VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech. in Industrial Electronics (EIE)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	CourseTitle	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ELD11	Advanced Engineering Mathematics	04	--	03	40	60	100	4
2	PCC	18ECS12	Advanced Digital Signal Processing	04	--	03	40	60	100	4
3	PCC	18EVE13	Advanced Embedded Systems	04	--	03	40	60	100	4
4	PCC	18ELD14	Digital Circuit and Logic Design	04	--	03	40	60	100	4
5	PCC	18EIE15	Advanced Control System	04	--	03	40	60	100	4
6	PCC	18EIEL16	Controls and Virtual Instrumentation lab	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Internship: All the students shall undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III 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 failed and have to complete during subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech. in Industrial Electronics (EIE)
Choice Based Credit System (CBCS)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EIE21	Process Control Instrumentation	04	--	03	40	60	100	4
2	PCC	18EVE22	Real Time Operating System	04	--	03	40	60	100	4
3	PCC	18EIE23	Design of Power Converters	04	--	03	40	60	100	4
4	PEC	18XXX24X	Professional Elective 1	04	--	03	40	60	100	4
5	PEC	18XXX25X	Professional Elective 2	04	--	03	40	60	100	4
6	PCC	18EIEL26	Embedded and Signal Processing Lab	--	04	03	40	60	100	2
7	PCC	18EIE27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

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

Professional Elective 1		**Professional Elective 2**	
Course Code under 18XXX24X	**Course title**	**Course Code under 18XXX25X**	**Course title**
18ECS241	Wireless Sensor Networks	18EIE251	Automotive Electronics
18EVE242	Nanoelectronics	18EIE252	Industrial Drives
18ECS243	Cryptography and Network Security	18ELD253	Micro Electro Mechanical Systems

Note:

1.Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide in any and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters 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 Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III 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 failed and have to complete during subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech in Industrial Electronics (EIE)
Choice Based Credit System (CBCS)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18EIE31	PLCs and Industrial Automation	04	--	03	40	60	100	4
2	PEC	18XXX32X	Professional Elective 3	04	--	03	40	60	100	4
3	PEC	18XXX33X	Professional Elective 4	04	--	03	40	60	100	4
4	Proj	18EIE34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	INT	18EIE35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective, Proj: Project, INT: Internship.

Professional Elective 3		**Professional Elective 4**	
Course Code under 18XXX32X	**Course title**	**Course Code under 18XXX33X**	**Course title**
18ECS321	Advances in Image Processing	18EIE331	Advanced Power Electronic Converters and Applications
18EIE322	Medical Imaging	18ESP332	Pattern Recognition and Machine Learning
18ECS323	Real Time Systems	18ECS333	Internet of Things

Note:

1. Project 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 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 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 failed and have to complete during subsequent University examinations after satisfying the internship requirements.
Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech in Industrial electronics (EIE)
Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Proj	18EIE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note: Proj: Project.

Note:

1. Project 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 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.

M.Tech 2018-Industrial Electronics-
FIRST SEMESTER SYLLABUS

ADVANCED ENGINEERING MATHEMATICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject	**18ELD11**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.
- To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences.

Modules	RBT Level
Module -1	
Linear Algebra-I 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 (Text Book:1).	**L1, L2**
Module -2	
Linear Algebra-II Computation of eigen values and eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process (Text. Book:1).	**L1, L2**
Module -3	
Calculus of Variations : - Concept of functional-Eulers equation**.**Functionaldependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries.	**L1, L2**
Module -4	

Probability Theory:-Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-examples. (Text Book: 3)	**L1, L2**
Module -5	
Engineering Applications on Random processes:- Classification. Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process. (Text Book: 3)	**L2, L3, L4**

Course Outcomes: After studying this course, students will be able to:

CO-1 :Understand vector spaces, basis, linear transformations and the process of obtaining
matrix of linear transformations arising in magnification and rotation of images.

CO-2 :Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.

CO-3 :Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.

CO-4 :Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.

CO-5 :Analyze random process through parameter-dependent variables in various random processes.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. David C.Lay, Steven R.Lay and J.J.McDonald: "LinearAlgebra and its Applications",
   5thEdition, Pearson Education Ltd., 2015
2. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications, 3rdEdition, 1977.
3. T.Veerarajan: "Probability, Statistics and Random Process",3rd Edition,Tata Mc-Graw Hill Co.,2016.

Reference Book:

1. Gilbert Strang: Introduction to Linear Algebra, 5thEdition, Wellesley-Cambridge Press., 2016
2. Richard Bronson: "Schaum's Outlines of Theory and Problems of Matrix Operations", McGraw-Hill, 1988.
3. Scott L.Miller,DonaldG.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press,2nd Edition,2013.

Web links:

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

ADVANCED DIGITAL SIGNAL PROCESSING **[As per Choice Based Credit System (CBCS) Scheme]** **SEMESTER – I**			
Course Code	**18ECS12**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50** **(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: This course will enable students to

- Understand Multirate digital signal processing principles and its applications.
- Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.
- Design and implement an optimum adaptive filter using LMS and RLS algorithms.
- Understand the concepts and mathematical representations of Wavelet transforms.

Modules	**RBT Levels**
Module-1	
Multirate Digital Signal Processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank. (Text 1)	L1, L2, L3
Module-2	
Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters. (Text 1)	L1, L2, L3
Module-3	
Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. Adaptive direct form filters- RLS algorithm. (Text 1)	L1, L2, L3
Module-4	
Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods. **Parametric Methods for Power Spectrum Estimation:**	L1, L2, L3

Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation. (Text 1)	
Module-5	
WAVELET TRANSFORMS: The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future. **Continuous Wavelet and Short Time Fourier Transform:** Wavelet Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets. (Chapters 1, 3 & 4 of Text 2)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Design adaptive filters for a given application
- Design multirate DSP Systems
- Implement adaptive signal processing algorithm
- Design active networks
- Understand advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. "Digital Signal Processing, Principles, Algorithms and Applications", JohnG. Proakis, Dimitris G.Manolakis, Fourth edition, Pearson-2007.

2. Insight into Wavelets- from Theory to Practice", K.P Soman, Ramachandran, Resmi- PHI Third Edition-2010.

ADVANCED EMBEDDED SYSTEM
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject	18EVE13	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	Revised Bloom's Taxonomy (RBT) Level
Module -1	
Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).	**L1, L2, L3**
Module -2	
Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics From Ch-7, 9, 12, 13).	**L1, L2, L3**
Module -3	
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3)	**L1, L2, L3**
Module -4	

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6).	**L1, L2, L3**
Module -5	
Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10).	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Explain the hardware software co-design and firmware design approaches.
- Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.

2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.

Reference Book:

James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.

