Code: 17EEEC201 **L-T-P: 3-0-0**
Course Title: Electrical Machines. **CIE: 50**
Teaching Hours: 40 **SEE: 50**

Unit –I

Chapter 1 : Transformer : Transformer construction and principle of operation, Ideal Transformer, Practical Transformer, Transformer phasor diagrams, Equivalent circuit of transformers, Open circuit and short circuit tests, Voltage regulation, transformer losses and efficiency, Testing of transformers, Three phase transformers, Auto-transformers.	**10 hours**
Chapter 2: DC Machines: Construction of DC machine and DC machine as generator, EMF equation of DC machine, Operating characteristics of types of DC generators, Operating characteristics of DC motors, DC motor starting, Speed control of DC motors.	**05 hours**

Unit – II

Chapter 3: Induction (Asynchronous) Machines: Induction motor as transformer, Principle of operation, Rotor frequency, e.m.f, current and power, Losses and Efficiency, Equivalent circuit, Torque slip and Power-slip characteristics, Determination of equivalent circuit parameters. Circle diagram, Starting of polyphase induction motors.	**10 hours**
Chapter 4 : Synchronous Machines: Cylindrical and salient pole machines, Phasor diagram of cylindrical rotor alternator. AC armature winding, Voltage regulation of alternator using e.m.f method.	**05 hours**

Unit – III

Chapter 5 : Synchronous Machines: Synchronous motor phasor, Power angle characteristic of synchronous machine, Measurement of Xd and Xq, Capability curves of synchronous generators, Power factor correction by synchronous motors.	**5 hours**
Chapter 6:Single phase induction machines:: Double field revolving theory, Equivalent circuit, Resistance split phase motors, capacitor start motor, permanent capacitor motor, two-value capacitor motor, shaded-pole motor. Performance and cost comparison and choice of single phase induction motors.	**5 hours**

Text Book

1. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons Publications, Canada, 2nd Edition, 2001.

References

1. Bhimbra, “Principles of Electrical machinery”, Khanna Publishers.2006.
2. D. P. Kothari and I. J. Nagrath, “Electrical Machines”, MGH Publishers. 4th Edition, 2011.
3. Fitzgerald, Kingsly & Stephen, “Electric Machinery”, 5ed., McGraw Hill, 1992

Course Code: 18EEEC301 **Course Title: Linear Integrated Circuits**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Chapter No.	Unit-I	
1	**Current Mirrors** Current Mirror circuits and Modeling, Figures of merit (output impedance, voltage swing), Widlar, Cascode and Wilson current Mirrors, Current source and current sink.	05 Hrs
2	**Basic OPAMP architecture** Basic differential amplifier, Common mode and difference mode gain, CMRR, 5-pack differential amplifier, 7-pack operational amplifier, Slew rate limitation, Instability and Compensation, Bandwidth and frequency response curve	06 Hrs
3	**OPAMP characteristics** Ideal and non-ideal OPAMP terminal characteristics, Input and output impedance, output Offset voltage, Small signal and Large signal bandwidth.	04 Hrs
	Unit-II	
4	**OPAMP with Feedback** OPAMP under Positive and Negative feedback, Impact Negative feedback on linearity, Offset voltage, Bandwidth, Input and Output impedances,Follower property, Inversion property	05Hrs
5	**Linear applications of OPAMP** DC and AC Amplifiers, Voltage Follower, Summing, Scaling and Averagingamplifiers (Inverting, Non-inverting and Differential configuration), Integrator, Differentiator, , Currentamplifiers, Instrumentation amplifier,Phase shifters, Voltage to current converter, Phase shift oscillator, Weinbridge oscillator, Active Filters –First and second order Low pass & High pass filters.	10 Hrs
	Unit-III	
6	**Nonlinear applications of OPAMP** Crossing detectors (ZCD. Comparator),Schmitt trigger circuits, Monostable & Astable multivibrator, Triangular/rectangular wave generators, Waveform generator, Voltage controlled Oscillator,Precisionrectifiers, Limiting circuits.Clamping circuits, Peak detectors, sample and hold circuits, Log and antilog amplifiers, Multiplier and divider Amplifiers, Voltage Regulators.	10 Hrs

Text Books

1 Sedra and Smith, “Microelectronics ”, 5th edition , Oxford University Press.
2 Ramakant A. Gayakwad, “Op - Amps and Linear Integrated Circuits”, 4th edition, PHI.

