VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus

M.TECH MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech MICRO ELECTRONICS AND CONTROL SYSTEMS (EMS)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20EEE11	Mathematical Methods in Control	03	--	02	03	40	60	100	4
2	PCC	20EMS12	Analysis of Linear Systems	03	--	02	03	40	60	100	4
3	PCC	20EMS13	VLSI Design	03	--	02	03	40	60	100	4
4	PCC	20EMS14	Embedded Systems	03	--	02	03	40	60	100	4
5	PCC	20EMS15	Industrial Control Technology - 1	03	--	02	03	40	60	100	4
6	PCC	20EMSL16	Microelectronics and Control Laboratory - 1	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20EMS21	Optimal Control Theory	03	--	02	03	40	60	100	4
2	PCC	20EMS22	High Speed VLSI Design	03	--	02	03	40	60	100	4
3	PCC	20EMS23	CAD Tools for VLSI Design	03	--	02	03	40	60	100	4
4	PEC	20EMS24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20EMS25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20EMSL26	Microelectronics and Control Laboratory - 2	--	04	--	03	40	60	100	2
7	PCC	20EMS27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20EMS24X	**Course title**	**Course Code under 20EMS25X**	**Course title**
20EMS241	Nonlinear Systems	20EMS251	Reset Control Systems
20EMS242	Process Control and Instrumentation	20EMS252	Robust Control Theory
20EMS243	Control Systems for HVAC	20EMS253	Digital System Design With VHDL
20EMS244	Neural and Fuzzy Logic Control of Drives	20EMS254	Internet-Based Control Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini –Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20EMS31	Industrial Control Technology - 2	03	--	02	03	40	60	100	4
2	PEC	20EMS32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20EMS33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20EMS34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20EMS35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20EMSI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under 20EMS32X	**Course title**	**Course Code under 20EMS33X**	**Course title**
20EMS321	Industrial Control - Software And Routines	20EMS331	Microelectronic Fabrication
20EMS322	Digital System Design With FPGA	20EMS332	Low Power VLSI Design
20EMS323	Real Time approach to Process Control	20EMS333	Nanotechnology for Microelectronics and Optoelectronics
20EMS324	Data Analytics for the Smart Grid	20EMS334	Cybersecurity in the Electricity Sector

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20EMS41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

MATHEMATICAL METHODS IN CONTROL			
Course Code	20EEE11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions. Matrix form of linear transformations-Illustrative examples. ■

Module-2

Solution of Systems of Linear Equations: Direct methods-Relaxation method, Partition method, Croute's Triangularisation method. Eigen values and Eigen vectors. Bounds on Eigen Values. Jacobi method & Givens method for symmetric matrices. ■

Module-3

Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. SVD and Applications. ■

Module-4

Probability: Random variables, Probability distributions: Binomial, Poisson, Normal distributions, Joint probability distribution (discrete and continuous)-Illustrative examples. ■

Module-5

Moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-examples. ■

Course outcomes:

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

1. Understand the fundamentals of vector space and bases in reference to transformations.
2. Solve system of linear equations using direct and iterative methods.
3. Use the idea of Eigen values and Eigen vectors for the application of SVD.
4. Describe the basic notions of discrete and continuous probability distributions.
5. Find out responses of linear systems using statistical and probability tools. ■

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

1. Linear Algebra and its Applications, David C.Lay et al, Pearson, 5th Edition, 2015.

2. Numerical Methods for Scientific and Engineering Computation, M. K. Jain et al, New Age International, 9th Edition, 2014.

Reference Books

1. Signals, Systems, and Inference, Alan V. Oppenheim and George C. Verghese, Spring, 2012.

2. Numerical methods for Engineers, Steven C Chapra and Raymond P Canale, McGraw-Hill, 7th Edition, 2015.

3. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44th Edition, 2017.

ANALYSIS OF LINEAR SYSTEMS			
Course Code	20EMS12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

State space Representation of Continuous Time Systems: Introduction, concepts of state, consistency conditions, State space representation using physical variables, phase variables, canonical variables. Eigen values, Eigen vectors, state equations for dynamic systems, Non-uniqueness of state model, state diagrams- state diagrams for continuous time state models. ■

Module-2

State Space Representation of Discrete Time Systems: Digital control system, quantizing and quantization error, Data acquisition and conversion, Impulse sampling and data hold, pulse transfer function, State space representation of discrete time systems, State diagrams - state diagrams for discrete time state models. ■

Module-3

Solution of State Equations: Introduction, Existence and Uniqueness of solution to continuous time state equations, Solution of Linear time invariant continuous time state equations – Evaluation of matrix exponential, series evaluation, Evaluation using symmetry transformation, Evaluation using Cayley- Hamilton technique, Evaluation using Inverse Laplace transformation. Solution of Discrete time state equations – Z transform approach, Pulse transfer function matrix, Discretization of continuous time state space equations. ■

Module-4

Controllability and Observability of Systems: Introduction, General Concept of Controllability, General Concept of Observability, Controllability Tests For Continuous Time Systems – Time Invariant Case, Observability Tests For Continuous Time Systems – Time Invariant Case, Controllability and Observability of Discrete Time Systems – Time Invariant Case

Controllability and Observability of State Model in Jordan Canonical Form. Loss of Controllability and Observability due to Sampling. ■

Module-5

Model Control: Introduction, Controllable and Observable Companion Forms – Single Input /Single Output Systems, Effect of State feedback on Controllability and Observability, Pole Placement by State Feedback- Single Input Systems, Stabilizability, Full Oder Observer, Reduced Order Observer, Deadbeat Observer. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text/Reference Books

1. Modern Control System Theory, M Gopal, New Age International, 2012 Reprint.

2. Discrete Time Control Systems, Ogata K, PHI, 2nd Edition, 2016.

VLSI DESIGN			
Course Code	20EMS13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

MOS Transistor Theory: MOS Transistors, CMOS Fabrication and Layout,Long – Channel I-V Characteristics, C-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics, Pitfalls and Fallacies.
CMOS Processing Technology: Introduction, CMOS Technologies, Layout Design Rules, CMOS Process Enhancements. ■

Module-2

Combinational Circuit Design: Introduction, Circuit Families, Circuit Pitfalls, More Circuit Families, Silicon-on-Insulator Circuit Design, Subthreshold Design, Pitfalls and Fallacies, Historical Perspective. ■

Module-3

Sequential Circuit Design: Introduction, Sequencing Static Circuits, Circuit Design of Latches and Flip-flops, Static Sequencing Element Methodology, Sequencing Dynamic Circuits, Synchronizers, Wave Pipelining, Pitfalls and Fallacies, Case study■