DIGITAL CIRCUITS AND LOGIC DESIGN
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	**18ELD14**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course objectives: This course will enable students to:

- Understand the concepts of sequential machines
- Design Sequential Machines/Circuits
- Analyze the faults in the design of circuits
- Apply fault detection experiments to sequential circuits

Modules	**RBT Levels**
Module-1	
Threshold Logic: Introductory Concepts, Synthesis of Threshold Networks, Capabilities, Minimization, and Transformation of Sequential Machines: The Finite- State Model, Further Definitions, Capabilities.	**L1, L2,L3**
Module-2	
Fault Detection by Path Sensitizing, Detection of Multiple Faults, Failure-Tolerant Design, Quadded Logic, Reliable Design and Fault Diagnosis Hazards: Fault Detection in Combinational Circuits.	**L1, L2, L3**
Module-3	
Fault-Location Experiments, Boolean Differences, Limitations of Finite – State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines.	**L1, L2, L3**
Module-4	
Structure of Sequential Machines: Introductory Example, State Assignments Using Partitions, The Lattice of closed Partitions, Reductions of the Output Dependency, Input Independence and Autonomous Clocks, Covers and Generation of closed Partitions by state splitting, Information Flow in Sequential Machines, ELD ecompositions, Synthesis of Multiple Machines.	**L1, L2, L3**
Module-5	

State Identifications and Fault-Detection Experiments: Homing Experiments, Distinguishing Experiments, Machine Identification, Fault Detection Experiments, Design of Diagnosable Machines, Second Algorithm for the Design of Fault Detection Experiments, Fault-Detection.	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Understand the concepts of sequential machines
- Design Sequential Machines/Circuits
- Analyze the faults in the design of circuits
- Apply fault detection experiments to sequential circuits

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Zvi Kohavi, "Switching and Finite Automata Theory", 2nd Edition, TMH, 2008, ISBN: 978_0_07_099387_7

Reference Books:

1. Charles Roth Jr., "Digital Circuits and logic Design", 7thedn, Cengage Learning, 2014.
2. Parag K Lala, "Fault Tolerant And Fault Testable Hardware Design", Prentice Hall Inc. 1985.
3. E. V. Krishnamurthy, "Introductory Theory of Computer", Macmillan Press Ltd, 1983
4. Mishra & Chandrasekaran, "Theory of computer science – Automata, Languages and Computation", 2nd Edition, PHI, 2004.

ADVANCED CONTROL SYSTEMS
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – I

Subject	**18EIE15**	**CIE Marks**	**40**
Number	**04**	**SEE Marks**	**60**
Total Number	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable the students to

- Acquaint with basic digital controller analysis and design methods for computer controlled systems.
- Understand the fundamentals of control design and analysis using state-space methods
- Familiarize with State-space representation of dynamic systems
- Design controllers using state-space methods, pole-placement and optimal control methods.
- Provide an overview of techniques for design and analysis of nonlinear systems.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Digital Control Systems: Review of Difference equations, Z — transforms and Inverse Z transforms, The Z- transfer function (Pulse transfer function), The Z -Transform Analysis of Sampled data Control Systems, The Z and S - domain relationship, Stability analysis (Jury's Stability Test and Bilinear Transformation)(Text 1, Text 2).	**L1, L2, L3**
Module -2	
State Models& Solution of State equations: State models for Linear Continuous Time and Linear Discrete Time systems, Diagonalization, Solution of State Equations (for both Continuous and Discrete Time systems), Relevant problems(Text1).	**L2, L3, L4**
Module -3	

State Feedback Systems: Concepts of Controllability and Observability (for both Continuous and Discrete Time systems), Pole Placement by State Feedback (for both continuous and discrete Time systems), Observer System (Full order and Reduced order observers for both Continuous and Discrete Time systems), Relevant problems(Text 1, Text 2).	**L2, L3, L4**
Module -4	
Regulators: Dead beat Control by State Feedback, Optimal control problems using State Variable approach, State regulator and Output regulator, Concepts of Model Reference Adaptive Control (MRAC)(Text 1, Text 2).	**L2, L3, L4**
Module -5	
Nonlinear Control Systems: Behavior of Nonlinear Systems, Common Physical Nonlinearities, Describing Function Method, Stability Analysis by Describing Function Method, Phase Plane Method, Stability Analysis by Phase Plane Method (Text 1).	**L2, L3**

Course Outcomes: After studying this course, students will be able to:

- Derive the pulse transfer function for various closed loop configurations and understand the stability analysis of sampled data control systems.
- Apply state space techniques to model linear continuous and discrete time systems, convert state space (SS) representations to transfer function (TF) representation and vice versa.
- Apply controllability and observability tests.
- Explain the design of state feedback systems using pole placement and observer systems.
- Solve the optimal control problems using state variable approach and knowledge of adaptive control systems.
- Understand the types of nonlinearities, characteristics of Nonlinear systems and the stability analysis of Nonlinear control systems.

Question Paper Pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. I.J. Nagrath & M.Gopal, "Control Systems Engineering", New Age International Publishers, Fifth edition, 2007.
2. K. Ogata, "Discrete Time Control Systems", 2nd edition, PHI, 2009.

Reference Books:

1. K. Ogata, "Modern Control Engineering", 5thEdition, PHI, 2010.
2. 2. M. Gopal ,“Modern Control System Theory", New Age International, 2012.
3. M. Gopal, "Digital Control and State Variable methods", 4th edition, Tata McGrawHill, 2012.
4. A. Nagoorkani, “Advanced Control Theory”, RBA publications, 2006.

Controls and Virtual Instrumentation lab

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER – I

Laboratory Code	**18EIEL16**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions) + 03 Hours Laboratory**	**SEE Marks**	**60**
		Exam Hours	**03**

CREDITS – 02

Course objectives: This course will enable students to:

- Simulate ladder logic for various applications using PLC control system
- Practice LabVIEW for virtual instrumentation applications
- Learn Assembly language programming for different applications using ARM-Cortex M3 Kit and Keil uVision- 4 tool.
- Learn C language programming for different applications using ARM- Cortex M3 Kit and Keil uVision-4 tool.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. Use the suitable software simulation tool to develop and implement the ladder logic for PLC a. Binary to gray code using PLC. The logic should be solved using ladder diagram technique. b. Bottle filling process using PLC. The logic should be solved using ladder diagram technique. c. Elevator using PLC. The logic should be solved using ladder diagram technique. d. Controlling the Rotation of the motor using timer. The logic should be solved using ladder diagram technique.	**L2,L3,L4**
2. Introduction of the basics of data acquisition and computer controlled Instrumentation using Virtual Instrumentation (LabVIEW programs) a. Simulation of temperature indicators using LabVIEW. b. Simple calculator using LabVIEW. c. Design of a variable function generator using VI d. Creation of a CRO using VI and measurement of frequency and amplitude e. Data acquisition using VI for temperature measurement with thermocouple and AD590	**L2, L3, L4**

3. ARM Cortex M3 Programs: (Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ATSAM3U). a. Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+.....+1 b. Write a Assembly language program to link multiple object files and link them together. c. Write an Assembly language program to store data in RAM d. Write a C program to Output the "Hello World" message using UART e. Write a C program to Design a Stopwatch using interrupts.	**L2,L3,L4**

Course Outcomes: On the completion of this laboratory course, the students will be able to:

