	Motes over the radiofrequency.		
13.	Reading Temperature, Relative Humidity, Light intensity value from light sensor, Proximity detection with IR LED value from the sensor.	1	5
14.	Transmitting the measured physical value from the sensor over the air.	1	5
15.	Demonstration of a peer-to-peer network topology using Coordinator and End Device network device types.	1	5
16.	Demonstration of peer-to-peer communication between Coordinator and End Device through Router.	1	5
17.	Demonstrate CoAP Protocol using Terminal	1	5
18.	Demonstrate MQTT protocol using Terminal	1	5
19.	Demonstrate IOT Gateway.	1	5
20.	Demonstrate DHT11 Sensor using free cloud services.	1	5

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

Semester III

SI. No.	Course Code	Course Title	Hours/ week			Total Credits	Theory Marks		Practical Marks
			L	T	P		ESE Marks	Internal Marks	
1.	M301	Optical Fiber Communication System	3	0	0	3	70	30	0
2.	M302	Software Engineering	3	0	0	3	70	30	0
3.	M303	Project Work and Seminar I	0	0	20	10	25	25	50
4.	ML301	Optical Fiber Communication System Laboratory	0	0	2	1	40	10	50
		Total	6	0	22	17	205	95	100

Third Semester

Course Code	**M301**
Course Title	**Optical Fiber Communication System**
Credits	**3-0-0:3**
Pre-requisutes	**Nil**

Objective

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Design optimization of SM fibers, RI profile and cut-off wavelength.
- To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes and different fiber amplifiers.
- To learn the fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration.
- To learn fiber slicing and connectors, noise effects on system performance, operational principles WDM and solutions.
- To be able to design transmitter and receiver circuit of the optical fiber link.
- Should get aware of the criteria of selection of optical fiber cable in an optical link
- Should get the knowledge about difference in video, voice and data transmitter system.
- Should get the concepts of other optoelectronics techniques like acousto-optics, electro optics and Integrated Optics.

Syllabus:

- Introduction, Opto electronics sources and Detections, Opto Electronics Instructions, Laser system, Electro optics and non liner optics effects, Optical communication systems and design, Optical sensors and systems

Course Outcome

- After finishing the course student will become familiar with all components of optical fiber system like sources, detector and optical fiber
- Students will become knowledgeable about the working principal of above devices.
- Student will get knowledge about the construction mechanism and selection criteria of Optical fiber cables.
- The student will be able to design transmitter circuits, receiver circuit and selection of optical fiber cable for a given conditions of the optical fiber link.
- Will have the knowledge about selection of optical fiber and optical fiber cable for different type of an optical link, with having application for voice, video or data transmission.

- Will have knowledge of other optoelectronics techniques like acousto-optic acoustooptic , electro optics and Integrated Optics.

TEXT BOOKS:

1. J. Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 1994.
2. Fiber optics by R. P. Khare, oxford university press

REFERENCES:

1. Gerd Keiser, "Optical Fiber Communication" McGraw -Hill International, Singapore, 3rd ed., 2000
2. J.Gower, "Optical Communication System", Prentice Hall of India, 2001
3. Fundamentals of Photonics 2nd ed., Saleh and Teich, (John Wiley & Sons, inc., 2007).
4. Fiber Optic Communication Systems – Govind P. Agarwal, John Wiley, 3rd Edition, 2004
5. Photonics: Optical Electronics in Modern Communications by Yariv, Pochi yeh

Course Plan:

Modules (Theory)	No. of Hours	%ESE marks
Module 1: Introduction: **Ray theory of transmission**, propagation of light in anisotropic media, light propagation in wave guides. Fiber optics-history, types of fibers, characteristics of optical fiber, fabrication.Fiber splicing-mechanical and fusion splicing and testing of optical fibers. **Laser Devices:** Historical introduction, emission and absorption of radiation, spontaneous and stimulated emission, population inversion, optical feedback, the laser resonator.	7	25
Module 2: Optical sources and detectors **Light emitting diodes:** LED of different colors, Materials used for emission of lightLED power and efficiency, irradiance, LED structures, Characteristics of LED. **LASER:** Injection laser diodes, Basic Homojunction laser, Double hetro-junction laser. Laser system, power supplies for laser, Various gas, solid state semiconductor lasers and their properties, application in brief. **Detectors:** Optical detection principle, Absorption, Quantum efficiency, Responsivity, Long-wavelength cutoff, Rise time and bandwidth. Photodiodes without internal gain- The PN photodiode, PIN photodiode- construction, speed of response. Photodiodes with internal gain- APD, silicon reach through avalanche photodiode. Photo detector Noise-Noise Sources, Signal-to-Noise Ratio, Noise-Equivalent Power.	10	25