Module-4

Single Stage Amplifiers: Basic Concepts, Common – Source Stage, Source Follower, Common – Gate Stage, Cascode Stage, Choice of Device Models.
Differential Amplifiers: Single – Ended and Differential Operations, Basic Differential Pair, Common – Mode Response, Differential Pair with MOS Loads, Gilbert Cell.■

Module-5

Passive and Active Current Mirrors: Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.
Operational Amplifiers: General Considerations, One – Stage Op Amps, Two – Stage Op Amps, Gain Boosting, Comparison, Common – Mode Feedback, Input Range Limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps.■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text/Reference Books

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

EMBEDDED SYSTEMS			
Course Code	20EMS14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems – on –chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design of Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skill required for an Embedded System Designer.■

Module-2

Processor Architecture and Memory Organisation: 8051 Architecture, Real world Interfacing, Introduction to Advanced Architecture, Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory – Types, Memory – Maps and Addresses, Processor Selection, Memory Selection.■

Module-3

Devices and Communication Buses, Interrupt Services: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Device Protocols – Parallel Communication Network Using ISA,PCI, PCI –X and Advanced Protocols.

Device Drivers and Interrupts Service Mechanisms: Programmed – I/O Busy – wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing Mechanism, Direct Memory Access. ■

Module-4

Program Modelling concepts: Program Models, DFG Models, State Machine Programming Models for Event – controlled Program Flow, Modelling of Multiprocessor Systems, UML Modelling.

Interprocess Communication and Synchronization of Processes, Threads and Tasks: Multiple Processes in an Application, Multiple Threads in an Application, Tasks, Task Status, Task and Data, Clear – cut Distention Between Functions, ISRS and Tasks by their Characteristics, Concept of Semaphores, Shared Data, Interprocess Communication, Signal Function, Semaphore Functions, Message Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC Functions. ■

Module-5

Real - Time Operating Systems: OS Services, Process Management, Timer Functions, Event Functions, Memory management, Device, File and IO Subsystems Management , Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real – time Operating Systems, Basic Design Using an RTOS, Rtos Task Scheduling Models, Interrupt Latency and Response of the task as performance Metrics, OS Security Issues. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

<table>
<tr><th colspan="4">INDUSTRIAL CONTROL TECHNOLOGY - 1</th></tr>
<tr><td>Course Code</td><td>20EMS15</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Teaching Hours/Week (L:P:SDA)</td><td>3:0:2</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Credits</td><td>04</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">Module-1</td></tr>
<tr><td colspan="4">Industrial Control Systems: Embedded Control Systems, Real-Time Control Systems, Distributed Control System.
Industrial Control Engineering: Industrial Process Controls, Industrial Motion Controls, Industrial Production Automation. ■</td></tr>
<tr><td colspan="4">Module-2</td></tr>
<tr><td colspan="4">Sensors and Actuators: Industrial Optical Sensors, Industrial Physical Sensors, Industrial Measurement Sensors, Industrial Actuators. ■</td></tr>
<tr><td colspan="4">Module-3</td></tr>
<tr><td colspan="4">Transducers and Valves: Industrial Switches, Industrial Transducers, Industrial Valves. ■</td></tr>
<tr><td colspan="4">Module-4</td></tr>
<tr><td colspan="4">Microprocessors: Single-Core Microprocessor Units, Multicore Microprocessor Units. ■</td></tr>
<tr><td colspan="4">Module-5</td></tr>
<tr><td colspan="4">Programmable-Logic and Application-Specific Integrated Circuits (PLASIC): Fabrication Technologies and Design Issues, Field-Programmable-Logic Devices, Peripheral Programmable-Logic Devices. ■</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course outcomes:
At the end of the course the student will be able to:
• Differentiate between different types of industrial control systems; embedded control systems, real time control systems and distributed control systems.
• Explain three types of industrial control engineering; process control, motion control and production automation.
• Explain the need of sensors and actuators used in industrial control systems.
• Explain the working of transducers and valves used in industrial control systems.
• Explain the need of microelectronic components in industrial control systems
• Explain the use of multi-core microprocessors in industrial control systems.
• Describe programmable peripheral I/O ports, programmable interrupt controllers, programmable timers, and CMOS and DMA controllers, the application specific integrated circuits used in industrial control systems. ■</td></tr>
<tr><td colspan="4">Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
• The question paper will have ten full questions carrying equal marks.
• Each full question is for 20 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.
• The students will have to answer five full questions, selecting one full question from each module.</td></tr>
<tr><td colspan="4">Text Book</td></tr>
<tr><td colspan="4">1. Advanced Industrial Control Technology, Peng Zhang, Elsevier, 2010.</td></tr>
</table>

MICROELECTRONICS AND CONTROL LABORATORY - 1			
Course Code	20EMSL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

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

Course outcomes:

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

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

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, and Cautions in Using Chi Square Tests. ■

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

Course outcomes:

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.

2. Research Methodology a step-by-step guide for beginners, Ranjit Kumar, SAGE Publications, 3rd Edition, 2011. (For the topic Reviewing the literature under module 2),

3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

1. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

2. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END ***

OPTIMAL CONTROL THEORY			
Course Code	20EMS21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Problem Formulation, State Variable Representation of a System.
The Performance Measure: Performance Measure for Optimal Control Problems, Selecting a Performance Measure, Selection of a Performance Measure.
Dynamic Programming: The optimal Control Law, the Principle of Optimality, Application of the principle of Optimality to Decision- Making, Dynamic Programming applied to a Routing Problem, An Optimal Control System, Interpolation. ■

Module-2

Dynamic Programming (continued): A Recurrence Relation of Dynamic Programming, Computational Procedure for Solving Control Problems, Characteristics of Dynamic Programming Solution, Analytical Results – Linear Regulator Problems, The Hamilton- Jacobi-Bellman Equation, Continuous Linear Regulator Problem, The Hamilton- Jacobi-Bellman Equation – Some Observations.
The Calculus Of Variations: Fundamental Concepts, Functions of a Single Function. ■

Module-3

The Calculus of Variations (continued): Functionals involving several independent Functions, Piecewise – smooth Externals, Constrained Extrema.
The Variational Approach to Optimal Control Problems: Necessary Conditions for Optimal Control. ■

Module-4

The Variational Approach to Optimal Control Problems (continued): Linear regulator problem, Pontryagin's Minimum Principle and state Inequality Constraints, Minimum –Time problems. ■

Module-5

The Variational Approach to Optimal Control Problems (continued): Minimum Control-Effort Problems, Singular Intervals in Optimal Control Problems. ■

Course outcomes:

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

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

HIGH SPEED VLSI DESIGN			
Course Code	20EMS22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Preliminary Concepts: Interconnections for VLSI Applications, Copper Interconnections, Method of Images, Method of Moments, Even- and Odd-Mode Capacitances, Transmission Line Equations, Miller's Theorem, Inverse Laplace Transformation, Resistive Interconnection as Ladder Network, Propagation Modes in Micro strip Interconnection, Slow-Wave Mode Propagation, Propagation Delays.