- Simulate ladder logic for various applications using PLC
- Use LabVIEW for virtual instrumentation applications
- Develop Assembly language programs for different applications using ARM-
- Cortex M3 Kit and Keil uVision-4 tool.
- Develop C language programs for different applications using ARM- Cortex M3 Kit and Keiluvision-4 tool.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. For examination, two questions using different tool to be set.
3. Students are allowed to pick one experiment from the lot.
4. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
5. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

RESEARCH METHODOLOGY AND IPR

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –I

Course Code	18RMI17	CIE Marks	40
Number of Lecture Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	25	SEE Marks	60
Credits - 02			

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.■

Module-1	**Teaching Hours/ RBT Level**
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. ■	**05** **L1, L2**
Module-2	
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **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. ■	**05** **L1, L2**
Module-3	

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. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■	**05** **L1, L2**
Module-4	
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout. **Interpretation and Report Writing (continued):** of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■	**05** **L1, L2, L3, L4**
Module-5	
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.■	**05** **L1, L2, L3, L4**

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 and their characteristics.
- Explain the art of interpretation and the art of 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:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

M.Tech 2018-Industrial Electronics-
SECOND SEMESTER SYLLABUS

PROCESS CONTROL INSTRUMENTATION [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**18EIE21**	**CIA Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: This course will enable students to

- Impart the knowledge about the interface between process and control subsystem, manual interaction with the processes, process industrial automation system.
- Present the latest hardware and software modules for realizing the Data Acquisition and Control Unit.
- Manage inter and intra systems data exchange in process industrial automation systems.
- Explain the structure of field bus I/O and the management of safety in process plants.
- Understand the manufacturing, utility in industrial processes and also to give the Integration of operational technology and Information Technology to derive operational and business excellence.

Modules	**RBT Levels**
Module-1	
AUTOMATION – NEED AND BENEFIT: Instrumentation subsystems- Structure, Signal Interface Standards, Input data reliability enhancement, Isolation and Protection, human interface subsystems - Operation panel, Construction, control subsystems – Structure, interfacing, automation strategies- Basic and advanced strategies.	L1,L2
Module-2	
DATA ACQUISITION AND CONTROL UNIT: Hardware and Software- Basic modules, functional modules, DACU capacity expansion, system cables, Integrated assemblies, DACU construction, Data exchange on bus, Software structure, application programming, Programmable control subsystems.	L1,L2,L3
Module-3	
DATA COMMUNICATION AND NETWORKING: Communication	L1,L2

network, signal and data transmission, Data communication protocol, Inter process communication, cyber security, Safe and redundant network.	
Module-4	
FIELDBUS TECHNOLOGY & SAFETY SYSTEMS: Centralized, remote- input-output, Field bus- input-output, communication, device integration, Other networks. Safety systems introduction, Process and Machine safety management.	L1,L2,L3
Module-5	
MANAGEMENT AND INFORMATION TECHNOLOGY IN INDUSTRIAL PROCESSES: Introduction, Classification of industrial processes, Manufacturing and utility processes, industrial robotics, operation technology and IT, before and after convergence, ISA 95 standard, new developments.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Understand the safety requirements in process plants.
- Understand the use of information technology and standards in process control operation
- Describe the hardware and software modules for realizing the Data Acquisition and Control Modules
- Explain the techniques of Automation in industries and describe the networking requirements.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

1. K L S Sharma, Overview of Industrial Process Automation, 2nd edition, ELSEVIER, 2016.

Real Time Operating System [**As per Choice Based credit System (CBCS) Scheme** **SEMESTER – II**			
Subject Code	**18EVE22**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable the students to:

- Introduce the fundamental concepts of Real Time Operating Systems and the real time embedded system
- Apply concepts relating to operating systems such as Scheduling techniques, Thread Safe Reentrant Functions, Dynamic priority policies.
- Describe concepts related to Multi resource services like blocking, Deadlock, live lock & soft real-time services.
- Discuss Memory management concepts, Embedded system components, Debugging components and file system components.
- Study programs for multithreaded applications using suitable data structures.

Modules	**RBT Level**
Module 1	
Real-Time Systems and Resources: Brief history of Real Time Systems, A brief history of Embedded Systems. System Resources, Resource Analysis, Real-Time Service Utility, Scheduler concepts, Real-Time OS, State transition diagram and tables, Thread Safe Reentrant Functions. (Text 1: Selected sections from Chap. 1, 2)	L1,L2,L3
Module 2	
Processing with Real Time Scheduling: Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies with timing diagrams and problems and issues, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies, Alternative to RM policy. (Text 1: Chap. 2,3,7)	L1,L2,L3
Module 3	
Memory and I/O: Worst case execution time, Intermediate I/O, Shared Memory, ECC Memory, Flash file systems. Multi-resource Services, Blocking, Deadlock and live lock, Critical sections to protect shared resources, Missed deadline, QoS, Reliability and Availability, Similarities and differences, Reliable software, Available software. (Text 1: Selected topics from Chap. 4,5,6,7,11)	L1,L2,L3
Module 4	
Firmware Components: The 3 firmware components, RTOS system software mechanisms, Software application components. Debugging Components, Exceptions, assert, Checking return codes, Single-step debugging, Test access ports, Trace Ports. (Text 1: Selected	L1,L2,L3

topics from Chap. 8,9)	
Module 5	
Process and Threads: Process and thread creations, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication (Text 2: Chap. 11)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Develop programs for real time services, firmware and RTOS, using the fundamentals of Real Time Embedded System, real time service utilities, debugging methodologies and optimization techniques.
- Select the appropriate system resources (CPU, I/O, Memory, Cache, ECC Memory, Microcontroller/FPGA/ASIC to improve the system performance.
- Apply priority based static and dynamic real time scheduling techniques for the given specifications.
- Analyze deadlock conditions, shared memory problem, critical section problem, missed deadlines, availability, reliability and QoS.
- Develop programs for multithreaded applications using suitable techniques and data structure

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Sam Siewert, "Real-Time Embedded Systems and Components", Cengage Learning India Edition, 2007.

2. Dr. K.V.K.K Prasad, Embedded/Real Time Systems, Concepts, Design and Programming, Black Book, Dream Tech Press, New edition, 2010.

Reference Books:

1. James W S Liu, "Real Time System", Pearson education, 2008.
2. Dream Tech Software Team, "Programming for Embedded Systems", John Wiley, India Pvt. Ltd., 2008.

Design of Power Converters

[As per Choice Based credit System (CBCS) Scheme]

SEMESTER – II

Subject Code	**18EIE23**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Acquire knowledge about various power semiconductor devices.
- Analyze and design different power converter circuits.
- Analyze various single phase and three phase power converter circuits and understand their applications.
- Identify the basic requirements for power electronics based design application.
- Develop skills to build, and troubleshoot power electronics circuits.
- Understand the use of power converters in commercial and industrial applications.