Reference Books:

1 Robert. F. Coughlin &Fredrick F. Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, PHI/Pearson, 2006.
2 James M. Fiore, “Op - Amps and Linear Integrated Circuits”, Thomson Learning, 2001
3 Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, TMH, 3e, 2005
4 David A. Bell, “Operational Amplifiers and Linear IC’s”, 2nd edition, PHI/Pearson, 2004

Laboratory Title: **Control System Lab** Lab. Code: **18EEEP302**
Total Hours: **32** Duration of Exam: **02**
Total Exam Marks: **20** Total ISA. Marks: **80**

Category: Demonstration	**Total Weightage: 10.00 No. of lab sessions: 2.00**
Expt./ Job No.	**Experiment/job Details**
1	Demonstration of heat tank simulator without controller using Labview Interactive learning model
2	Demonstration of temperature control of liquid tank simulator using Labview Interactive learning model
Category: Exercises	**Total Weightage: 40.00 No. of lab sessions: 5.00**
Expt./ Job No.	**Experiment/job Details**
1	Time response specifications of second order system
2	Frequency response of second order system
3	P,PI and PID controllers-effect on plant step response
4	Lag and Lead Compensators- determination of frequency response
5	Determination of Phase and Gain margin
Category: Structured Enquiry	**Total Weightage: 30.00 No. of lab sessions: 4.00**
Expt./ Job No.	**Experiment/job Details**
1.	Each batch consisting of 4 students work on a given design problem- To employ MATLAB to design compensator/controller for a system to meet given specifications and analyze the performance by simulating the time and frequency responses. To submit a technical report (consisting of objectives, specifications set, list of assumptions, design formulation, design calculations, simulation results, design validation)

Course Code: 18EEEE301 **Course Title: Object Oriented Programming with C++**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 03 hrs

Content	Hrs
Unit - 1	
Chapter 01: Introduction Principles of Object Oriented Programming, Procedure oriented and Object oriented Programming, Basic Concepts of OOP, Benefits and Applications of OOP, Beginning with C++, Simple C++ program, C++ with classes, Structure of C++ program, Creating, compiling and linking C++ programs.	4 hrs
Chapter 02: Classes and Objects Structures and Classes, Specifying a Class, Defining Member functions, C++ program with class, Access Specifiers, Scope Resolution Operators, Inline functions, Static Data Members, Static Member Functions, Friend Functions.	7 hrs
Chapter 03: Constructors and Destructors Introduction, Parameterized Constructors, Multiple Constructors, Copy Constructor, Dynamic Constructor, Destructors, Dynamic allocation of objects - new and delete operators.	4 hrs
Unit - 2	
Chapter 04: Inheritance Introduction, Defining Derived Classes, Types of Inheritance, Virtual Base Classes, Abstract Classes, Constructors in Derived Classes, Nesting of Classes.	6 hrs
Chapter 05: Virtual Functions and Polymorphism Pointers to objects, this pointer, Pointers to Derived classes, Virtual Functions. Pure Virtual Functions.	5 hrs
Chapter 06: Exception Handling Basics, Exception Handling Mechanism, Throwing, Catching and Rethrowing Exceptions.	4 hrs
Unit - 3	
Chapter 07: Function Overloading, Operator Overloading Function Overloading, Overloading Constructors, Defining operator Overloading, Unary and Binary operator overloading, Rules for overloading operators.	5 hrs
Chapter 08: Templates, STL Class Templates, Function Templates, Overloading of Template functions, Components of STL, Containers, Iterators, Application of Container Classes.	5 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. E.Balagurusamy, Object Oriented Programming with C++, 4th edition, Tata McGrawHill, 2008
2. Herbert Schildt, C++ The Complete Reference, Fourth Edition, Tata McGrawHill, 2003

References

1. Yashavant P. Kanetkar, Let Us C++, 1st, BPB Publications,
2. Stanley B.Lippmann, Josee Lajore, Barbara E. Moo, C++ Primer, 4th Edition, Pearson Education, 2005

Course Title: Digital System Design using Verilog Course Code: 18EEEP303
L-T-P: 0-0-2 Credits: 2 Contact Hours: 4Hrs/week
ISA Marks: 80 SEA Marks:20 Total Marks: 100
Teaching + Lab. Hours: 48 Hrs Examination Duration: 2 Hrs

1.	Chapter No. 1. Architecture of FPGA Architecture of FPGS: Spartan 3, What Is HDL, Verilog HDL Data Types and Operators.	4hrs
2.	Chapter No. 2. Data Flow Descriptions Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors, Testbench.	6 hrs
3.	Chapter No. 3. Behavioral Descriptions Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement, sequential statements, Tasks and Functions	10 hrs
4.	Chapter No. 4. Structural Descriptions Highlights of structural Description, Organization of the structural Descriptions, Binding, state Machines, Generate, Generic, and Parameter statements	10 hrs
5.	Chapter No. 5:Finite State Machine: Moore Machines, Mealy Machines	4hrs
6.	Chapter No. 6:Timing Issues in Digital Circuits: Setup Time Constraints, Hold Time Constraints, Static Time analysis, Critical Path, Clock Skew.	6hrs
7.	Chapter No. 7. Advanced HDL Descriptions File operations in Verilog, Memories: RAM, ROM, Block Memories(Xilinx IP)	8hrs

