Sanjay Ghodawat University

Kolhapur

School of Technology

Department of Electronics Engineering

M. Tech. Electronics Engineering

(Embedded Systems)

Syllabus

(Programme Structure and Course Contents)

Academic Year 2017 - 18

Preamble

The Sanjay Ghodawat University (SGU) stands as a beacon of light to guide the younger generation of the day on the right path to fulfillment in career and life. The focus of the University is its research based curriculum and academically oriented teaching staff. The world class ambience and infrastructure helps the students to easily accommodate themselves in an environment that is conducive to the teaching- learning process. Hands on experience, challenge based case studies, maximum participation of students in the classroom, use of modern digital technology, smart classrooms, solution oriented thinking promotion, stress on research and innovation, international tie ups, choice based credit system for flexibility in choosing areas of interest etc. are some of the features of the University.

Vision of SGU is Internationally recognized university of excellence in creating and disseminating knowledge through value-based quality education leading to betterment of mankind. To achieve the vision SGU will develop state-of-the-art infrastructure that promotes conducive ambience promoting innovation and research. Create intellectual manpower relevant to the industry and society at large. Foster mutually beneficial partnership with alumni, industry and academia. Inculcate ethics and values to develop socially responsible citizens and promote entrepreneurship.

SGU is offering various programs through schools such as School of Technology, School of Commerce and Management, School of Sciences and School of Arts.

SGU has implemented the outcome based Education (OBE) system and Credit based Evaluation System in all the schools.

This booklet gives information on Academic and Examination rules and regulations for all the schools of Sanjay Ghodawat University. These rule will be updated, revised and corrected with reference to discussions with various faculties those who have worked in University systems.

1.1 Introduction to Outcome Based Education (OBE) System

OBE is an approach to education in which decisions about the curriculum are driven by the outcomes the students by the end of the course. It is a performance-based approach at the cutting edge of curriculum development, offering a powerful and appealing way of reforming the education. In outcome-based education the educational outcomes are clearly specified.

These determine the curriculum content and its organization, the teaching methods and strategies, the courses offered, the assessment process, the educational environment and the curriculum timetable. They also provide a framework for curriculum evaluation.

Learning outcomes are important in the teaching/learning process so that both teachers and students understand the purpose of the education. OBE system gives benefits over traditional method. It helps teachers to set objectives/goals in organized manner, Plan and deliver appropriate instructions for all class of students, design valid assessment tasks and strategies, ensure that instruction and assessment are aligned with the objectives. There are many advantages of OBE over traditional methods such as,

Clarity : The focus on outcomes creates a clear expectation of what needs to be accomplished by the end of the course. Students will understand what is expected of them and teachers will know what they need to teach during the course.

Flexibility : Instructors will be able to structure their lessons around the student's needs. OBE does not specify a specific method of instruction, leaving instructors free to teach their students using any method. Instructors will also be able to recognize diversity among students by using various teaching and assessment techniques during their class. OBE is meant to be a student-centered learning model. Teachers are meant to guide and help the students understand the concepts.

Involvement : Student involvement in the classroom is a key part of OBE. Students are expected to do their own learning, so that they gain a full understanding of the material. Increased student involvement allows students to feel responsible for their own learning, and they should learn more through this individual learning.

1.2 Introduction to Credit Based Evaluation (CBE) System

A credit system is a systematic way of describing an educational program by attaching credits to its components. The definition of credits in higher education systems may be based on different parameters, such as student workload, learning outcomes and contact hours.

A course credit (or just credit or "unit") is a basic measure of student workload. In other words, it is a standard method adopted by SGU like many other institutes for specifying the number of hours of learning effort that a student is expected to put in while completing a course. In contemporary education delivery models, this learning effort can be across multiple modes of learning, such as Lectures, Lab Work, Assignments, Self-study, E-learning, etc. Norms for relative weightages across these learning modes have also evolved.

The credit system allows an institute to specify programs and individual courses in terms of their required Credit load.

This in turn gives a clear picture of the learning effort that a student will have to put into each course as well as the overall program. In general calendar time is not used to define a program though there would be a typical duration based on a standard load that students are expected to take.