Modules	**RBT Level**
Module 1	
Introduction to Control characteristics of power semiconductor devices: SCR, BJT, MOSFET, GTO, MCT, SITH, IGBT. Comparison of controllable switches. **AC to Controlled DC Converter:** Thyristor circuits and their control, Gate Triggering, Single phase converters, Three phase converters**.**(Text 1)	L1,L2
Module 2	
DC to DC converters: Introduction, control of DC-DC converters, Buck, Boost, Buck-Boost, Cuk converter. **Inverters:** Introduction, principle of operation, single phase inverters, three phase inverters-120 and 180 modes of operation. (Text 1)	L1,L2,L3
Module 3	
Switching DC power supplies: linear power supply, overview of switching power supply, DC - DC converters with electrical isolation, flyback converter, forward converter, push-pull converter, Half and Full bridge converter, current mode control,	L1,L2,L3

power supply protection. (Text 1)	
Module 4	
Magnetics for switched mode converters: Power Handling capacity of a transformer, Area product, window utilization factor. Transformer designs – forward converter, half and Full Bridge converter, Push-pull converter, Flyback converter. Design of Inductors, problems. (Text 2)	L1, L2,L3
Module 5	
PWM controlling Techniques: single PWM, Multiple, sinusoidal, modified, phase displacement control. **Power electronic applications**: UPS, control of motor drives, criteria for selecting drive components, High frequency fluorescent lighting. **Industrial applications:** Induction heating, Electric welding.(Text 1)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Describe the fundamental concepts and techniques used in power electronics.
- Design AC/DC rectifier circuit, DC-DC and DC-AC inverters.
- Design single phase and three phase power converter circuits and understand their applications.
- Troubleshoot power electronics circuits and fix the design problems.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. M.Ned Mohan Tore, Undeland and William. P. Robbins; "Power Electronics: Converters, Applications and Design", 3rd Edition, John Wiley and Sons, 2003

2. Umanand. L. & S.R.Bhat. "Design of Magnetic Components for Switched Mode Power Converters", Wiley Eastern Publication, 1992.

Reference Books:

M. H. Rashid, "Power Electronics" 3rd edition, PHI / Pearson publisher 2004.

Embedded and Signal Processing Lab [As per Choice Based credit System (CBCS) Scheme SEMESTER – II			
Subject Code	**18EIEL26**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions)+ 02 Hours Laboratory**	**Exam marks**	**60**
		Exam Hours	**03**

CREDITS – 02

Course Objectives: The aim of this course is to

- To understand the suitability of different techniques of IPC and task switching in a multithreaded application.
- To study and implement different types of data structures required to implement inter task communication.
- To successfully implement Inter task communication using an appropriate data structure.
- To introduce signals, systems, time and frequency domain concepts and the associated mathematical tools that is fundamental to all DSP techniques.
- To provide a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.

Laboratory Experiments **PART A: Following RTOS experiments to be done using Linux**	**RBT Level**
1. Develop and test programs to (a) create child process and display it's id and (b) Execute child process function using switch structure.	**L2,L3,L4**
2. Develop and test the program for a multithreaded application, where communication is through a buffer for the conversion of lowercase text to uppercase text, using semaphore concept.	**L2,L3,L4**
3. Develop and test the program for a multithreaded application, where communication is through shared memory for the conversion of lowercase text to uppercase text.	**L2,L3,L4**
4. Develop program for inter-thread communication using message queue. Data is to be input from the keyboard for the chosen application.	**L2, L3, L4**
5. Create 'n' number of child threads. Each thread prints the message " I'm in thread number …" and sleeps for 50 ms and then quits. The main thread waits for complete execution of all the child threads and then quits. Compile and execute in Linux.	**L2, L3, L4**

4. Implement the multi-thread application satisfying the following : i. Two child threads are created with normal priority. ii. Thread 1 receives and prints its priority and sleeps for 50ms and then quits. iii. Thread 2 prints the priority of the thread 1 and rises its priority to above normal and retrieves the new priority of thread 1, prints it and then quits. iv. The main thread waits for the child thread to complete its job and quits.	**L2, L3, L4**
5. Implement the usage of anonymous pipe with 512 bytes for data sharing between parent and child processes using handle inheritance mechanism.	**L2,L3,L4**
PART B: Digital Signal Processing using MATLAB	
1. Comparison of DFT and DCT (in terms of energy compactness) Generate the sequence x[n] = n-64 for n=0,…127. (a) Let X[k]=DFT{x[n]}. For various values of L, set to zero the "high frequency coefficients" X[64-L]=….X[64]= …….= X[64+L]=0 . Take the inverse DFT and plot the results. (b) Let X_{DCT}[k]=DCT(x[n]). For the same values of L, set to zero the high frequency coefficients X_{DCT}[127-L]=….. X_{DCT}[127]. Take the inverse DCT for each case and compare the reconstruction with the previous case.	**L2,L3,L4,L5**
2. Design digital FIR LPF and HPF using the following windows techniques. i) Hamming window function ii) Kaiser window function	**L2,L3,L4,L5**
3. Design digital IIR Butterworth low pass and high pass filter using bilinear transformation. Compare FIR and IIR filter in terms of performance (accuracy in meeting specifications) and computational complexity.	**L2,L3,L4,L5**
3. Compute Fourier Transform & its inverse Fourier Transform of an image.	**L2,L3,L4,L5**
4. Compute FFT when N is not a power of 2.	**L2,L3,L4,L5**

5. Design an equiripple filter for the given specification.	**L2,L3,L4,L5**

Course Outcomes: After studying this course, students will be able to:

- Select a suitable task switching technique in a multithreaded application.
- Implement different techniques of message passing and Inter task/thread communication.
- Implement different data structures such as pipes, queues, shared memory, semaphores, buffers in multithreaded programming.
- Implement DCT, DFT, FFT and IFFT for the given input data
- Implement the appropriate design method for FIR and IIR filters.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot, consisting of two questions selected one from each part.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Dreamtech Software Team, "Programming for Embedded Systems", John Wiley, India Pvt. Ltd., 2008. (For Few programs of Part A)

Professional Elective 1

Wireless Sensor Networks **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – II**			
Course Code	**18ECS241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Outcomes:

At the end of this course, students will be able to

- Understand the hardware details of different types of sensors and select right type of sensor for various applications.
- Understand conversion of sensor information into digital data and packetize to a specific protocol for Transmission
- Understand radio standards and communication protocols to be used for wireless sensor.
- Understand the issues involved in synchronization and security.