Course Code: 19EEEC401 **Course Title: Power System Modeling, Operation & Control**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Chapter No.	**Unit-I**	
1	**Formation of network matrices :**Multi-port power system representation, performance equations in bus frame of reference, definitions of Network models Ybus and Zbus, Primitive element representations, primitive performance equations,. Formation of Ybus by method of Inspection, Introduction to graph theory- definitions of terms, Bus incidence matrix, Ybus by the method of singular transformation, Examples on Ybus formation by singular transformation (with no mutual coupling) and Inspection method, Zbus building algorithm-addition of uncoupled branches and links, modification of Zbus for changes in elements not mutually coupled, Examples on Zbus formation	8 hrs
2	**Optimal load dispatch :** Importance and objective of economic load dispatch, Fuel cost and Incremental fuel cost, Optimal load allocation between plants neglecting transmission losses, Examples on optimal load allocation with and without generation constraints, Optimal load allocation considering transmission losses, General transmission loss formula, Examples.	7 hrs
	Unit-II	
3	**Load flow analysis :**Importance of Power flow, Classification of busses, General steps in load flow analysis, Off-nominal ratio tap changing ratio transformer representation. Bus voltage solution by Gauss and Gauss-Seidel methods without PV buses, Handling PV buses in Gauss-Seidel method, N-R load flow model in polar coordinates, formation of NR Jacobian, Introduction to FDLF load flow model, Comparison of Gauss-Seidel, NR and FDLF load flow methods, Examples on one iteration of load flow solution.	8 hrs
4	**Load frequency control :**Introduction to load frequency control problem, Working principle of speed governor, Model of isolated power system area –block diagram representation, Expression for steady-state frequency deviation, Parallel operation of generators –expression for operating frequency and load sharing,, two area load frequency control, steady-state operation of multi-area system under free governor operation, Examples on load sharing between areas.	7 hrs
	Unit-III	
5	**Reactive power and voltage control :** Power flow through a line, Relation between voltage, power and reactive power at a node, Brief descriptions of methods of voltage control-by injection of reactive power and tap changing transformer. Generator reactive power control by AVR-simplified AVR system model, AVR response.	5 hrs
6	**Power System Simulations:** Simulation of automatic generation control, simulation of small signal stability of a SMIB power system, Transient stability simulation of SMIB power system using trapezoidal integration, simulation of classical economic load dispatch Algorithm	5 hrs

Text Books

1 Stagg and El-Abid, Computer Methods in power system analysis, First Edition, Mc-Graw Hill, 1968

2 Kothari and Nagarath, Modern power system analysis, 3rd Edition, Tata McGraw Hill, 2004

Reference Books:

1 P. Kundur, Power system stability and control, First Edition, Tata McGraw Hill, 2007

2 Hadi Sadat, Power System analysis, Ed. First Edition, Tata McGraw Hill, 2002

3 A.R. Bergen and Vijay Vittal, Power system analysis, Ed. First Edition, Pearson Ed, 2009

Course Code: 19EEEE401 L-T-P: **3- 0- 0**
Course Title: **Flexible AC Transmission System (FACTS)** CIE Marks: **50**
Teaching Hrs: **40 hrs** SEE Marks: **50**

	UNIT I	Hrs
1.	**FACTS: Concept and General System Considerations:** Transmission Interconnection, Flow of power in AC system, Limits of loading capability, Power flow and dynamic stability consideration of a Transmission Interconnection, Relative importance of controllable parameters, and Basic types of FACTS controllers, Brief description and Definitions of FACTS controllers, Perspective: HVDC or FACTS	10 hrs
2.	**Voltage Sourced Converters:** Basic Concepts, Single Phase Full Wave Bridge Converter Operation, Single phase Leg operation, Three Phase Full Wave Bridge Converter, Transformer Connection for 12 pulse operation	05 hrs
	UNIT II	
3.	**Current Sourced Converters:** Basic concepts, Three phase full wave diode rectifier, Thyristor based converter Rectifier operation with gate turn ON, Current sourced converter with turn OFF devices, Current sourced versus Voltage sourced converter.	05 hrs
4.	**Objectives of Series and Shunt Compensation:** Objective of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators SVC STATCOM, Objective of Series Compensation, Static Series Compensators, GCSC, TSSC, TCSC and SSSC	10 hrs
	Unit – III	
5.	**Static Voltage, Phase Angle Regulators:** Objectives of Static Voltage and Phase Angle Regulators, Approach to Thyristor Controlled Voltage and Phase Angle Regulators, TCVR and TCPAR,	05hrs
6.	**Combined Compensators:** Unified Power Flow Controller UPFC and Interline Power Flow Controller IPFC.	05hrs

Text Book:
1. Narain G. Hingorani, and Laszlo Gyugyi., "*Understanding FACTS*", IEEE Press, Standard Publishers Distributors, Delhi, 200, ISBN 81 86308 79 2.

References Book:
1. K. R Padiyar, "*FACTS controllers in Power Transmission and Distribution",* New Age International Publishers, New-Delhi, 2007, ISBN 978 81 224 2142 2.