Parasitic Resistances, Capacitances, and Inductances: Parasitic Resistances: General Considerations, Parasitic Capacitances: General Considerations, Parasitic Inductances: General Considerations, Approximate Formulas for Capacitances. ■

Module-2

Parasitic Resistances, Capacitances, and Inductances (continued): Green's Function Method: Using Method of Images, Green's Function Method: Fourier Integral Approach, Network Analog Method, Simplified Formulas for Interconnection Capacitances and Inductances on Silicon and GaAs Substrates, Inductance Extraction Using FastHenry, Copper Interconnections: Resistance Modeling, Electrode Capacitances in GaAsMESFET:Application of Program IPCSGV. ■

Module-3

Interconnection Delays: Metal–Insulator–Semiconductor Microstripline Model of an Interconnection, Transmission Line Analysis of Single-Level Interconnections, Transmission Line Analysis of Parallel Multilevel Interconnections, Analysis of Crossing Interconnections, Parallel Interconnections Modelled as Multiple Coupled Microstrips. ■

Module-4

Interconnection Delays (continued): Modelling of Lossy Parallel and Crossing Interconnections as Coupled Lumped Distributed Systems, Very High Frequency Losses in Microstrip Interconnection, Compact Expressions for Interconnection Delays, Interconnection Delays in Multilayer Integrated Circuits, Active Interconnections.

Crosstalk Analysis: Lumped-Capacitance Approximation, Coupled Multiconductor MIS Microstrip line Model of Single-Level Interconnections, Frequency-Domain Modal Analysis of Single-Level Interconnections. ■

Module-5

Crosstalk Analysis: Transmission Line Analysis of Parallel Multilevel Interconnections, Analysis of Crossing Interconnections, Compact Expressions for Crosstalk Analysis, Multiconductor Buses in GaAs High-Speed Logic Circuits.

Electromigration-Induced Failure Analysis: Electromigration in VLSI Interconnection Metallizations: Overview.■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

CAD TOOLS FOR VLSI DESIGN			
Course Code	20EMS23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

VLSI Physical Design Automation: VLSI Design Cycle, New Trends in VLSI Design Cycle, Physical Design Cycle, New Trends in Physical Design Cycle, Design Styles, System Packaging Styles.
Design and Fabrication of VLSI Devices: Fabrication Materials, Transistor Fundamentals, Fabrication of VLSI Circuits, Design Rules, Layout of Basic Devices. ■

Module-2

Data Structures and Basic Algorithms: Basic Terminology, Complexity Issues and NP-hardness, Basic Algorithms, Basic Data Structures, Graph Algorithms for Physical design. ■

Module-3

Partitioning: Problem Formulation, Classification of Partitioning Algorithms, Group Migration Algorithms, Simulated Annealing and Evolution, Other Partitioning Algorithms, Performance Driven Partitioning.
Floor planning and Pin Assignment: Floor planning, Chip planning, Pin Assignment, Integrated Approach. ■

Module-4

Placement: Problem Formulation, Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algorithms, Performance Driven Placement.
Global Routing: Problem Formulation, Classification of Global Routing Algorithms, Maze Routing Algorithms, Line-Probe Algorithms, Shortest Path Based Algorithms, Steiner Tree based Algorithms, Integer Programming Based Approach, Performance Driven Routing. ■

Module-5

Detailed Routing: Problem Formulation, Classification of Routing Algorithms, Single-Layer Routing Algorithms, Two-Layer Channel Routing Algorithms, Three-Layer Channel Routing Algorithms, Multi-Layer Channel Routing Algorithms, Switchbox Routing Algorithms. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

NONLINEAR SYSTEMS			
Course Code	20EMS241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Nonlinear Systems: Introduction to Nonlinear systems, Behavior of Nonlinear Systems- Frequency –Amplitude dependence, Jump resonance, Sub- harmonic oscillations, Frequency entrainment, Limit Cycles, Asynchronous quenching. Common Physical Non-linearities, Classification of nonlinearities, methods of analysis of nonlinear systems Definition of describing function, Linearization of nonlinear system. ■

Module-2

Describing Function Method: Introduction, assumptions and definition, evaluation of describing function for functions like x2, x3,|x|x and common nonlinearities like relay, saturation, dead zone, hysteresis, backlash and a combination of these, Analysis of nonlinear systems – Concept of enclosure, stable and unstable limit cycles, Review of polar plot and Nichols Plot, Evaluation of existence of limit cycle and calculation of magnitude and frequency of oscillation. ■

Module-3

Phase-Plane Analysis: Introduction to phase plane and phase trajectory, Singular points –evaluation, classification and trajectories, Stability analysis of nonlinear system using phase trajectories, Limit cycles in phase portrait, Construction of phase trajectories - Analytical method, Isocline method, Delta method, and Pell's method.■

Module-4

Lyapunov Stability: Stability Definitions, Some Preliminaries, Lyapunov's Direct Method, Stability of Linear Systems, Lyapunov's Linearization Method, The Lur'e Problem, Krasovskii;s method of stability assessment, Variable gradient method of stability assessment. Stability assessment of discrete time systems.■

Module-5

Stability Assessment in the Frequency Domain: Circle criteria and its application, Popov's method.
Sliding mode control: Introduction An overview of classical sliding mode control, introductory example, Dynamics in sliding mode – Linear Systems, Nonlinear Systems, Chattering Problems, Reachability Condition, Applications of Sliding mode control.■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Text/Reference Books

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

PROCESS CONTROL AND INSTRUMENTATION			
Course Code	20EMS242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Process Control: Introduction, Process Control, Definition of the Elements in a Control Loop, Instrumentation and Sensors, Control System Evaluation, Analog and Digital Data, Process Facility Considerations.
Units and Standards: Introduction, Basic Units, Units Derived from Base Units, Standard Prefixes, Standards.
Basic Electrical Components: Introduction, Circuits with R, L, and C, RC Filters, Bridge Circuits.
Analog Electronics: Introduction, Analog Circuits, Types of Amplifiers, Amplifier Applications. ■