Modules	RBT Levels
Module-1	
Motivation for a Network of Wireless Sensor Nodes Sensing and Sensors, Wireless Sensor Networks, Challenges and Constraints (Chapt 1 till 1.2.7) **Applications:**Structural Health Monitoring (till 2.1.4), Traffic Control (2.2), Health Care (2.3), Pipeline Monitoring (2.4), Precision Agriculture (2.5)	L1, L2, L3
Module-2	
Sensing Node Architecture: The Sensing Subsystem (3.1),The Processor (3.2) Subsystem (3.2) (in brief only), Communication Interfaces (3.3), Prototypes (3.4) **Medium Access Control :**Overview - Contention-Free Medium Access, Contention-Based Medium Access (6.1), Wireless MAC Protocols – CSMA, MACA and MACAW, MACA By Invitation, IEEE 802.11, IEEE 802.15.4 and ZigBee (6.2), Characteristics of MAC Protocols in Sensor Networks (6.3), Contention-Free MAC Protocols (6.4), Contention-Based MAC Protocols (6.5), Hybrid MAC Protocols (6.6)	L1, L2, L3
Module-3	
Network Layer: 7.1 Overview , 7.2 Routing Metrics, 7.3 Flooding and Gossiping, 7.4 Data-Centric Routing, 7.5 Proactive Routing, 7.6 On-Demand Routing, 7.8 Location-Based Routing , 7.9 QoS-Based Routing Protocols	L1, L2, L3
Module-4	

Power management: 8.1 Local Power Management Aspects, 8.2 Dynamic Power Management, 8.3 Conceptual Architecture. **Time Synchronization:** 9.1 Clocks and the Synchronization Problem, 9.2 Time Synchronization in Wireless Sensor Networks, 9.3 Basics of Time Synchronization,9.4 Time Synchronization Protocols till (9.4.5)	L1, L2, L3
Module-5	
Localization: 10.1 Overview, 10.2 Ranging Techniques, 10.3 Range-Based Localization, 10.4 Range-Free Localization, 10.5 Event-Driven Localization. **Network Security**: 11.1Fundamentals of Network Security, 11.2 Challenges of Security in Wireless Sensor Networks, 11.3 Security Attacks in Sensor	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

CO1: Explain the concepts of sensors and conversion to digitally formatted signal for transmission.

CO2: Evaluate the capacity and degradation in performance of various wireless MAC protocols in a transmission environment.

CO3: Analyze schemes to transport sensor data to a server in a power efficient and time efficient manner.

CO4: Develop and evaluate the performance of a sensor network including localization of sensor faults.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as see marks is 60.

Text Book:

1. **WaltenegusDargie and Christian Poellabauer,** "Fundamentals ofWireless Sensor Networks Theory and Practice", John Wiley & Sons Ltd.ISBN 978-0-470-99765-9, 2010.

Reference Book:

1. **Ian F. Akyildiz** and **Mehmet Can Vuran** "Wireless Sensor Networks",John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010.

NANOELECTRONICS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	18EVE242	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Enhance basic engineering science and technological knowledge of nanoelectronics .
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Modules	(RBT) Level
Module -1	
Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).	**L1, L2**
Module -2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques,spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties(Text1)	**L1,L2, L3**
Module -3	
Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1). **Carbon Nanostructures:**Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).	**L1, L2, L3**

Module -4	
Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	**L1, L2, L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text1).	**L1, L2, L3**

Course outcomes: After studying this course, students will be able to:

1. Know the principles behind Nanoscience engineering and Nanoelectronics.
2. Apply the knowledge to prepare and characterize nanomaterials.
3. Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
4. Design the process flow required to fabricate state of the art transistor technology.
5. Analyze the requirements for new materials and device structure in the future tech nologies.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
2. Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

- Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC press, 2003.

CRYPTOGRAPHY AND NETWORK SECURITY
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II

Subject Code	**18ECS243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand the basics of symmetric key and public key cryptography.
- Understand some basic mathematical concepts and pseudorandom number generators required for cryptography.
- Authenticate and protect the encrypted data.
- Enrich knowledge about Email, IP and Web security.

Modules	**RBT Level**
Module 1	
Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6) **SYMMETRIC CIPHERS:** Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4)	L1,L2,L3
Module 2	
Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5) Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4)	L1,L2,L3
Module 3	
Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16)	L1,L2, L3
Module 4	
One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)	L1,L2,L3
Module 5	

E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2). **IP Security:** IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations. (Text 1: Chapter 18: Section 18.1 to 18.4). **Web Security:** Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2).	L1,L2, L3

Course Outcomes: After studying this course, students will be able to:

- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. William Stallings , "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X

Reference Books:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003.

Professional Elective 2

AUTOMOTIVE ELECTRONICS **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – II**			
Subject Code	**18EIE251**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Understand the complete dynamics of automotive electronics
- Design and implement the electronics that attributes the smartness to the automobiles by way of unprecedented safety, add-on features, and comforts.

Modules	**RBT Level**
Module 1	
Automotive Fundamentals, the Systems Approach to Control and Instrumentation: Use Of Electronics In The Automobile, Antilock Brake Systems, (ABS), Electronic steering control, Power steering, Traction control, Electronically controlled suspension. (Chap.1 and 2 of Text)	L1,L2
Module 2	
Automotive instrumentation Control: Sampling, Measurement and signal conversion of various parameters. (Chap. 4 of Text)	L1,L2, L3
Module 3	
The basics of Electronic Engine control: Integrated body: Climate controls, Motivation for Electronic Engine Control, Concept of An Electronic Engine Control System, Definition of General Terms, Definition of Engine Performance Terms, Electronic fuel control system, Engine control sequence, Electronic Ignition, Sensors and Actuators, Applications of sensors and actuators, air flow rate sensor, Indirect measurement of mass air flow, Engine crankshaft angular position sensor, Automotive engine control actuators, Digital engine control, Engine speed sensor, Timing sensor for ignition and fuel delivery, Electronic ignition control systems, Safety systems, Interior safety, Lighting, Entertainment systems. (Chap. 5 and 6 of Text)	L1,L2,L3
Module 4	

Vehicle Motion Control and Automotive diagnostics: Cruise control system, Digital cruise control, Timing light, Engine analyzer, On-board and off-board diagnostics, Expert systems. Stepper motor-based actuator, Cruise control electronics, Vacuum - antilock braking system, Electronic suspension ystem Electronic steering control, Computer-based instrumentation system, Sampling and Input\output signal conversion, Fuel quantity measurement, Coolant temperature measurement, Oil pressure measurement, Vehicle speed measurement, Display devices, Trip-Information-Computer, Occupant protection systems. (Chap. 8 and 10 of Text)	L1,L2, L3
Module 5	
Future automotive electronic systems: Alternative Fuel Engines, Collision Wide Range Air/Fuel Sensor, Alternative Engine, Low Tire Pressure Warning System, Collision avoidance Radar Warning Systems, Low Tire Pressure Warning System, Radio Navigation, Advance Driver information System. Alternative-Fuel Engines , Transmission Control , Collision Avoidance Radar Warning System, Low Tire Pressure Warning System, Speech Synthesis Multiplexing in Automobiles, Control Signal Multiplexing, Navigation Sensors, Radio Navigation, Sign post Navigation , Dead Reckoning Navigation Future Technology, Voice Recognition Cell Phone Dialing Advanced Driver information System, Automatic Driving Control. (Chap. 11 of Text)	L1, L2, L3
Course Outcomes: After studying this course, students will be able to: • Implement various control requirements in the automotive system. • Comprehend dashboard electronics and engine system electronics. • Identify various physical parameters that are to be sensed and monitored for maintaining the stability of the vehicle under dynamic conditions. • Understand and implement the controls and actuator system pertaining to the comfort and safety of commuters. • Design sensor network for mechanical fault diagnostics in an automotive vehicle.	
Question paper pattern: • Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks. • Each full question can have a maximum of 4 sub questions. • There will be 2 full questions from each module covering all the topics of the module. • Students will have to answer 5 full questions, selecting one full question from each module. • The total marks will be proportionally reduced to 60 marks as SEE marks is 60.	