Course Code: 19EEEO401 **L-T-P:3-0-0**
Course Title: Wind and PV Electrical Energy Systems **CIE: 50 Marks**
SEE: 50 Marks **Teaching Hours: 42**

1.	**Introduction to Wind Energy Systems** Historical development of wind power, types of wind turbines, power in the wind.	**2 hrs**
2.	**Wind Turbine generators** Impact of tower height, maximum rotor efficiency, wind turbine generators, importance of variable rotor speeds, pole changing induction generators, multiple gear boxes, variable slip induction generators, indirect grid connection systems.	**5 hrs**
3.	**Average power in the wind** Discrete wind histogram, wind power probability density functions, Weibull and Rayleigh statistics, average power in the wind with Rayleigh statistics. Annual energy using average turbine efficiency, wind farms.	**8 hrs**
	Unit–II	
4.	**Specific wind turbine performance calculations** Aerodynamics, idealized wind turbine power curve, optimizing rotor diameter and generator rated power, wind speed cumulative distribution function, using real power curves with Weibull statistics, using capacity factor to estimate energy produced.	**5 hrs**
5.	**PV materials and electrical characteristics** Introduction, generic PV cell, cells to modules to arrays, PV I-V curve at STC, impacts of temperature and insolation on I-V curve, shading impacts on I-V curve	**5 Hrs**
6.	**PV systems** Introduction, current-voltage curves for loads, grid connected systems, grid connected PV system economics, stand-alone PV systems, PV power water pumping	**5 Hrs**
	Unit -III	
7.	**The solar resource** Solar spectrum, earth's orbit, altitude angle of the sun, solar position at any time of day, sun path diagrams, solar time and civil time, sun rise and sun set, clear sky direct beam radiation.	**5 Hrs**
8.	**Insolation and its measurement** Total insolation on a solar collecting surface, monthly clear sky insolation, solar radiation measurements, average monthly insolation.	**5 Hrs**

Text Book

1. Gillbert M Masters, Renewable and efficient Electric Power Systems, Wily Interscience, New Jersey, 2004.

References:

1. B. H. Khan, Non Conventional Energy Resources, TMH Publishers, New Delhi , 2006.

Course Code: 19EEEP403	**Course Title: Embedded Linux**	
L-T-P: 3-0-0	Credits: 03	Contact Hrs: 03
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 03 hrs

Content	Hrs
Unit - 1	
Chapter 01: Introduction to Embedded Linux: A Brief History of Linux -Benefits of Linux -Acquiring and Using Linux -Examining Linux Distributions - Devices and Drives in Linux-Components: Kernel, Distribution, Sawfish, and Gnome.	4 hrs
Chapter 02: Overview of Embedded Linux: Overview: Development-Kernel architectures and device driver model- Embedded development issues-Tool chains in Embedded Linux-GNU Tool Chain (GCC,GDB, MAKE, GPROF & GCONV)- Linux Boot process.	5 hrs
Chapter 03: System Management and user interface: Boot sequence-System loading, sys linux, Lilo, grub-Root file system-Binaries required for system operation-Shared and static Libraries overview-Writing applications in user space-GUI environments for embedded Linux system.	5 hrs
Unit - 2	
Chapter 04: File system in Linux: File system Hierarchy-File system Navigation -Managing the File system –Extended file systems-INODE-Group Descriptor-Directories-Virtual File systems- Performing File system Maintenance -Locating Files –Registering the File systems- Mounting and Unmounting –Buffer cache-/proc file systems-Device special files.	6 hrs
Chapter 05: Configuration: Configuration, Compilation & Porting of Embedded Linux-Examining Shells -Using Variables -Examining Linux Configuration Script Files -Examining System Start-up Files -Creating a Shell Script.	4 hrs
Chapter 06: Process management and Inter process communication: Managing Process and Background Processes -Using the Process Table to Manage Processes -Introducing Delayed and Detached Jobs - Configuring and Managing Services - Starting and Stopping Services -Identifying Core and Non-critical Services -Configuring Basic Client Services -Configuring Basic Internet Services –Working with Modules. IPC-Benefits of IPC- Basic concepts-system calls-creating pipes-creating a FIFO-FIFO operations-IPC identifiers-IPC keys-IPCS commands- Message queues-Message buffer-Kernel Ring Buffer semaphores-semtools-shared memory semtools- signals-sockets.	8 hrs
Unit - 3	
Chapter 07: Linux device drivers: Devices in Linux- User Space Driver APIs- Compiling, Loading and Exporting- Character Devices- Tracing and Debugging- Blocking and Wait Queues- Accessing Hardware-Handling Interrupts- Accessing PCI hardware- USB Drivers- Managing Time- Block Device Drivers- Network Drivers- Adding a Driver to the Kernel Tree.	8 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Embedded Linux – Hardware, Software and Interfacing - Craig Hollabaugh, Addison-Wesley Professional, 2002
2. Embedded / Real-Time Systems: Concepts, Design and Programming Black Book, New ed (MISL-DT) Paperback – 12 Nov 2003.