Module-2

Digital Electronics: Introduction, Digital Building Blocks, Converters, Data Acquisition Devices,Basic Processor.
Microelectromechanical Devices and Smart Sensors: Introduction, Basic Sensors, Piezoelectric Devices, Microelectromechanical Devices, Smart Sensors Introduction.
Pressure: Introduction, Pressure Measurement, Measuring Instruments, Application Considerations.
Level: Introduction, Level Measurement, Application Considerations. ■

Module-3

Flow: Introduction, Fluid Flow, Flow Measuring Instruments, Application Considerations.
Temperature and Heat: Introduction, Temperature and Heat, Temperature Measuring Devices, Application Considerations.
Position, Force, and Light: Introduction, Position and Motion Sensing, Force, Torque, and Load Cells, Light. ■

Module-4

Humidity and Other Sensors: Humidity, Density and Specific Gravity, Viscosity, Sound, pH Measurements, Smoke and Chemical Sensors.
Regulators, Valves, and Motors: Introduction, Pressure Controllers, Flow Control Valves, Power Control, Motors, Application Considerations.
Programmable Logic Controllers: Introduction, Programmable Controller System, Controller Operation, Input/output Modules, Ladder Diagrams. ■

Module-5

Signal Conditioning and Transmission: Introduction, General Sensor Conditioning, Conditioning Considerations for Specific Types of Devices, Digital Conditioning, Pneumatic Transmission, Analog Transmission, Digital Transmission, Wireless Transmission.
Process Control: Introduction, Sequential Control, Discontinuous Control, Continuous Control,
Process Control Tuning, Implementation of Control Loops.
Documentation and P&ID: Introduction, Alarm and Trip Systems, PLC Documentation, Pipe and Instrumentation Symbols, P&ID Drawings. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Text Book

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

CONTROL SYSTEMS FOR HVAC			
Course Code	20EMS243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Control Theory and Terminology: Introduction, Elementary Control System, Purposes of Control, Control action, Energy Sources for Control, Systems, Measurement, Symbols and Abbreviations, Psychrometrics, Relationships.
Pneumatic Control Devices: Introduction, Pneumatic Control Devices, Control Cabinets, Air Supply.
Electric and Electronic Control: Devices, Electric Control Devices, Electronic Control Devices. ■

Module-2

Fluidic Control Devices: Introduction, Wall Attachment Devices, Turbulence Amplifiers, Vortex Amplifiers, Radial Jet Amplifier, Fluidic Transducers, Manual Switches.
Flow Control Devices: Dampers, Steam and Water Flow, Control Valves.
Elementary Control Systems: Introduction, Outside Air Controls, Air Stratification, Heating, Cooling Coils, Humidity Control, Dehumidifiers, Static Pressure Control, Electric Heat, Gas-Fired Heaters, Oil-Fired Heaters, Refrigeration Equipment, Fire and Smoke Control, Electrical Interlocks, Location of Sensors.■

Module-3

Complete Control Systems: Introduction, Single-Zone Systems, Multizone Air Handling Systems, Dual-Duct Systems, Variable-Volume Systems, Reheat Systems, Heat Reclaim, Fan-Coil Units, Induction Systems, Unit Ventilators, Packaged Equipment, Other Packaged Equipment, Radiant Heating and Cooling, Radiators and Convectors, Heat Exchangers, Solar Heating and Cooling Systems.■

Module-4

Electric Control Systems: Introduction, Electric Control Diagrams, Electrical Control of a Chiller, Electrical Control of an Air Handling Unit, Example: A Typical Small Air- Conditioning System, Electric Heaters, Reduced-Voltage Starters, Multispeed Starters, Variable Speed Controllers.
Special Control: Introduction, Close Temperature and/or Humidity Control, Controlled Environment, Rooms for Testing.
Digital and Supervisory Control Systems: Introduction, Hard-Wired Systems, Multiplexing Systems, Computer-Based Systems for Monitoring and Control, Benefits of the Computer System, Training for Maintenance and Operation. ■

Module-5

Psychrometrics: Introduction, Psychrometric Properties, Psychrometric Tables, Psychrometric Charts, Processes on the Psychrometric Chart, HVAC Cycles on the Chart, Impossible Processes, Effects of Altitude.
Central Plant Pumping and Distribution Systems: Introduction, Diversity, Constant Flow Systems, Variable Flow Systems, Distribution Systems, Building Interfaces.
Retrofit of Existing Control Systems: Introduction, Economic Analysis, Discriminators, Control Modes, Economy Cycle Controls, Single-Zone systems, Reheat Systems, Multizone Systems, Dual-Duct Systems, Systems with Humidity Control, Control Valves and Pumping Arrangements.
Dynamic Response And Tuning: Introduction, Dynamic Response, Tuning HVAC Control Loops. ■

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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

NEURAL AND FUZZY LOGIC CONTROL OF DRIVES			
Course Code	20EMS244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Modern control systems design using CAD techniques: Introduction, Control systems for AC drives, Electronic design automation (EDA), Application specific integrated circuit (ASIC) basics, Field programmable gate arrays (FPGAs), ASICs for power systems and drives, Electric motors.
Electric motors: Motors, Pulse width modulation, The space vector in electrical systems, Induction motor control. ■

Module-2

Elements of neural control: Neurone types, Artificial neural networks architectures, Training algorithms, Control applications of ANNs, Neural network implementation.
Neural FPGA implementation: Neural networks design and implementation strategy, Universal programs FFANN, hardware implementation, Hardware implementation complexity analysis. ■

Module-3

Fuzzy logic fundamentals: Introduction, Fuzzy sets and fuzzy logic, Types of membership functions, Linguistic variables, Fuzzy logic operators, Fuzzy control systems, Fuzzy logic in power and control, Applications.
VHDL fundamentals: Introduction, VHDL design units, Libraries, visibility and state system in VHDL, Sequential statements, Concurrent statements, Functions and procedures, Advanced features in VHDL. ■

Module-4

Neural current and speed control of induction motors: The induction motor equivalent circuit, The current control algorithm, The new sensorless motor control Strategy. .■

Module-5

Neural current and speed control of induction motors (continued): Induction motor controller VHDLDesign, FPGA controller experimental results.■

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

- Discuss control strategies for electric drives/power systems.
- Understand the complex features of control strategies, EDA, neural networks, fuzzy logic, electric machines and drives, power systems and VHDL. ■

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1. Neural and Fuzzy Logic Control of Drives and Power Systems, M.N. Cirstea, et al, Newnes, 2002.