The Program requirements are met not just because the calendar time has elapsed, but because the student has actually completed the required number and type of courses and thereby, accumulated the required number of credits to graduate.

A credit based academic architecture makes it easy for a program to be updated and remain current.

There are many advantages of Credit Based Education System such as Accepted system at Universities all over the world, Quantifies academic work done by student, Transfer of credits from one University to other, Accepted by industry while giving jobs to students. SGU is adopting this Credit based evolution system and later it will be converted to Choose Based Credit System.

Semester I

Course Code	Course Title	L	T	Pr	C	Evaluation Scheme for Theory and Practical			
						Compo-nent	Exam	WT	Pass
EES 501 (UC) Version: 1.0	Research Methodology	3	1	-	4	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 503 (PC | ST) Version: 1.0	Automotive Embedded Systems - I	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 505 (PC | ST) Version: 1.0	Advanced Embedded Systems	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 507 (PC | ST) Version: 1.0	Real Time Operating Systems	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 509 (PE | ST) Version: 1.0	Program Elective I	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 511 (PC | ST) Version: 1.0	Automotive Embedded Systems – I Lab [TTL]	-	-	4	2	Pr (100)	TW	50	Min 40
							POE	50	
EES 513 (PC | ST) Version: 1.0	Automotive Electrical & Electronic Systems Lab [TTL]	-	-	4	2	Pr (100)	TW	50	Min 40
							POE	50	
EES 515 (PC | ST) Version: 1.0	Seminar I	-	-	2	1	Pr (100)	TW	50	Min 40
							POE	50	
	Total	**15**	**01**	**10**	**21**	Total Hrs: 26, Total Credits: 21			

L: Lecture, T: Tutorial, Pr: Practical, C: Credits, Th. : Theory, WT: Weight Age
PC: Program Core, PE: Program Elective, UC: University Core, UE: University Elective
ST: School of Technology, SS: School of Sciences, SC: School of Commerce, SM: School of Management, SA: School of Arts
FET: Faculty Evaluation Theory, CAT: Continuous Assessment Test, ESE End Semester Examination, TW : Term Work,
POE : Practical Oral Examination. Program Codes (XXX): Cloud Computing (CCC), Digital Manufacturing (MDM), Embedded Systems (EES), Geotechnical Engineering (CGT), Power and Energy (EPE).

Semester II									
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	Evaluation Scheme for Theory and Practical			
						Compo -nent	**Exam**	**WT**	**Pass**
EES 502 (PC | ST) Version: 1.0	Automotive Embedded Systems - II	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 504 (PC | ST) Version: 1.0	Embedded Systems Software	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 506 (PC | ST) Version: 1.0	Embedded Linux	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 508 (PE | ST) Version: 1.0	Program Elective II	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 510 (PE | ST) Version: 1.0	Program Elective III	3	-	-	3	Th (100)	FET	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
EES 512 (PC | ST) Version: 1.0	Automotive Embedded Systems – II Lab [TTL]	-	-	4	2	Pr (100)	TW	50	Min 40
							POE	50	
EES 514 (PC | ST) Version: 1.0	Vehicle Networking & Diagnostics Lab [TTL]	-	-	4	2	Pr (100)	TW	50	Min 40
							POE	50	
EES 516 (PC | ST) Version: 1.0	Seminar II	-	-	2	1	Pr (100)	TW	50	Min 40
							POE	50	
	Total	**15**	**00**	**10**	**20**	Total Hrs: 25, Total Credits: 20			

L: Lecture, T: Tutorial, Pr: Practical, C: Credits, Th. : Theory, WT: Weight Age
PC: Program Core, PE: Program Elective, UC: University Core, UE: University Elective
ST: School of Technology, SS: School of Sciences, SC: School of Commerce, SM: School of Management, SA: School of Arts
FET: Faculty Evaluation Theory, CAT: Continuous Assessment Test, ESE End Semester Examination, TW : Term Work,
POE : Practical Oral Examination