References

3. Building Embedded Linux Systems, Karim Yaghmour, First edition, April 2003.
4. Embedded Linux- John Lombardo, Newriders.com

Course Code: 18EEEP201 Title: Data Structure Using C Lab
L-T-P: **(0-0-3)** Credits:3 Contact Hrs: **4 hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Teaching Hrs: 48**hrs** Exam Duration: **3 hrs**

Chapter No.	**Unit-I**	
1	**Programming on pointer concepts**: Pointer concepts,1D and 2D arrays, pointers to functions, memory management functions	02+02 Hrs
2	**Programming on string handling functions using pointers, structures, bit-fields**: Perform string handling functions like String length, String concatenate, Strings compare, String copy and Strings reverse, Implementing Structures, union and bit-field.	02+02 Hrs
3	**Programming on files:** Open, Close, Read, Write and Append the file.	02+02 Hrs
4	**Programming on stack data structures and applications:** Insert delete and display an integer in a stack, Conversion from Infix to postfix & Infix to Prefix, Recursion.	02+02 Hrs
5	**Programming on queue data structures:** Insert at rear end ,delete at front end and display the integers in queue, Deque and circular queue.	02+02 Hrs
6	**Programming on linked lists:** Insert, delete and display a node in Singly Linked List, Doubly Linked List and Circular Linked List.	06+03 Hrs
7	**Programming on trees:** Perform various operations on binary trees, find max, min value in a binary search trees, find the height of a tree, count nodes in a tree, delete a node in a tree.	02+02 Hrs
8	**Programming on sorting:** Merge sort, Quick sort, Heap sort, Shell sort, Radix sort**.**	02+02 Hrs
9	**Programming on graphs:** Compare Breadth First Sort Sort, and Depth First Sort	02+02 Hrs
10	**Programming on hashing tables:** Implement different methods of hash tables.	02+02 Hrs
11	**Open ended experiment:** Implement given Data structures.	02+02 Hrs

Text Books

1 Horowitz, Sahani, Anderson-Feed, “Fundamentals of Data Structures in C”, 2ed,Universities Press, 2008

2 Aaron M. Tenenbaum , “Data Structures Using C”, Pearson Education India, 2003

3 Richard F. Gilberg, Behrouz A. Forouzan “Data Structures: A Pseudocode Approach With C”, 2nd Edition , Course Technology, Oct 2009.

Reference Books:

1 E Balaguruswamy, “The ANSI C programming Language”, 2ed., PHI, 2010.

2 Yashavant Kanetkar, “Data Structures through C”, BPB publications 2010

Course Code: 19EEEE301 **Course Title: CMOS VLSI Circuits**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Content	Hrs
Unit – 1	
Chapter No. 1. Introduction to VLSI and IC fabrication technology VLSI Design Flow, Semiconductor Technology - An Overview, Czochralski method of growing Silicon, Introduction to Unit Processes (Oxidation, Diffusion, Deposition, Ion-implantation), Basic CMOS technology - Silicon gate process, n-Well process, p-Well process, Twin-tub Process, Oxide isolation.	06 hrs
Chapter No. 2. Electronic Analysis of CMOS logic gates DC transfer characteristics of CMOS inverter, Beta Ratio Effects, Noise Margin, MOS capacitance models. Transient Analysis of CMOS Inverter, NAND, NOR and Complex Logic Gates, Gate Design for Transient Performance, Switch-level RC Delay Models, Delay Estimation, Elmore Delay Model, Power Dissipation of CMOS Inverter, Transmission Gates & Pass Transistors, Tristate Inverter.	14 hrs
Unit – 2	
Chapter No. 3. Design of CMOS logic gates Stick Diagrams, Euler Path, Layout design rules, DRC, Circuit extraction, Latch up – Triggering Prevention.	06 hrs
Chapter No. 4. Designing Combinational Logic Networks Gate Delays, Pseudo nMOS, Clocked CMOS, Dynamic CMOS Logic Circuits, Dual-rail Logic Networks: CVSL, CPL.	08 hrs
Unit – 3	
Chapter No. 5. VLSI Design Flow Structured Design Strategies: Hierarchy, Regularity, Modularity, Locality, SDEF Layout Flow, Case Study IC tape out.	06 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, 1, Wiley, 2007
2. Neil Weste, David Harris & Ayan Banerjee, CMOS VLSI Design, 3, Pearson Ed, 2005
3. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 3, Tata McGra, 2007

References

1. Wayne, Wolf, Modern VLSI design: System on Silicon, 3, Pearson Ed, 2005
2. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design, 3, PHI, 2005
3. Phillip. E. Allen, Douglas R. Holberg, CMOS Analog circuit Design, 1, Oxford University, 2002