RESET CONTROL SYSTEMS			
Course Code	20EMS251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Motivation of reset control, Basic concepts of RCSs, Fundamental theory of traditional reset design. ■

Module-2

Describing function analysis of reset systems: Sinusoid input response, Describing function, Application to HDD systems. ■

Module-3

Stability of reset control systems: Preliminaries, Quadratic stability, Stability of RCSs with time-delay, Reset times-dependent stability, Passivity of RCSs. ■

Module-4

Robust stability of reset control systems: Definitions and assumptions, Quadratic stability, Affine quadratic stability, Robust stability of RCS with time-delay, Examples.
RCSs with discrete-time reset conditions: Preliminaries and problem setting, Stability analysis, A heuristic design method, Application to track-seeking control of HDD systems. ■

Module-5

Reset control systems with fixed reset instants: Stability analysis, Moving horizon optimization, Optimal reset law design, Application to HDD systems, Application to PZT-positioning stage.
Reset control systems with conic jump sets: Basic idea, L 2 -gain analysis. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

1. Analysis and Design of Reset Control Systems, YuqianGuo et al, IET, 2015.

ROBUST CONTROL THEORY			
Course Code	20EMS252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Systems and Control, Modern Control Theory, Stability, Optimal Control, Optimal Control Approach, Kharitonov Approach, H_∞ and H_2 Control, Applications.
Optimal Control and Optimal Observers: Optimal Control Problem, Principle of Optimality, Hamilton–Jacobi–Bellman Equation, Linear Quadratic Regulator Problem, Kalman Filter. ■

Module-2

Robust Control of Linear Systems: Introduction, Matched Uncertainty, Unmatched Uncertainty, Uncertainty in the Input Matrix. ■

Module-3

Robust Control of Nonlinear Systems: Introduction, Matched Uncertainty, Unmatched Uncertainty, Uncertainty in the Input Matrix.
Kharitonov Approach: Introduction, Preliminary Theorems, Kharitonov Theorem, Control Design Using Kharitonov Theorem. ■

Module-4

H_∞ and H_2 Control: Introduction, Function Space, Computation of H_∞ and H_2 Norms, Robust Control Problem as H_∞ and H_2 Control Problem, H_∞ / H_2 Control Synthesis. ■

Module-5

Robust Active Damping: Introduction, Problem Formulation, Robust Active Damping Design, Active Vehicle Suspension System.
Robust Control of Manipulators: Robot Dynamics, Problem Formulation, Robust Control Design, Simulations.
Aircraft Hovering Control: Modelling and Problem Formulation, Control Design for Jet-borne Hovering, Simulation. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

DIGITAL SYSTEM DESIGN WITH VHDL			
Course Code	20EMS253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Modern digital design, CMOS technology, Programmable logic, Electrical properties.
Combinational logic design: Boolean algebra, Logic gates, Combinational logic design, Timing, Number codes.
Combinational logic using VHDL gate models: Entities and architectures, Identifiers, spaces and comments, Netlists, Signal assignments, Generics, Constant and open ports, Testbenches, Configurations. ■

Module-2

Combinational building blocks: Three-state buffers, Decoders, Multiplexers, Priority encoder, Adders, Parity checker, Testbenches for combinational blocks.
Synchronous sequential design: Synchronous sequential systems, Models of synchronous sequential systems, Algorithmic state machines, Synthesis from ASM charts, State machines in VHDL, VHDL testbenches for state machines. ■

Module-3

VHDL models of sequential logic blocks: Latches, Flip-flops, JK and T flip-flops, Registers and shift registers, Counters, Memory, Sequential multiplier, Testbenches for sequential building blocks.
Complex sequential systems: Linked state machines, Datapath /controller partitioning, Instructions, A simple microprocessor, VHDL model of a simple microprocessor. ■

Module-4

VHDL simulation: Event-driven simulation, Simulation of VHDL models, Simulation modelling issues, File operations.
VHDL synthesis: RTL synthesis, Constraints, Synthesis for FPGAs, Behavioural synthesis, Verifying synthesis results.
Testing digital systems: The need for testing, Fault models, Fault-oriented test pattern generation, Fault simulation, Fault simulation in VHDL. ■

Module-5

Design for testability: Ad hoc testability improvements, Structured design for test, Built-in self-test, Boundary scan (IEEE 1149.1).
Asynchronous sequential design: Asynchronous circuits, Analysis of asynchronous circuits, Design of asynchronous sequential circuits, Asynchronous state machines, Setup and hold times and metastability.
Interfacing with the analogue world: Digital to analogue converters, Analogue to digital converters, VHDL-AMS, Phase-locked loops, VHDL-AMS simulators. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

INTERNET-BASED CONTROL SYSTEMS			
Course Code	20EMS254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Networked Control Systems (NCS), Internet-based Control Systems (ICS), Challenges of NCS/ICS.
Requirements Specification for Internet-based Control Systems: Introduction, Requirements Specification, Functional Modelling of Internet-based Control Systems, Information Hierarchy, Possible Implementation of Information Architecture.
Internet-based Control System Architecture Design: Introduction, Traditional Bilateral Tele-operation Systems, Remote Control over the Internet, Canonical Internet-based Control System Structures.
Web-based User Interface Design: Features of Web-based User Interface, Multimedia User Interface Design, Case Study. ■

Module-2

Real-time Data Transfer over the Internet: Real-time Data Processing, Data Wrapped with XML, Real-time Data Transfer Mechanism, Case Study.
Dealing with Internet Transmission Delay and Data Loss from the Network View: Requirements of Network Infrastructure for Internet-based Control, Features of Internet Communication, Comparison of TCP and UDP, Network Infrastructure for Internet-based Control, Typical Implementation for Internet-based Control. ■

Module-3

Dealing with Internet Transmission Delay and Data Loss from the Control Perspective: Overcoming the Internet Transmission Delay, Control Structure with the Operator Located Remotely, Internet-based Control with a Variable Sampling Time, Multi-rate Control, Time Delay Compensator Design, Simulation Studies, Experimental Studies.
Design of Multi-rate SISO Internet-based Control Systems: Introduction, Discrete-time Multi-rate Control Scheme, Design Method, Stability Analysis, Simulation Studies, Real-time Implementation. ■

Module-4

Design of Multi-rate MIMO Internet-based Control Systems: Introduction, System Modeling, Controller Design, Stability Analysis, Design Procedure, Model-based Time Delay Compensation, Simulation Study.
Safety and Security Checking: Introduction, Similarity of Safety and Security, Framework of Security Checking, Control Command Transmission Security, Safety Checking, Case Study. ■