Semester III									
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	Evaluation Scheme for Theory and Practical			
						Compo-nent	**Exam**	**WT**	**Pass**
EES 601 (UE | ST) Version: 1.0	Open Elective*	-	-	-	AU	Th (100)	ESE	100	Min 40
EES 603 (PC | ST) Version: 1.0	Field Training/Mini Project	-	-	-	AU	Pr (100)	TW	50	Min 40
							POE	50	
EES 605 (PC | ST) Version: 1.0	Dissertation Phase I	-	-	24	12	Pr (100)	TW	50	Min 40
							POE	50	
EES 607 (PC | ST) Version: 1.0	Dissertation Phase II	-	-	24	12	Pr (100)	TW	50	Min 40
							POE	50	
	Total	**00**	**00**	**24**	**24**	Total Hrs: 24, Total Credits: 24			

L: Lecture, T: Tutorial, Pr: Practical, C: Credits, Th. : Theory, WT: Weight Age, AU: Audit Course (Pass/Fail) No Credits, PC: Program Core, PE: Program Elective, UC: University Core, UE: University Elective, * Self Study Course
ST: School of Technology, SS: School of Sciences, SC: School of Commerce, SM: School of Management, SA: School of Arts
CAT –I Continuous Assessment Test I, CAT – II Continuous Assessment Test II, ESE End Semester Examination
TW : Term Work, POE : Practical Oral Examination, Dissertation Phases: Students is required to undergo Internship Program as per the Program requirement with minimum 20 Hrs/Week. Dissertation Phase I and II are in continuation Phases in Internship Program or In Campus Requirement. Field Training/Mini Project: Student will undergo Field Training/carry out Mini Project work in between Semester II and III in related Industry.

Semester IV									
Course Code	**Course Title**	**L**	**T**	**Pr**	**C**	Evaluation Scheme for Theory and Practical			
						Component	**Exam**	**WT**	**Pass**
EES 602 (PC| ST) Version: 1.0	Dissertation Phase III	-	-	24	12	Pr (100)	TW	50	Min 40
							POE	50	
EES 604 (PC| ST) Version: 1.0	Dissertation Phase IV	-	-	30	15	Pr (100)	TW	50	Min 40
							POE	50	
	Total	**00**	**00**	**30**	**27**	Total Hrs: 30, Total Credits: 27			
						Grand Total of credits 92			

L: Lecture, T: Tutorial, Pr: Practical, C: Credits, Th. : Theory, WT: Weight Age
PC: Program Core, PE: Program Elective, UC: University Core, UE: University Elective
ST: School of Technology, SS: School of Sciences, SC: School of Commerce, SM: School of Management, SA: School of Arts
CAT –I Continuous Assessment Test I, CAT – II Continuous Assessment Test II, ESE End Semester Examination
TW : Term Work, POE : Practical Oral Examination, Dissertation Phase IV: In Campus Requirement of 10 Hrs/week in addition to Internship Program (If any).

Program Elective-I

Course Code	Course Title
EES 509.1 (PE | ST) Version: 1.0	Low Power VLSI
EES 509.2 (PE | ST) Version: 1.0	Intelligence Systems
EES 509.3 (PE | ST) Version: 1.0	Optimization Techniques

Program Elective-II

Course Code	Course Title
EES 508.1 (PE | ST) Version: 1.0	CMOS- RF & Microwaves Electronics
EES 508.2 (PE | ST) Version: 1.0	Communication Network Processors
EES 508.3 (PE | ST) Version: 1.0	Remote Sensing & Network

Program Elective-III

Course Code	Course Title
EES 510.1 (PE | ST) Version: 1.0	Internet Of Things
EES 510.2 (PE | ST) Version: 1.0	Embedded Wireless Sensor Networks
EES 510.3 (PE | ST) Version: 1.0	DSP Integrated Circuits

Note:

1. Minimum 40% marks in ESE and 50% marks considering ESE and CAT I and CAT II together for every theory course are necessary for passing in the course.
2. For a course with theory and practical examination weight of theory paper is 6o and 40 for evaluation of performance in practical sessions.