Module 3: Optical communication system and design Optical fibers and other components for fiber optic communication, fiber optic communication system. System consideration- Wavelength, Photo detector, Optical source, optical fiber, Losses. Link power budget and rise time consideration, Transmitter & receiver circuits. WDM- working principle, Optical Amplifiers-Erbium Doped Fiber Amplifier, Semiconductor optical amplifier, Photonic switching, SONET/SDH.	10	20
Module 4Electro optics and non-linear optics effects: Design of A.O modulators and deflectors. Electro- optic effects-Pockels and Kerr effects: change in refractive index in KDP crystal. Design of electro optional modulators, switching, multiplexers and other devices. Integrated optical circuits. Nonlinear Effects: Effective Length and Area, Stimulated Raman Scattering (SRS), Stimulated Brillouin Scattering (SBS), Self-Phase Modulation (SPM), Cross-Phase Modulation, Four-Wave Mixing.	8	20
Module 5:Opto-electronic instructions: Laser interferometry and application to metrology and testing, Holography and holographic interferometry, speckle techniques. Digital speckle pattern interferometer, Laser gyro and Doppler velocimetry, OTDR, LIDAR applications,	5	10

Course Code	**M302**
Course Title	**Software Engineering**
Credits	**3-0-0:3**
Pre-requisites	**Nil**

Objective

- Understand basic SW engineering methods and practices, and their appropriate application.
- Understand u of software process models such as the waterfall and evolutionary models.
- Role of project management including planning, scheduling and, risk management.
- Discuss data models, object models, context models and behavioral models.
- Understand of different software architectural styles and Process frame work.
- Understand of implementation issues such as modularity and coding standards.

Syllabus:

- System Analysis and Design: Overview of System Analysis & Design , Business System Concept, System Development Life Cycle ,System Design – Problem Partitioning, Top-Down And Bottom-Up design ;Decision tree, Testing – Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, Monitoring & Control. Software Project Management – Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring and Mobile application security

Course Outcome

- Knowledge of basic SW engineering methods and practices, and their appropriate application.
- Describe software engineering layered technology and Process frame work.
- A general understanding of software process models such as the waterfall and evolutionary models.
- Understanding of software requirements and the SRS documents.
- Understanding of the role of project management including planning, scheduling, risk management, etc.
- Describe data models, object models, context models and behavioral models.
- Understanding of different software architectural styles.
- Understanding of implementation issues such as modularity and coding standard should get the concepts of other optoelectronics techniques like acoustic-optics, electro optics and Integrated Optics.

TEXT BOOKS:

1. 1. R. G. Pressman – Software Engineering, TMH

REFERENCES:

1. IEEE Standards on Software Engineering. Kane, Software Defect Prevention, SPD
2. Behforooz, Software Engineering Fundamentals, OUP
3. Ghezzi, Software Engineering, PHI
4. Object Oriented & Classical Software Engineering(Fifth Edition), SCHACH,TMH
5. Vans Vlet, Software Engineering, SPD
6. Uma, Essentials of Software Engineering, Jaico
7. Sommerville, Ian – Software Engineering, Pearson Education
8. Benmenachen, Software Quality, Vikas

Course Plan:

Modules (Theory)	No. of Hours	%ESE marks
Module 1: System Analysis and Design : Overview of System Analysis & Design , Business System Concept, System Development Life Cycle, Waterfall Model , Spiral Model, Feasibility Analysis, Technical Feasibility, Cost-Benefit Analysis, COCOMO model.	10	25
Module 2: Design related issues: System Requirement Specification – DFD, Data Dictionary, ER diagram, Process Organization & Interactions. System Design – Problem Partitioning, Top-Down And Bottop-Up design ;Decision tree, decision table and structured English; Functional vs. Object- Oriented approach.	8	25
Module 3: Coding & Documentation: Coding & Documentation – Structured Programming, OO Programming, Information Hiding, Reuse, System Documentation. Testing – Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, Monitoring & Control.	10	25
Module 4: User Interface : Module Introduction, Objectives of Usability, How to Approach Usability, Designing with Usability in mind, Measuring Usability, Guidelines for User Interface Design, User Interface Elements.	6	10
Module 5: Software Project Management & Software security : Software Project Management – Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring , Software security life cycle Software quality attributes Security requirement gathering principles and guidelines A case Study (Mobile application security) Mobile application security Malware classification and analysis Module 4 (Design and testing for security, best practices) Secure software design principles Static analysis techniques Security testing (black	**7**	15