Text Book:

William B. Ribbens , "Understanding Automotive Electronics", SAMS/Elsevier publishing, 6th Edition, 1997.

Reference Book:

Robert Bosch Gmbh, "Automotive Electrics and Automotive Electronics-Systems and Components, Networking and Hybrid Drive", Springer Vieweg, 5th Edition, 2007.

Industrial Drives **[As per Choice Based credit System (CBCS) Scheme]** **SEMESTER – II**			
Subject Code	**18EIE252**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50** **(8 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Acquire knowledge on industrial drives and its various applications.
- Learn the characteristics and its features of various motors and loads used in industries.
- Develop control and operational procedures for various industrial drives.
- Learn single phase and three phase control techniques for separately excited DC motors.
- Acquire the knowledge of different speed control methods in a.c motors using thyristor based circuits.

Modules	**RBT Level**
Module 1	
AN INTRODUCTION TO ELECTRICAL DRIVES & ITS APPLICATIONS: Electrical Drives, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drive, Status of dc and ac Drives, Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation. **Applications:** Rolling mill drives, cement mill drives, paper mill drives and textile mill drives.	L1,L2
Module 2	
SELECTION OF MOTOR POWER RATING: Thermal model of motor for heating and cooling, Classes of motor duty, determination of motor rating. **D C MOTOR DRIVES 1:** Starting braking, transient analysis, single phase fully controlled rectifier, control of dc separately excited motor, Single-phase half controlled rectifier: control of dc separately excited motor.	L1,L2
Module 3	
DC MOTOR DRIVES 2: Three phase fully controlled rectifier: control of dc separately excited motor, three phases half controlled rectifier: control of dc separately excited motor, multiquadrant operation of dc separately excited motor fed form fully controlled rectifier. Rectifier control of dc series motor, chopper controlled dc drives, chopper control of separately excited dc motor. Chopper control of series motor.	L1,L2
Module 4	
INDUCTION MOTOR DRIVES: Operation with unbalanced source voltage and single phasing, operation with unbalanced rotor impedances, analysis of induction	L1,L2

motor fed from non-sinusoidal voltage supply, starting braking, transient analysis. Stator voltage control variable voltage frequency control from voltage sources, voltage source inverter control, closed loop control, current source inverter control, current regulated voltage source inverter control.	
Module 5	
SYNCHRONOUS MOTOR DRIVES: Operation form faced frequency supply, synchronous motor variable speed drives, and variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thruster inverter.	L1, L2

Course Outcomes: After studying this course, students will be able to:

- Identify suitable power converter from the available configurations.
- Design controllers for closed-loop operation of a separately excited DC motor drive with symmetrical optimization technique
- Model existing and modified power converters under small signal and steady state condition
- Develop power converters with better performance for challenging applications
- Design power converters and feedback loops

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

G.K Dubey, **Fundamentals of Electrical Drives,** 2 Edition, 5th reprint, Narosa publishing house.

Reference Books:

1. N.K De and P.K. Sen, **Electrical Drives,** PHI, 2007
2. S.K Pillai**, A First Course On Electric Drives**, S.K Pillai-Wiley Eastern Ltd 1990.
3. V.R. Moorthi, **Power Electronics, Devices, Circuits and Industrial Applications**, Oxford University Press, 2005.

MICRO ELECTRO MECHANICAL SYSTEMS
[As per Choice Based credit System (CBCS) Scheme
SEMESTER – II

Subject Code	**18ELD253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Know an overview of microsystems, their fabrication and application areas.
- Teach working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices
- Know methods to fabricate MEMS devices
- Expose the students to various application areas where MEMS devices can be used.

Modules	**RBT Level**
Module 1	
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module 2	
Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication:** Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.	L1, L2
Module 3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1,L2,L3
Module 4	
Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body	L1,L2,L3

Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	
Module 5	
Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro-manufacturing. **Microsystem Design:** Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Understand the technologies related to Micro Electro Mechanical Systems.
- Describe the design and fabrication processes involved with MEMS devices.
- Analyse the MEMS devices and develop suitable mathematical models
- Understand the various application areas for MEMS devices

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, John Wiley & Sons, 2008. ISBN: 978-0-470-08301-7

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.

M.Tech 2018-Industrial Electronics-
THIRD SEMESTER SYLLABUS

PLCs and INDUSTRIAL AUTOMATION **[As per Choice Based Credit System (CBCS) Scheme]** **SEMESTER – III**			
Subject Code	**18EIE31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the concepts of PLC programming and its operations.
- Design the connectivity between various modules in a system with PLC.
- To create ladder diagrams from process control descriptions.
- Understand various types of PLC registers and apply PLC Timers and Counters for the control of industrial processes.
- Understand PLC functions, Data Handling Function.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
Module -1	
Introduction to PLC Technical Definition , Advantages, Characteristic Functions, Chronological Evolution, Types, Unitary PLC, Modular PLC, SMEEl PLC, Medium PLC, Large PLC, Block Diagram Of PLC, Input / Output Section, Processor Section, Power Supply, Memory, Central Processing Unit, Processor Software / Executive Software, Multitasking, Languages, Ladder Language. **Bit Logic Instructions** Introduction, Input And Output Contact Program, Symbols, Numbering System Of Inputs And Outputs, Program Format, Introduction To Logic, Equivalent Ladder Diagram Of - AND Gate, OR Gate, NOT Gate, XOR Gate, NAND Gate, NOR Gate, Equivalent Ladder Diagram To Demonstrate De Morgan Theorem, Ladder Design.	**L1-L3**
Module -2	

PLC Timers And Counters Timer And Its Classification, Characteristics Of PLC Timer, Functions In Timer, Resetting – Retentive And Non-Retentive, Classification Of PLC Timer, On Delay, And Off Delay Timers, Timer-On Delay, Timer Off Delay, Retentive And Non-Retentive Timers, Format of a Timer Instruction. PLC Counter, Operation Of PLC Counter, Counter Parameters, Counter Instructions. Overview, Count Up (CTU), Count Down (CTD). **Advanced Instructions** Comparison Instructions, Addressing Data Files, Format Of Logical Address, Addressing Format for Micrologic System, Different Addressing Types. Data Movement Instructions.	**L1-L3**
Module -3	
Logical Instructions Mathematical Instructions and its Features, Special Mathematical Instructions, Scale with Parameters or SCP Instruction. Data Handling Instructions and its Features, Program Flow Control Instructions, Proportional Integral Derivative (PID) Instruction. **PLC I/O Modules And Power Supply** Classification Of I/O, I/O System Overview, Practical I/O System and its mapping, Addressing Local and Expansion I/O, Input-Output Systems, Direct I/O Parallel I/O Systems Serial I/O Systems, Sinking And Sourcing, Sourcing and Sinking in PLC Interfacing, Discrete Input Module, Discrete DC Input Module, Discrete AC Input Module, Rectifier with Filter, Threshold Detection, Isolation, Logic Section, Discrete Output Modules, Advantages and Disadvantages Of Output Modules, Types of Analog Input Module.	**L1-L3**
Module -4	
Industrial Communication Introduction, Evolution Of Industrial Control Process, Types Of Communication Interface, Types Of Networking Channels, Parallel Communication Interface. Serial Communication Interface, communication mode, Synchronous And Asynchronous Transmissions , Standard Interface RS 232C, RS 422, EIA 485, Comparison, Software Protocol, Industrial Network. Network Topology, Media Access Methods.	**L1-L3**
Module -5	