Instructions for Students:

1. Students shall earn 92 credits during 2 years of M. Tech. from School of Technology.

Instructions for Faculty:

1. **Continuous Assessment Test I & II (weight 20):** CAT I is to be conducted on units 1, 2 and 3 and CAT II is to be conducted based on and units 3, 4 and 5 for 30 marks each and 1 hour duration. The department will conduct CAT I and CAT II as per the Academic Calendar. The weight for the examinations is 20 each.
2. **End Semester Examination (ESE weight 60**): University will evaluate the students' performance by ESE This evaluation will be by Closed book test. University will constitute Central Examination Committee (CEC) and will conduct this evaluation. ESE will be conducted at the End of Semester for entire syllabus for 100 Marks with duration of 3 hrs.
3. **Term Work:** Faculty will evaluate the term work by conducting Open/Close book tests, Surprise tests, Quizzes, Assignments, Viva Voce examinations etc. Faculty can also evaluate the course of 20 weight by his/her own methodology. Faculty shall submit the FEL evaluation methodology before commencement of term/course to Head of Department and Students. The term work FEL will be conducted during the semester.
4. **Department Evaluation L Component (DEL of weight 30):** Department will evaluate the students' performance by DEL. This evaluation will be by Closed book test. COE will constitute Department Examination Committee (DEC) and will conduct this evaluation. DEL will be conducted at Mid of Semester for 50 % syllabus for 40 Marks examination with duration of 2 hrs.
5. **Faculty Evaluation P Component (FEP of weight 50):** Faculty will evaluate the practical course by conducting experiments with progressive assessment, Viva Voce examinations, Assignments etc. Faculty can also evaluate the course of weight 50 by his own methodology. Faculty shall submit the FEP evaluation methodology before commencement of course to Head of Department and students. Active Learning Laboratory concept shall be implemented in the laboratory by faculty.
6. **Department Evaluation P Component: (DEP of weight 50):** Department will evaluate the students' practical performance by DEP. This evaluation will be carried out by conducting external viva voce examination of weight 50.

EES 501: Research Methodology

(Ver 1.0, University Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Research:** Definition of research, Applications of research and types, Research process and steps in it, Deductive and inductive reasoning; Validity-conclusion, internal, construct and external; Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method.	08
II	**Single Factor Experiment:** Analysis of Variance (ANOVA) for fixed effect model; Total treatment and error sums of squares, Decomposition of total sum of squares, ANOVA for Randomized complete block design to control effects of nuisance factors. **Two factor Factorial Design**: Basic definitions and principles, main effect and interaction, response surface and contour plots, Blocking, General arrangement for a two factor factorial design; Models- Effects, means and regression	08
III	**Taguchi Techniques for Experimental Design:** Taguchi loss function, Average loss, nominal-the-best, smaller-the-best, larger-the-best, design process steps, selection of factors affecting- methods, factor levels, Test strategies- Full factorial experiment, fractional factorial experiment, Orthogonal arrays and their selection; Interaction effects, Parameter Design- Control and noise factors and parameter design, signal to noise ratio, types, parameter design strategy, tolerance design, robust design.	08
IV	**Design of Experiments (DOE):** Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles- replication, randomization, blocking, Guidelines for design of experiments, process of DOE, Simple Comparative Experiments- Basic statistical concepts, random variable, sample mean and variance, degrees of freedom, standard normal distribution, statistical hypothesis, Two sample t test-value, Confidence intervals, Paired comparison.	08

V	**Literature review:** Need, Procedure- Search for existing literature, Review the literature selected, Develop a theoretical and conceptual framework, Writing up the review, Formulating a research problem: Sources, Considerations, Steps in formulation of a problem, formulation of objectives, Definition of variables – Concepts, indicators and variables, Types of variables, Types of measurement scales, Constructing the Hypothesis- Null(Research) and alternative, one-tailed and two-tailed hypotheses, Hypothesis testing, errors in testing.	08
VI	**Research Modeling:** Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling, Data collection methods, Surveys-types and method selection. **Research Proposal**: Contents-Preamble, the problem, objectives, hypothesis to be tested, study design, setup, measurement procedures, analysis of data, organization of report; Displaying data- tables, graphs and charts, Writing a research report-Developing an outline, Key elements- Introduction, Methods, Measurement section, Design& procedure section, Results, conclusion section, Referencing of books and research papers, Report Writing- Prewriting considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.	08