Course Code: 19EEEE302 | Course Title: **Battery Management Systems**

L-T-P: 3-0-0 | Credits: 3 | Contact Hrs: 40

ISA Marks: 50 | ESA Marks: 50 | Total Marks: 100

Teaching Hrs: 40 | Exam Duration: 3 hrs

Content	**Hrs**
Unit – 1	
Chapter No. 1. Introduction: Introduction to electric vehicle & hybrid electric vehicle, types of batteries and their specific applications, Lithium-ion battery fundamentals: Battery Operation, Battery Construction, Battery Chemistry, Safety, Longevity, Performance, and Integration.	03 hrs
Chapter No. 2. Battery Models: Battery Models, Overview, self-Discharge Modeling, Thevenin Equivalent Circuit, Hysteresis, Coulombic Efficiency, Nonlinear Elements, parameter identification using SOC/OCV.	04hrs
Chapter No. 3. BMS (Black-box approach): Need for BMS, Typical inputs, typical outputs and typical functions Battery management system network in a typical electric vehicle.	02 hrs
Chapter No. 4. BMS Architectures: Monolithic, Distributed, Semi-Distributed, Connection Methods, Additional Scalability, Battery Pack Architectures.	02 hrs
Chapter No. 5. System Control: Contactor Control, Soft Start or Precharge Circuits, Control Topologies, Contactor Opening Transients, Chatter Detection, Economizers, Contactor Topologies, Contactor Fault Detection.	04 hrs
Unit – 2	
Chapter No. 6. Data acquisition (Measurement): Cell voltage, current and temperature measurement, Synchronization of Current and Voltage.	05 hrs
Chapter No. 7. Battery Management System Functionalities: CC/CV Charging Method, Target Voltage Method, Constant Current Method, Thermal Management, and Operational Modes.	03 hrs
Chapter No. 8. Charge Balancing(Cell balancing): Charge Balancing Strategies, Balancing Optimization, Charge Transfer Balancing, Flying capacitor.	05 hrs
Chapter No. 9. SoC Estimation: Columb counting, SoC corrections, OCV measurements, temperature compensation.	02 hrs
Unit – 3	
Chapter No. 10. BMS communications: Overview, Network Technologies ,I2C/SPI, RS-232 and RS-485 134, Local Interconnect Network, CAN 136 ,Ethernet and TCP/IP, Modbus, FlexRay, Network Design.	05 hrs
Chapter No. 11. Battery Safety: Functional Safety, Hazard Analysis, Safety Goals, Safety Concepts and Strategies, Reference Design for Safety.	05hrs

Text Books

1. Phillip Weicker *"A Systems Approach to Lithium-Ion Battery Management"* 2013, Artech house publisher

References

1. Jiuchun Jiang and Caiping Zhang, "*Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles*", John Wiley & Sons, 2015

Laboratory Title: **Electric Drives and Control Lab** Lab. Code: **19EEEP302**

Total Hours: **24** Duration of SEE Hours: 3

SEE Marks: **20** CIE Marks: **80**

Category: Demonstration	
Expt./ Job No.	**Experiment / Job Details**
1	Forward and Flyback DC-DC Converter
2	Single phase full bridge inverter
3	Half controlled Rectifier feeding R and RL load
4	Introduction to STEmbed Model based design and C-code generation for Power Electronics & Drives Application using TI's DSPs.
Category: Exercise	
Expt./ Job No.	**Experiment / Job Details**
1	Three phase full bridge controlled rectifier fed DC motor drive.
2	Fully controlled bridge rectifier feeding R and RL load
3	VSI based open loop volts/hertz control of three phase induction motor drive.
4	ADC, PWM pulse Generation and PI Controller design for PE and Drives application using STEmbed and TI's DSPs.
Category: Structured Enquiry	
Expt./ Job No.	**Experiment / Job Details**
1	To design, simulate and experimentally verify given drive system to meet defined specifications.

Course Code: 20EEEE401 Course Title: **Traction Systems for Electric Vehicles**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 40