Industrial Networking Open System Interconnection (OSI), Network Model, Network Components, Control Network Issues, Advantage of Standardized Industrial Network, Intelligent Devices, Industrial Network Bus Network, Device Bus Network Vs. Process Bus Network, Controller Area Network (CAN), Devicenet, Controlnet, Ethernet Protocol, AS-I Interface, FOUNDATION FIEAEBUS, Application of Profibus for Real PLC Communication. **Industrial Automation** Introduction, Utility Of Automation, General Structure of a Automated Process, Examples of Simple Automated Systems, Selection Of PLC.	**L1-L3**

Course Outcomes:

After studying this course, students will be able to:

- Gain knowledge on Programmable Logic Controllers.
- Understand different types of Devices to which PLC input and output modules are connected.
- Create ladder diagrams from process control descriptions.
- Apply PLC timers and counters for the control of industrial processes.
- Acquire the Knowledge of Networking in Industrial automation.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Madhuchhanda Mitra and Samarjit Sen Gupta, "Programmable Logic Controllers and Industrial Automation", Penram International Publishing (India) Pvt. Ltd., 2007. ISBN: 81-87972-17-3.

Reference Books:

1. Garry Dunning, "Introduction to Programmable Logic Controllers", 2nd Edition, Delmar Thomson Learning, 2001. ISBN: 981-240-625-5.
2. M. Chidambaram, "Computer Control of Processes", CRC Press, 2002. ISBN:0849310105.

Professional Elective 3

Advances in Image Processing **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – III**			
Subject Code	**18ECS321**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:
1. Acquire fundamental knowledge in understanding the representation of the digital image and its properties
2. Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
3. Select the region of interest in the image using segmentation techniques.
4. Represent the image based on its shape and edge information.
5. Describe the objects present in the image based on its properties and structure.

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
Module 3	
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.	L1, L2, L3
Module 4	
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons	L1, L2, L3

and object marking, Morphological segmentations and watersheds.	

Course Outcomes: After studying this course, students will be able to:

1.Understand the representation of the digital image and its properties
2.Apply pre-processing techniques required to enhance the image for its further analysis.
3.Use segmentation techniques to select the region of interest in the image for analysis
4.Represent the image based on its shape and edge information.
5.Describe the objects present in the image based on its properties and structure.
6.Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Cengage Learning, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011.

Medical Imaging **[As per Choice Based credit System (CBCS) Scheme]** **SEMESTER – III**			
Subject Code	**18EIE322**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50** **(10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Acquire the knowledge of all currently available imaging procedures such as X-Ray Imaging, X-Rat Tomography, Radio Nuclide Imaging and Ultrasonic Imaging.
- Understand the characteristics of X-ray, MRI and Radio Nuclide images.
- Learn the Biological effects of X-Rays and Ultrasound.
- Acquire the knowledge of some of the recent developments in the field of medical imaging.
- Learn the procedures used for the generation and detection of X-rays, MRI and Ultrasound.

Modules	**RBT Level**
Module 1 :	
Generation and Detection of X-Rays: X-Ray generation and X-Ray generators, Filters, Beam Restrictors and Grids, Screens, X-Ray Detectors. **X-Ray Diagnostic Methods:** Conventional X-Ray Radiography, Fluoroscopy, Angiography, Mammography, Xeroradiography, Image Subtraction. **X-Ray Image Characteristics:** Spatial Resolution, Image Noise, Image contrast. **Biological Effects of Ionizing Radiation:** Determination of biological effects, Short term and Long term effects.	L1,L2
Module 2:	
X-Ray Tomography: Conventional Tomography, Computed Tomography - Projection function, Algorithms for Image Reconstruction, CT number, Image Artifacts. **Digital Radiography:** Digital Subtraction Angiography (DSA), Dual Energy Subtraction, K-Edge subtraction, 3-D Reconstruction. **Recent Developments:** Dynamic Spatial Reconstructor (DSR), Imatron or Fastrac Electron Beam CT.	L1, L2
Module 3	
Generation and Detection of Ultrasound: Piezoelectric effect, Ultrasonic Transducers, Transducer Beam Characteristics, Axial and Lateral resolution, Focussing and Arrays. **Ultrasonic Diagnostic Methods:** Pulse Echo systems - A mode, B mode, M mode and C mode, Transmission Methods, Doppler methods, Duplex Imaging **Biological Effects of Ultrasound:** Acoustic phenomena at high	L1,L2

intensity levels, Ultrasound Bioeffects.	
Module 4	
Generation and Detection of Nuclear Emission: Nuclear Sources, Radionuclide Generators, Nuclear Radiation Detectors, Collimators. **Diagnostic methods using Radiation Detector Probes:** Thyroid Function test, Renal function test, Blood volume measurement. **New Radio Nuclide Imaging methods:** Longitudinal Section Tomography, SPECT and PET **Characteristics of Radionuclide Images:** Spatial Resolution, Image contrast, Image Noise.	L1,L2,L3
Module 5	
Generation and Detection of NMR signal: The NMR Coil/Probe, The transmitter and the Receiver, Data acquisition. **Magnetic Resonance Imaging methods:** Spin Echo Imaging, Gradient Echo Imaging, Blood flow Imaging. **Characteristics of MRI images:** Spatial Resolution, Image Contrast. **Imaging Safety.**	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Understand the Generation and Detection of X-Rays, the Diagnostic Methods, Characteristics of X-ray images and Biological effects of X-rays.
- Analyze Computed tomography and Digital Radiography.
- Learn the techniques of Generation and Detection of Ultrasound, Pulse Echo Systems and Ultrasonic Diagnostic Methods.
- Understand the principles of various radiological imaging techniques such as SPECT and PET.
- Understand the principles of Magnetic Resonance Imaging, the concepts of Radionuclide Generation and Detection.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Kirk Shung, Michael B, Smith, Benjamin M W Tsui, "Principles of Medical Imaging", Academic Press, 2012.

Reference Books:

1. Zhong Hicho and Manbir Singh "**Fundamentals of Medical Imaging**", John Wiley, 1993.
2. Peter Josefell & Edward Sudney "**Nuclear Medicine Introductory Text**", William Blackwell Scientific Publishers, London.

Real Time Systems **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – III**			
Subject Code	**18ECS323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand basics of Real Time systems.
- Distinguish a real-time system with other systems.
- Identify the functions of operating system
- Evaluate the need for Real time operating system.
- Design and develop embedded applications by means of real-time operating systems.

Modules	**RBT Level**
Module 1	
Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history of Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Re-entrant Functions.	L1, L2
Module 2	
Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Montonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies. **I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.	L1, L2
Module 3	
Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion. **Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.	L1, L2
Module 4	
Embedded System Components: Firmware components, RTOS system software mechanisms, Software application components. **Debugging Components:** Exceptions assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace ports, Power-On self test and diagnostics.	L1, L2, L3
Module 5	

Performance Tuning: Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length. **High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Analyze Real time operating systems.
- Describe the functions of Real time operating systems.
- Demonstrate embedded system applications.
- Design a Real Time operating system.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Sam Siewert, "Real-Time Embedded Systems and Components", Cengage Learning India Edition, 2007.