References

1. Krishnaswamy, K. N., Sivakumar, Appa Iyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
2. Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi,Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1
3. Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN:978-81-265-1424-3
4. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners,(Pearson Education, Delhi) ISBN: 81-317-0496-3
5. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press,New Delhi), ISBN: 81-7722-372-0
6. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (NewAge International, New Delhi)
7. Ross, Philip J. (1996), 2/e, Taguchi Techniques for Quality Engineering, (McGraw Hill,New York)

EES 503: Automotive Embedded Systems - I

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Transducer Principles:** Transducers classification and basic principles, General Input-output configuration, static characteristics and dynamic characteristics of instruments, Variable resistance transducers, Metal and semiconductor strain gages and their signal conditioning, Inductive transducers, Electromagnetic sensors, Hall effect sensors, Capacitive transducers, Piezo electric transducers and their signal conditioning, Ultrasonic sensors.	08
II	**Electronics in the Automobile:** Automotive Architecture, Overview Auto electrical and Electronics systems: Starting and Charging system, HMI & Instrumentation, Lighting System, Switches, Power And Signal Distribution, Body Electronics, Powertrain Electronics, Chassis Electronics, Safety and Security.	06
III	**Powertrain Electronic Systems:** Gasoline Engine Management (EMS ECU), Diesel Engine Management system (EMS ECU), Transmission Control(TCU), Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems navigation systems multimedia systems cross application technologies. 42V vehicle power supply system.	06
IV	**Batteries & Charging systems:** Vehicle Batteries –Lead-Acid batteries – maintenance and charging –diagnosing Lead acid battery faults – advanced battery technology –new developments in electrical storage and batteries.	05
V	**Charging systems:** Requirements of charging systems ––generation of electrical energy in motor vehicle –physical principles – alternators – characteristic curves –charging circuits –diagnosing charging system faults –advanced charging system technology –new developments.	05

VI	**Sensors for Automobile:** Basic sensor arrangement, types of sensors such as- oxygen sensors, crank angle position sensors- Fuel metering vehicle speed sensors and destination sensors, Altitude sensor, Flow sensor, exhaust temperature, air mass flow sensors. Throttle position sensor, solenoids, stepper motors, relays, Steering wheel angle sensor, Vibration and acceleration sensors, Pressure sensors, Speed and RPM sensors, torque sensors.	10

References

1. "Automotive Electrics, Automotive Electronics: Systems & Components, 4th Ed., BOSCH. 2005
2. Automotive Sensors, BOSCH. 2002
3. Ronald K. Jurgen, "Sensors and Transducers, 2nd Edition, SAE, 2003.
4. Ernest O. Doebelin, "Measurement Systems – Application and Design", 4th Edition, McGraw-Hill, 2000
5. Embedded System Design: A unified Hardware / Software Introduction" – Frank Vahid and Tony Givargis, Wiley India Publishers.
6. A Practical Introduction to Hardware/Software Co-Design"- Patrick R. Schaumont, Springer Publishers.

EES 505: Advanced Embedded Systems

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to Embedded Systems & ARM Processors:** Embedded system (ES) definition, Embedded System Evaluation, ES Types with examples, Distinguish a Real Time Embedded System from other systems, Components of an Embedded system, Embedded system design issues & Design flow, a comparative study ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, ARM11.	08
II	**Bootloader, Firm- ware and OS:** Firmware execution flow, ARM firmware suit, Redhat RedBoot, an introduction to operating systems, fundamental components of OS, case study of simple operating system.	06
III	**ARM Cache Memory Systems:** Memory hierarchy, Cache Architecture, Cache policy, CP15 and Caches, Flushing and cleaning cache, Cache lock down, Cache Performance, Memory protection unit, Memory management unit, Virtual memory.	06
IV	**LPC3250 SOC Architecture :** Bus architecture and memory map, System control block, Clocking and power control, external memory controller, NAND flash controller, LCD controller	06
V	**Architecture of MSP430:** Architecture, Key features of the MSP430x1xx, Flexible Clock System, Embedded Emulation, Address Space, Flash, RAM, Peripheral Modules, Special Function Registers (SFRs)	05
VI	**Special Features in MSP 430:** Memory Organization, System Reset and Initialization, Power-On Reset (POR), Brownout Reset (BOR), Device Initial conditions After System Reset, Interrupts (Non)- Maskable Interrupts (NMI), Maskable Interrupts, Interrupt Processing, Interrupt Vectors.	06