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Motion and dynamic equations for vehicles Introduction to hybrid and electric vehicles, dynamics of hybrid and electric vehicles, motion and dynamic equations for hybrid and electric vehicles.	5 hrs
Chapter No. 2. Vehicle Power Plant and Transmission Characteristics The drive train configuration, Various types of vehicle power plants, The need of gearbox in a vehicle, The mathematical model of vehicle performance	5 hrs
Chapter No. 3: Basic Architecture of Electric Drive Trains Electric Vehicle Configuration, EV alternatives based on drivetrains, EV alternatives based on power source configuration, Single and Multi-motor drives in wheel drives	5 hrs
Unit - 2	
Chapter No. 4. Permanent Magnet Machines for Hybrid and Electric Vehicles Permanent Magnet (PM) Machines, Principle of Operation of PM Machine, Operation of PM Machine Supplied by DC-AC Converter with 120oMode of Operation, Operation of PM Machine Supplied by DC-AC Converter with 180oMode of Operation	7 hrs
Chapter No. 5. Permanent Magnet Machines suitability Electric Vehicles Relevance /operation of PM Motor specific to electric vehicles, Operation of PM Machine Supplied by DC-AC Converter with 120 degree Mode of Operation, Operation of PM Machine Supplied by DC-AC Converter with 180 degree Mode of Operation, Steady state characteristic operation of PM motor and importance of reluctance torque	8 hrs
Unit - 3	
Chapter No. 6. Control of PM machines Control Strategies of PM Machines, Constant Torque Angle Control, Constant Mutual Air gap Flux Linkage Control, Optimum Torque per Ampere Control	5 hrs
Chapter No. 7. Drive cycle analysis and sizing of Electric Machine for EVs and HEVs Power Train and Drive Cycles, New York City Cycle (NYCC), Federal Test Procedure (FTP-75), Sizing of Electric machine, Peak Torque and Power, Constant Power Speed Ratio, EM Sizing, Sizing Power Electronics	5 hrs

Text Book

1. Chris Mi and M Abul Masrur, "*Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*", John Wiley & Sons, 2018.

Course Code: 20EEEE402 **Course Title: Powertrain Control Laboratory**

L-T-P: 0-0-3	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

EV Laboratory (0-0-3) **Plan for 12 Weeks (12*6 = 72 Hours = 24 Lab sessions of 3 Hrs each)**	
Content	**Hrs**
1. **Introduction to Matlab-Simulink** (Numerical methods, configuration settings, data acquisition, data representation)	
2. Battery Modelling and Simulation a. Series and Parallel connection b. Charge and discharge curves of individual cell and battery pack. c. SoC algorithms d. Passive and Active Cell Balancing	(4 Sessions)
3. Mathematical Modelling and Simulation of Power Converters a. Bi-directional DC-DC converters (For interface between Inverter and battery) b. Three phase voltage source inverter (motor driver)	(3 Sessions)
4. dq Transformation theory a. Parks transformation b. Clarke's transformation	(1 sessions)
5. Induction Motor Drive a. dq Model of Three Phase Induction Machine b. Scalar Control (Constant Voltz/Hertz Law) c. Vector Control strategies i. Direct Torque Control ii. Field Oriented Control	(4 sessions)
6. PMBLDC Drive a. Model of BLDC motor b. Speed Control Strategies	(4 sessions)
7. PMSM Drive a. dq Model of PMSM machine b. Scalar Control (Constant Voltz/Hertz Law) c. Vector Control strategies i. Direct Torque Control ii. Field Oriented Control	(4 sessions)
Course Project (4 lab Sessions)	
1. System Integration and testing (End-to-End Simulation)	
2. Experimental Verification (Build sub modules throughout the semester)	

Laboratory Title: **Project** Lab. Code: 20EEEW401

Credits: L-T-P**: 0-0-14** Credits: 14 Duration of SEE Hours: 3

SEE Marks: **50** CIE Marks: **50**

Capstone Project Guidelines

(I) Preamble

A project work essentially gives the students a platform to integrate the concepts studied during the study, enhance their analytical capabilities and develop abilities to effectively communicate technical information in multiple formats. During the course of projects, students are asked to follow the research methodology in identifying a problem of their interest though literature survey, carry-out feasibility study, formulate the problem, develop mathematical models, select suitable solution technique etc. Students are also encouraged to develop new formulations, alternate solution techniques, study and apply new optimization algorithms, develop new simulation models and use modern engineering/simulation tools.

(II) Project batch and Guide

Each project batch consists of 3 or 4 students. Students will be informed to form their own batch based on the kind of project work and their interest. Each batch is supposed to give four faculty names as guides based on faculty expertise in the order of their preference. Guides will be allocated based on the preference given by the batch. The primary role of the guide is to supervise the work, give appropriate guidance in successfully carrying out the project work.

(III) Project implementation

The principal steps in carrying out the project work are summarized below:

Step-1: Selection of a specialized area for the project work

A specialized area in which the project work is to be carried out depends on the interest and specialized skills acquired by the project team. This includes areas such as power system analysis, power system dynamics, renewable energy, electric drives, VLSI & Embedded system, Power quality issues etc. The proposed work may include simulation studies, hardware implementation or both.

Step-2: Selection of topic based on literature survey

A literature survey in the selected specialized area is to be carried out in order to understand the state of the current research. Further, a critical review of the collected literature will facilitate to summarize key observations. Key observations will lead to identifying a specific problem for the project work in terms of alternate/new solution techniques, possible improvements, new formulations or models, hardware implementations etc.

Step-3: Prepare a synopsis

A synopsis highlights the definition of identified problem and its significance. The synopsis will also contain detailed literature review giving the state of the current research on the selected specialized area. It will also brief the problem formulation, solution methodology, tools employed and possible outcomes.

Step-4: Project implementation

The work is to be carried out in phase wise manner, testing or analyzing the partial results obtained. Guide will periodically monitor the progress of the work done giving suitable suggestions as required.