Module-5

Remote Control Performance Monitoring and Maintenance over the Internet: Introduction, Performance Monitoring, Performance Monitoring of Control Systems, Remote Control Performance Maintenance, Case Study.
Remote Control System Design and Implementation over the Internet: Introduction, Real-time Control System Life Cycle, Integrated Environments, A Typical Implementation of the General Integrated Environment, Case Study. ■

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

- Discuss requirements for Internet-based control systems and to building a functional model, traditional tele-operation systems and Web-based user interface design.
- Discuss Real-time Data Transfer over the Internet dealing with Internet Transmission Delay and Data Loss from the Network View and Control perspective.
- Discuss design of Multi-rate SISO and MIMO Internet-based Control Systems and Safety and Security Checking.
- Explain the basic concepts and general guidelines of control system performance monitoring, remotely designing, testing, and updating real-time control software through the Internet.■

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1. Internet-based Control Systems: Design and Applications, Shuang - Hua Yang, Springer-Verlag, 2011.

MICROELECTRONICS AND CONTROL LABORATORY - 2			
Course Code	20EMSL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

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

Course outcomes:

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

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

TECHHNICAL SEMINAR			
Course Code	20EMS27	CIE Marks	100
Number of contact Hours/week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

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

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

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

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

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

Marks distribution for CIE of the course 20EMS27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END ***

INDUSTRIAL CONTROL TECHNOLOGY - 2			
Course Code	20EMS31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Industrial Intelligent Controllers: PLC (Programmable Logic Control) Controllers, CNC (Computer Numerical Control) Controllers, FLC (Fuzzy Logic Control) Controllers. ■

Module-2

Industrial Process Controllers: PID (Proportional-Integral-Derivative) Controllers,BPC (Batch Process Control) Controllers,SMC (Servo Motion Control) Controllers.
Industrial Computers: Introduction, Industrial Computer Classes and Configurations,Industrial Computer Peripherals and Accessories.■

Module-3

Industrial Control Networks: Controller Area Network (CAN), Supervisory Control and Data Acquisition (SCADA) Network, Industrial Ethernet Network, Industrial Enterprise Networks.■

Module-4

Networking Devices: Hubs and Switches, Network Routers, Bridges, Gateways and Repeaters.■

Module-5

Human–machine interfaces: Human–Machine Interactions, User–Machine Interfaces, Industrial Application Examples.
Data Transmission Interfaces: Data Transmission Basics, Data Transmission I/O Devices,Data Transmission Control Devices. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

1. Advanced Industrial Control Technology, Peng Zhang, Elsevier, 2010.

INDUSTRIAL CONTROL - SOFTWARE AND ROUTINES			
Course Code	20EMS321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Microprocessor Boot Code: Code Structures, Single-Processor Boot Sequences, Multiprocessor Boot Sequences.
Real-Time Operating Systems: Introduction, Task Controls, Input /Output Device Drivers.■

Module-2

Real-Time Operating Systems (continued): Interrupts, Memory Management, Event Brokers, Message Queue, Semaphores, Timer.■

Module-3

Distributed Operating Systems: Multiprocessor Operating Systems,Multicomputer Operating Systems, Distributed and Parallel Facilities.■

Module-4

Industrial Control System Operation Routines: Self-Test Routines, Install and Configure Routines, Diagnosis Routines, Calibration Routines.■

Module-5

Industrial Control System Simulation Routines: Modelling and Identification, Simulation and Control, Software and Simulator.■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

1. Advanced Industrial Control Technology, Peng Zhang, Elsevier, 2010.

DIGITAL SYSTEM DESIGN WITH FPGA			
Course Code	20EMS322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Programmable Logic: Introduction, Electronic Circuits: Analogue and Digital, Programmable Logic versus Discrete Logic, Programmable Logic versus Processors, Types of Programmable Logic, PLD Configuration Technologies, Programmable Logic Vendors, Programmable Logic Design Methods and Tools, Technology Trends.

Design Languages: Introduction, Software Programming Languages, Hardware Description Languages, SPICE, System C ^{R}, System Verilog, Mathematical Modelling Tools. ■

Module-2

Electronic Systems Design: Introduction, Sequential Product Development Process versus Concurrent Engineering Process, Flowcharts, Block Diagrams, Gajski-Kuhn Chart, Hardware-Software Co-Design, Formal Verification, Embedded Systems and Real-Time Operating Systems, Electronic System-Level Design, Creating a Design Specification, Unified Modelling Language, Reading a Component Data Sheet, Digital Input/Output, Parallel and Serial Interfacing, System Reset, System Clock, Power Supplies, Power Management, Printed Circuit Boards and Multichip Modules, System on a Chip and System in a Package, Mechatronic Systems, Intellectual Property, CE and FCC Markings. ■

Module-3

Introduction to Digital Logic Design with VHDL: Introduction, Designing with HDLs, Design Entry Methods, Logic Synthesis. Entities, Architectures, Packages, and Configurations, A First Design, Signals versus Variables, Generics, Reserved Words, Data Types, Concurrent versus Sequential Statements, Loops and Program Control, Coding Styles for VHDL, Combinational Logic Design. ■

Module-4

Introduction to Digital Logic Design with VHDL (continued): Sequential Logic Design, Memories Unsigned versus Signed Arithmetic - Adder Example. Multiplier Example.

Testing the Design: Introduction, Integrated Circuit Testing, Printed Circuit Board Testing, Boundary Scan Testing, Software Testing. ■

Module-5

Digital-to-Analogue Conversion, and Power Electronics: Introduction, Digital-to-Analogue Conversion, Analogue-to-Digital Conversion, Power Electronics, Heat Dissipation and Heat sinks. Operational Amplifier Circuits.