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Course Code	**M303**
Course Title	**Project Work and Seminar I**
Credits	**0-0-10:10**
Pre-requisites	**Nil**

Objective:

- To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Syllabus:

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in electronics design related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute, subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee shall be headed by the head of the department with other faculty members in the area of the project.

The student is required to undertake the Project Work and Seminar I during the third semester and the same is continued in the 4^{th} semester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Course Outcome:

After successful completion of the project phase I, students should be able to:

- Formulate a research problem and perform literature review
- Systematically carrying out a research and write technical reports

Evaluation/ Assessment:

Guide (25 marks)	Evaluation Committee (25 marks)

Course Code	**ML301**
Course Title	**Optical Fiber Communication System Laboratory**
Credits	**0-0-1: 1**
Pre-requisutes	

Objective:

- To Train students practically in the field of optical communication so that they can relate theory with elements of design and applications.
- To understand different kinds of losses, signal attenuation in optical fibers.
- To make students familiarize with different types of connectors.
- To make student familiar with different splicing techniques.
- To train students by giving practical exposure on fiber optic splicing machine following proper methods for good splicing.
- To make students understand the use of OTDR and study various losses in the optical fiber.
- To make students interpret the trace in OTDR.

Syllabus:

- Different types of fiber cables, connectors, LED and Photo detectors. Establishment of analog and digital link, intensity modulation techniques, attenuation loss, Numerical Aperture, bending loss, OTDR.

Course Outcome:

- Students will be able to classify different types of fiber optic cable and their components.
- Students will be able to identify different types of fiber optic connectors.
- Students will get knowledge about different types of LED and Photodetectors.
- Students will be able to calculate losses.
- Students will learn proper methods to be followed for optical fiber splicing and joining.
- Students will be able to handle OTDR and interpret the traces plotted in OTDR.

Course Plan:

SI. No.	Practicals (at least 10 nos)	No. of Hours	% ESE marks
1.	Demonstration of different types of fiber cables and connectors.	2	10
2.	To study the characteristics of given LED and Photo detector.	2	10
3.	To Establish Analog and Digital link using optical fiber cable.	2	10
4.	Study of Intensity Modulation Technique using Analog input signal.	2	10

5.	To measure propagation or attenuation loss in optical fiber.	2	10
6.	To Study Bending Loss in fiber optic communication.	2	10
7.	To measure the Numerical Aperture (N.A.) of the fiber optic cable.	2	10
8.	To establish Fiber optic voice link.	2	10
9.	To study the Optical time Domain reflectometer and interpret the trace generated in OTDR.	2	10
10.	To Study the Fiber Optic Splicing and Joining.	2	10

Semester IV

SI. No.	Course Code	Course Title	Hours/ week			Total Credits	Theory Marks		Practical Marks
			L	T	P		ESE Marks	Internal Marks	
1.	M401	Project Work and Seminar II	0	0	40	20	50	50	100
		Total	0	0	40	20	50	50	100

Course Code	**M401**
Course Title	**Project Work and Seminar II**
Credits	**0-0-20:20**
Pre-requisites	**Nil**

Objective:

- To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
- The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Syllabus:

- Project Work and Seminar II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and External Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. External Evaluation Committee shall comprise of external subject matter expert, faculty members of the institute and industry supervisor in case project is a sponsored.

At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

Course outcome:

The students who successfully complete this course will have the demonstrated capability to

- Formulate a research problem in embedded systems area
- Systematically carrying out a research
- Write technical reports and research publications
- Publish research findings

Evaluation/ Assessment:

External Evaluation Committee (50 marks)	**Guide (50 marks)**

External Evaluation Committee	**Electronics Design (20 marks)**	**Physical Design (20 marks)**	**Project Presentation (5 marks)**	**Viva Voice (5 marks)**	**Total (50 marks)**