Reference Books:

1. Krishna CM and Kang Singh G, "Real time systems", Tata McGraw Hill, 2003, ISBN: 0-07-114243-64
2. Qing Li and Carolyn Yao, "Real-Time Concepts for Embedded Systems", CMP Books, 2003, ISBN:1578201241
3. Jane W. S. Liu, "Real Time Systems", Prentice Hall, 2000, ISBN: 0130996513
4. Phillip A. Laplante, "Real-Time Systems Design and Analysis", John Wiley & Sons, 2004.

Professional Elective 4

Advanced Power Electronic Converters and Applications [As per Choice Based credit System (CBCS) Scheme] SEMESTER – III			
Subject Code	**18EIE331**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Estimate and analyze the dynamics of power electronic converters
- Understand the sustainable energy generation technologies.
- Perform Modelling and analysis of power electronic systems and equipment using computational software.
- Simulate and analyze resonant converters.

Modules	**RBT Level**
Module 1	
Introduction to power electronics: Introduction to Power Processing, Several Applications of Power Electronics, Elements of Power Electronics. **Principles of Steady State Converter Analysis:** Inductor Volt-Second Balance, Capacitor Charge Balance, and the Small-Ripple Approximation, Boost Converter Example, Cuk Converter Example Estimating the Output voltage ripple and inductor current ripple in converters Containing Two-Pole Low-Pass Filter. (Text 1)	L1, L2, L3
Module 2	
Converter Dynamics and Control: AC Equivalent Circuit Modeling, The Basic AC Modeling Approach, State-Space Averaging, Circuit Averaging and Averaged Switch Modeling, The Canonical Circuit Model, Modeling the Pulse-Width Modulator, Analysis of Converter Transfer Functions, Graphical Construction of Impedances and Transfer Functions(Text 1)	L1, L, L3
Module 3	
Controller Design: Introduction, Effect of Negative Feedback on the Network Transfer Functions, Construction of the Important Quantities 1/(1 + T) and T/(1 + T) and the Closed-Loop Transfer Functions, Stability, The Phase Margin Test, The Relationship Between Phase Margin and Closed-Loop Damping Factor, Transient Response vs. Damping Factor, Regulator Design, Measurement of Loop Gains. (Text 1)	L1, L2, L3
Module 4	
Modern Rectifiers and Power System Harmonics: Power and	L1, L2,

Harmonics in Nonsinusoidal Systems, Pulse-Width Modulated Rectifiers. **Resonant Converters:** Sinusoidal Analysis of Resonant Converters with examples (Text 1)	L3
Module 5	
Power supply applications: Switching DC Power Supplies, Motor drive applications: Introduction to Motor Drives, DC-Motor Drives, Residential and Industrial Applications, Electric Utility Applications (Text 2)	L1,L2, L3

Course Outcomes: After studying this course, students will be able to:

- Design the power electronic converter systems.
- Apply the knowledge of mathematics to converter/machine dynamics in Electrical engineering.
- Work in multidisciplinary projects.

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Erickson and Maksimovic, "**Fundamentals of Power Electronics**", 2nd Edition, Kluwer Academic Publishers, 2001,

2. M.NedMohan, Tore. Undeland and William.P.Robbins, "**Power Electronics converters, Applications and Design**", John Wiley and Sons, 3rd Edition, 2002.

Reference Books:

1. Abraham Pressman, "**Switching Power Supply Design**", McGraw-Hill Publishers, 1998.

2. Muhammad H. Rashid, "**Power Electronics Handbook**", 2nd Edition, Academic Press, 2007.

PATTERN RECOGNITION and MACHINE LEARNING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	18ESP332	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50 (10 Hours per Module)	Exam Hours	03

Credits – 04

Course objectives: The objective of the course is to discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems. Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.

Modules	RBT Levels
Module-1	
Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory **Distributions:** Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods.**(Ch.: 1,2)**	**L1,L2**
Module-2	
Supervised Learning **Linear Regression Models:** Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison **Classification&Linear Discriminant Analysis:** Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode**(Ch. :3,4)**	**L1,L2,L3**
Module-3	
Supervised Learning **Kernels:** Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes **Support Vector Machines:** Maximum Margin Classifiers, Relevance Vector Machines **Neural Networks:** Feed-forward Network, Network Training, Error Backpropagation**(Ch:5,6,7)**	**L1,L2,L3**
Module-4	
Unsupervised Learning: **Mixture Models:** K-means Clustering, Mixtures of Gaussians, Maximum likelihood,EM for Gaussian mixtures, Alternative View of EM. **Dimensionality Reduction:** Principal Component Analysis, Factor/Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models **(Ch.:9,12)**	**L1,L2,L3**
Module-5	
Probabilistic Graphical Models: Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical	**L1,L2,L3**

Models, Markov Model, Hidden Markov Models**(Ch.:8,13)**	

Course Outcomes: At the end of this course, students will be able to

- Identify areas where Pattern Recognition and Machine Learning can offer a solution.
- Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
- Describe and model data.
- Solve problems in Regression and Classification.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

1. Pattern Recognition and Machine Learning. Christopher Bishop. Springer, 2006

Internet of Things **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ECS333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: This course will enable students to:

- Introduce concept of IOT and its applications in today's scenario.
- Understand IOT content generation and transport through networks
- Understand the devices employed for IOT data acquisition and communication access technologies
- Introduce some use cases of IOT

Module-1	**RBT**
What is IOT Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges **IOT Network Architecture and Design** Drivers behind new network Architectures, Comparing IOT Architectures, M2M architecture, IOT world forum standard, IOT Reference Model, Simplified IOT Architecture.	**L1, L2**
Module-2	
IOT Network Architecture and Design Core IOT Functional Stack, Layer1(Sensors and Actuators) , Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IOT Network management. Layer 3(Applications and Analytics) – Analytics vs Control, Data vs Network Analytics IOT Data Management and Compute Stack	**L2,L3**
Module-3	
Engineering IOT Networks Things in IOT – Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IOT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances – LTE Cat0, Cat-M, NB-IOT	**L2,L3**
Module-4	

Engineering IOT Networks IP as IOT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IOT. Application Protocols for IOT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IOT Application Layer Data and Analytics for IOT – Introduction, Structured and Unstructured data, IOT Data Analytics overview and Challenges.	**L3,L4**
Module-5	
IOT in Industry (Three Use cases) • IOT Strategy for Connected manufacturing, Architecture for Connected Factory • Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation. • Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.	**L3,L4**

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Course Outcomes: After studying this course, students will be able to:

- Understand the basic concepts IOT Architecture and devices employed.
- Analyze the sensor data generated and map it to IOT protocol stack for transport.
- Apply communications knowledge to facilitate transport of IOT data over various available communications media.
- Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device.

Text Book:

Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743

Reference Books:

Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547