System-Level Design: Introduction, Case Study-DC Motor Control. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

REAL TIME APPROACH TO PROCESS CONTROL			
Course Code	20EMS323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Control, simulation, and Process control hardware fundamentals: Control, Simulation, Control system components, Primary elements, Final control elements. ■

Module-2

Fundamentals of single input–single output systems: Open-loop control, Disturbances, Feedback control overview, Feedback control: a closer look, Process attributes: capacitance and dead time, Process dynamic response, Process modelling and simulation.■

Module-3

Basic control modes: On–off control, Proportional (P-only) control, Integral (I-only) control, Proportional plus integral (PI) control, Derivative action, Proportional plus derivative (PD) controller, Proportional integral derivative (PID) control, Choosing the correct controller, Controller hardware.
Tuning feedback controllers: Quality of control and optimisation, Tuning methods. ■

Module-4

Advanced topics in classical automatic control: Cascade control, Feedforward control, Ratio control, Override control (auto selectors).
Common control loops: Flow loops, Liquid pressure loops, Liquid level control, Gas pressure loops, Temperature control loops, Pump control, Compressor control, Boiler control. ■

Module-5

Distillation column control: Basic terms, Steady-state and dynamic degrees of freedom, Control system objectives and design considerations, Methodology for selection of a controller structure, Level, pressure, temperature and composition control, Optimizing control, Distillation control scheme design using steady-state models, Distillation control scheme design using dynamic models.
Using steady-state methods in a multi-loop control scheme: Variable pairing, The relative gain array, Niederlinski index, Decoupling control loops, Tuning the controllers for multi-loop systems, Practical examples.
Plant-wide control: Short-term versus long-term control focus, Cascaded units, Recycle streams, General considerations for plant-wide control. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

DATA ANALYTICS FOR THE SMART GRID			
Course Code	20EMS324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Putting the Smarts in the Smart Grid: Goal, The Imperative for the Data-Driven Utility, Big Data: We'll Know It When We See It, What Are Data Analytics? Starting from Scratch, Finding Opportunity with Smart Grid Data Analytics.
Building the Foundation for Data Analytics: Chapter Goal, Perseverance Is the Most Important Tool, Building the Analytical Architecture.
Transforming Big Data for High-Value Action: Goal, The Utility as a Data Company, Algorithms, Seeing Intelligence, Assessing the Business Issues. ■

Module-2

Applying Analytical Models in the Utility: Goal, Understanding Analytical Models, Using Descriptive Models for Analytics, Using Diagnostic Models for Analytics, Predictive Analytics, Prescriptive Analytics, An Optimization Model for the Utility, Toward Situational Intelligence.
Enterprise Analytics: Goal, Moving Beyond Business Intelligence.
Operational Analytics: Goal, Aligning the Forces for Improved Decision-Making, The Opportunity for Insight, Focus on Effectiveness, Distributed Generation Operations: Managing the Mix-Up, Grid Management, Resiliency Analytics, Extracting Value from Operational Data Analytics. ■

Module-3

Customer Operations and Engagement Analytics: Goal, Increasing Customer Value, What's in It for the Customer?
Analytics for Cybersecurity: Goal, Cybersecurity in the Utility Industry, The Role of Big Data Cybersecurity Analytics.
Sourcing Data: Goal, Sourcing the Data, Working with a Variety of Data Sources. ■

Module-4

Big Data Integration, Frameworks, and Databases: Goal, This Is Going to Cost, Storage Modalities, Data Integration, The Costs of Low-Risk Approaches, Let the Data Flow, Other Big Data Databases, The Curse of Abundance.
Extracting Value: Goal, We Need Some Answers Here, Mining Data for Information and Knowledge, The Process of Data Extraction, Stream Processing, Avoid Irrational Exuberance. ■

Module-5

Envisioning the Utility: Goal, Big Data Comprehension, Why Humans Need Visualization, The Role of Human Perception, The Utility Visualized, Making Sense of It All.
A Partnership for Change: Goal, With Big Data Comes Big Responsibility, Privacy, Not Promises, Privacy Enhancement, The Utility of the Future Is a Good Partner. ■

Course outcomes:

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

- Discuss the key role of data analytics; its architecture and the challenges of creating and implementing them.
- Discuss useful analytical models, traditional business functions and issues affecting how analytics are used in the control room.
- Discuss the methods to increase residential customer lifetime value, vulnerabilities, threats, and analytic approaches to responding to cyber warfare against the utility,
- Discuss the elements of big data infrastructure, their difficulties and benefits in adapting to the needs of high-volume and varied data types,
- Explain the basic concepts of data visualization and the importance of utility becoming trusted steward of big data. ■

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1. Big Data Analytics Strategies for the Smart Grid, Carol L. Stimmel, CRC Press, 2015.

MICROELECTRONIC FABRICATION			
Course Code	20EMS331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Historical Perspective, Overview of Monolithic Fabrication, Metal – Oxide Semiconductor (MOS) Process, Basic Bipolar Process, Safety.

Lithography: The Photolithographic Process, Etching Techniques, Photomask Fabrication, Exposure Systems, Exposure Sources, Optical and Electron Microscopy.

Thermal Oxidation of Silicon: The Oxidation Process, Modelling Oxidation, Factors Influencing Oxidation Rate, Dopant Redistribution during Oxidation, Masking Properties of Silicon Dioxide, Technology of Oxidation, Oxide Quality, Selective Oxidation and Shallow Trench Formation, Oxide Thickness Characterization, Process Simulation. ■

Module-2

Diffusion: TheDiffusion Process, Mathematical Model for Diffusion, The Diffusion Coefficient, Successive Diffusions, Solid – Solubility Limits, Junction Formation and Characterization, Sheet Resistance, Generation – Depth and Impurity Profile Measurement, Diffusion Simulation, Diffusion Systems, Gettering. ■

Module-3

Ion Implantation: Implantation Technology, Mathematical Model for Ion Implantation, Selective Implantation, Junction Depth and Sheet Resistance, Channeling, Lattice, Damage and Annealing, Shallow Implantations.

Film Deposition: Evaporation, Sputtering, Chemical Vapour Deposition, Epitaxy.

Interconnections and Contacts: Interconnections in Integrated Circuits, Metal Interconnections and Contact Technology, Diffused Interconnections, Polysilicon Interconnections and Buried Contacts, Silicides and Multilayer – Contact Technology, The Liftoff Process, Multilevel Metallization, Copper Interconnects and Damascene Process. ■

Module-4

Packaging and Yield: Testing, Water Thinning and Die Separation, Die Attachment, Wire Bonding, Packages, Flip – Chip and tape – Automated – Bonding Process, Yield.

MOS Process Integration: Basic MOS Device Considerations, MOS Transistor Layout and Design Rules, Complementary MOS (CMOS) Technology, Silicon on Insulator. ■

Module-5

Bipolar Process Integration: The Junction – Isolated Structure, Current Gain, Transit Time, Base Width, Breakdown Voltages, Other Elements in SBC Technology, Layout Considerations, Advanced Bipolar Structure, Other Bipolar Insulation Techniques, BICMOS.