(IV) Schedule

Sl. No.	Activity	Week No.	Evaluation Objectives
1	Announcement to form the batches	At the end of the previous 7th sem	NA
2	Allotment of guides	1st - 2nd	NA
3	Submission of Synopsis	4th- 5th	Literature review, problem formulation, methodology by respective Guides
4	Review-I	6th - 8th	Literature review, problem formulation, methodology, tools used in the presence Review Committee
5	Review-II	9th -10th	Implementation and analysis done
6	Review-III	12th - 14th	Completion along with Hardware/ Software/ Report. Results and Conclusions.

(V) Evaluation

Evaluation of the project work carried out by each batch will be reviewed periodically by a review committee. Review committee consists of guide and two/ three other faculty members who are guiding other batches. Generally, two to three reviews will be held during a semester. However, each project batch will be supervised by the guide on a weekly basis. Review committee will evaluate for 40% and guide will evaluate for 60% of the total marks.

Activity	Assessment	Marks
ISA (50%)	Project Review committee	20
	Evaluation by Project Guide	30
ESA (50%)	Using ESA Rubrics	50
	Total	**100**

Passing: 40% both in ISA and ESA

Review Committee Evaluation Schedule

Activity	Week	Marks
Review I: Problem Definition	6th	05
Review II: Progress	8th	05
Review III: Results & Conclusions	12th	10
Guide Evaluation	12th	30
Total		**50**

In Semester Assessment (ISA)

Review	Phases of the project	PI	Marks
1	Identification of problem, Literature survey, Methodology	2.4.1	10 Marks
	Relevance of project topic literature review	2..4.1	
	Tools/ Software/ Hardware using	2.2.3	
	Team and Individual Work	9.2.1	
2	Develop models and simulate power/ energy/ electronics systems using appropriate engineering tools	13.1.1	10 Marks
	Presentation and communication skills	10.3.2	
	Design/ Development of solutions	3.4.1	
	Investigation of complex problems	4.3.4	
	Work done	2.2.3	
	Team and Individual Work	9.2.1	
3	Develop models and simulate power/ energy/ electronics systems using appropriate engineering tools	13.1.1	30 Marks
	Work done	2.2.3	
	Design/ Development of solutions	3.4.1	
	Investigation of complex problems	4.3.4	
	Analysis and Results	3.4.1	
	Team and Individual Work	9.2.1	
Total (Average of three reviews)			50 Marks

End Semester Assessment (ESA)

CAPSTONE PROJECT					
End Semester Assessment (ESA)	**Group Evaluation**		**PO Assessed**	**PI Assessed**	**Weightage**
	Relevance of project topic and Literature review	• Problem identification • Problem objectives and scope	2	2.2.3 2.4.1	30%
	Quality and Quantity of work reported	• Problem formulation • Contribution to the field of knowledge • Experimentation/simulation • Analysis of results • Drawing conclusions • Assumptions and justifications	2 3 4 13	2.4.2 13.1.1 3.4.1 4.3.4	40%
	Quality of presentation and report	• Organization of the report/presentation • Clarity of language • Clarity of illustrations and Tables	10	10.3.2	20%
	Individual Evaluation				
	Presentation/ Communication skills	• Clarity of language • Technical Knowled	10	10.3.2	5%
	Viva Voce	• Demonstration of clear understanding of the concept	10	10.3.2	5%

Course Title: Signals and Systems **Course Code: 19EEEC205**
L-T-P: 3-0-0 **Credits:3** **Contact Hours: 3Hrs/week**
ISA Marks: 50 **SEA Marks:50** **Total Marks: 100**
Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

1.	**Chapter No. 1. Introduction and Classification of signals:** Definition of signal and systems. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. Elementary signals/Functions: exponential, sine, impulse, step and its properties, ramp, rectangular, triangular. Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration, time scaling, time shifting and time folding. Systems: Definition, Classification: linear and nonlinear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	8hrs
2.	**Chapter No. 2. Time domain representation of LTI System:** Definition of impulse response, convolution sum, convolution integral ,computation of convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	7hrs
3.	**Chapter No. 3. Fourier Representation of Periodic Signals:** Fourier Representation of Periodic Signals: Introduction to CTFS and DTFS, definition, properties and basic problems.	5hrs
4.	**Chapter No. 4. Fourier Representation of aperiodic Signals:** FT representation of aperiodic CT signals, definition, FT of standard CT signals, Properties and their significance. FT representation of aperiodic discrete signals DTFT, definition, DTFT of standard discrete signals, Properties and their significance, Impulse sampling and reconstruction: Sampling theorem and reconstruction of signals.	10hrs
5.	**Chapter No. 5: Z-Transforms:** Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Implementation of discrete time of LTI systems.	10hrs

Text Book

1. Simon Haykin and Barry Van Veen, Signals and Systems –2nd Edition, John Wiley, 2004 .