Process for Microelectromechanical Systems (MEMS): Mechanical Properties of Silicon, Bulk Micromachining, Silicon Etchants, Surface Micromachining, High – Aspect – Ratio Micromachining, Silicon Wafer Bonding, IC Process Compatibility. ■

Course outcomes:

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

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

Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.
Text Book
1. Introduction to Microelectronic Fabrication, Richard C Jaeger, Prentice Hall, 2nd Edition, 2002.

LOW POWER VLSI DESIGN			
Course Code	20EMS332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Low Power VLSI Chips: Introduction, Needs for Low Power VLSI Chips, Charging and Discharging Capacitance, Short-circuit Current in CMOS Circuit, CMOS Leakage Current, Static Current, Basic Principles of Low Power Design, Low Power Figure of Merits.
Simulation Power Analysis: SPICE Circuit Simulation, Discrete Transistor Modelling and Analysis, Gate-level Logic Simulation, Architecture-level Analysis, Data Correlation Analysis in DSP Systems, Monte Carlo Simulation. ■

Module-2

Probabilistic Power Analysis: Random Logic Signals, Probability and Frequency, Probabilistic Power Analysis Techniques, Signal Entropy. ■

Module-3

Circuit: Transistor and Gate Sizing, Equivalent Pin Ordering, Network Restructuring and Reorganization, Special Latches and Flip-flops, Low Power Digital Cell Library, Adjustable Device Threshold Voltage. ■

Module-4

Logic: Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Precomputation Logic.
Special Techniques: Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing, Low Power Techniques for SRAM. ■

Module-5

Architecture and System: Power and Performance Management, Switching Activity Reduction, Parallel Architecture with Voltage Reduction, Flow Graph Transformation.
Advanced Techniques: Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits. ■

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

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

1. Practical Low Power Digital VLSI Design, Gary Yeap, Springer, 1998.

NANOTECHNOLOGY FOR MICROELECTRONICS AND OPTOELECTRONICS			
Course Code	20EMS333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Mesoscopic Physics and Nanotechnologies: Trends in nanoelectronics and Optoelectronics, Characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Quantum wells, wires, and dots, Density of states and dimensionality, Semiconductor heterostructures, Quantum transport.

Survey of Solid State Physics: Introduction, review of quantum mechanics, free electron model of a solid. Density of states function, Bloch theorem, Electrons in crystalline solids, Dynamics of electrons in bands, Lattice vibrations, Phonons. ■

Module-2

Review of Semiconductor Physics: Introduction, Energy bands in typical semiconductors, Intrinsic and extrinsic semiconductors, Electron and hole concentrations in semiconductors, Elementary transport in semiconductors, Degenerate semiconductors, Optical properties of semiconductors.

The Physics of Low-Dimensional Semiconductors: Introduction, Basic properties of two-dimensional semiconductor nanostructures, Square quantum well of finite depth, Parabolic and triangular quantum wells, Quantum wires, Quantum dots, Strained layers, Effect of strain on valence bands, Band structure in quantum wells, Excitonic effects in quantum. ■

Module-3

Semiconductor Quantum Nanostructures and Superlattices: Introduction, MOSFET structures, Heterojunctions, Quantum wells, Superlattices.

Electric Field Transport in Nanostructures: Introduction, Parallel transport, Perpendicular transport, Quantum transport in nanostructures. ■

Module-4

Transport in Magnetic Fields and the Quantum Hall Effect: Introduction, Effect of a magnetic field on a crystal, Low-dimensional systems in magnetic fields, Density of states of a 2D system in a magnetic field, The Aharonov–Bohm effect, The Shubnikov–de Haas effect, The quantum Hall Effect.

Optical and Electro-optical Processes in Quantum Heterostructures: Introduction,
Optical properties of quantum wells and superlattices, Optical properties of quantum dots and nanocrystals, Electro-optical effects in quantum wells. Quantum confined Stark Effect, Electro-optical effects in superlattices. Stark ladders and Bloch Oscillations. ■

Module-5

Electronic Devices Based on Nanostructures: Introduction, MODFETs, Heterojunction bipolar transistors, Resonant tunnel effect, Hot electron transistors, Resonant tunneling transistor, Single electron transistor.

Optoelectronic Devices Based on Nanostructures: Introduction, Heterostructure semiconductor lasers, Quantum well semiconductor lasers, Vertical cavity surface emitting lasers (VCSELs), Strained quantum well lasers, Quantum dot lasers, Quantum well and superlattice photodetectors, Quantum well modulators. ■

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book

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

CYBERSECURITY IN THE ELECTRICITY SECTOR			
Course Code	20EMS334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Transformation, Dependence on the ICT, 8Cybersecurity, Priority Critical Infrastructure.
State of Cybersecurity in the Electricity Sector: Introduction, Vulnerabilities, Threats, Challenges, Initiatives, Future Directions. ■

Module-2

Cybersecurity Standards Applicable to the Electricity Sector: Introduction, Literature Search, Literature Analysis, Standards' Selection and Evaluation Criteria, Results, Most Relevant Standards, Standards' Limitations, Standards' Implementation and Awareness. ■

Module-3

A Systematic Approach to Cybersecurity Management: Introduction, Cybersecurity Management Approaches in Standards, The Systematic Approach to Cybersecurity Management in the Electricity Sector. ■

Module-4

Cost of Cybersecurity Management: Introduction, Economic Studies, Organisation Management Studies, Cost-Benefit Analysis, Cost Calculators, Costing Metrics, CAsPeA.
Cybersecurity Assessment: Introduction, Security Assessment Methods for the Electricity Sector, Cybersecurity Test beds for Power Systems, JRC Cybersecurity Assessment Method, Laboratory Infrastructure, MAlSim. ■

Module-5

Cybersecurity Controls: Introduction, Standard Technical Solutions, Information Sharing Platform on Cybersecurity Incidents for the Energy Sector, Situation Awareness Network. ■

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

- Discuss the current cybersecurity situation in the electricity sector and the relevant standards that can be employed for cybersecurity.
- Explain cybersecurity management approach and the methods for the electricity sector.
- Explain available solutions that support the cost-benefit analyses involved in cybersecurity management and cybersecurity assessment approach.
- Discuss cybersecurity controls, for reducing cyber risks. ■

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook

1. Cybersecurity in the Electricity Sector, Rafal Leszczyna, Springer, 2019

PROJECT WORK PHASE – 1			
Course Code	20EMS34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting, and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

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

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

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

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer. ■

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

MINI PROJECT			
Course Code	20EMS35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University. ■

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20EMSI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:
Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation
CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

Semester End Examination
SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20EMS41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■