References

1. ARM System Developers Guide- Designing & Optimizing System Software", Andrew N, Dominic Sloss, and Chris Wright, Elsevier, 2010.
2. Embedded System Design By Peter Marwedel, Springer publication.
3. An Embedded Software Primer, David E. Simon Pearson Education, Asia Publication
4. Embedded System Design A Unified Hardware/ Software Introduction By Frank Vahid/Tony Givargis, Wiley publication
5. ARM9EJ-S Technical reference manual
6. LPC32x0 User manual
7. MSP 430 User Guide

EES 507: Real Time Operating Systems

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to RTOS:** Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Embedded software architectures: Round robin, round robin with interrupts, Function queue scheduling and real time operating system, Basic architecture of an RTOS.	06
II	**RTOS Fundamentals:** Tasks and Task states – Semaphores – Shared data – Message queues, Mail boxes and pipes – Memory management – Interrupt routines – Encapsulating semaphore and queues Task management – Dual role of time – Intertask communication – Process input/output.	08
III	**Real Time Scheduling:** Schedulability problem: classification, schedulability test, worst case execution time (WCET) - static scheduling: - dynamic scheduling: dependent tasks, independent tasks.	06
IV	**Real Time Operating Systems:** VX works - uCOS – POSIX standards - RT Linux – device drivers – Real time library of Keil IDE - RTOS Porting to a Target.	06
V	**Threads:** Multithreading models, threading issues, thread libraries, synchronization, Mutex: creating, deleting, prioritizing mutex, mutex internals.	06
VI	**Case studies:** Free-RTOS architecture - Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems.	08

References

1. Hermann Kopetz, "Real–Time systems – Design Principles for distributed Embedded Applications", Second Edition, Springer 2011.
2. Micro C OS II reference manual.
3. VX works Programmers manual.
4. Keil Real Time library documentation
5. Doug Abbott, "Linux for embedded and real time applications", Elsevier Science, 2003

Program Elective-I

EES 509.1: Low Power VLSI

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to Low power VLSI** Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Basic Principles of Low Power Design, Low Power Figure of Merits	06
II	**Power estimation, Simulation Power analysis:** SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo Simulation	07
III	**Low Power Design at Logic level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic , Clock Power Reduction: Clock Gating, Oscillator Circuit for Clock Generation, Frequency Division and Multiplication	07
IV	**Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation	06
V	**Algorithm & Architectural Level Methodologies:** Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.	05
VI	**Software Design for Low Power:** Sources of software power dissipation, software power estimation, software power optimization, Automated low power code generation, codesign for low power	06

References

1. "Low Power Design Methodologies", P. Rashinkar, Paterson and L. Singh, Kluwer Academic, 2002
2. "Low power CMOS VLSI circuit design", Kaushik Roy, Sharat Prasad, ISBN: 0-471-11488-x, John Wiley & sons Inc.
3. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.

EES 509.2: Intelligence Systems

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction and Basic Concepts:** Introduction- Humans and Computers, the structure of the brain, learning in machines, the differences. The basic neuron- Introduction, modeling the single neuron, learning in simple neurons, the perception: a vectorial Perspective, the perception learning rule, proof, limitations of perceptrons.	08
II	**Multilayer Networks :** The multi layer perceptron: Introduction, altering the perception model, the new model, the new learning rule, multi layer perception algorithm, XOR problem. Multi layer feed forward networks	06
III	**Back propagation training algorithm:** Problems with back propagation, Boltzman training, Cauchy training, combined back propagation, Cauchy training.	06
IV	**Resonant Networks And Applications:** Hop-field networks: recurrent and bi-directional associative memories, counter propagation network, Artificial Resonance Theory (ART) Application of neural network: Hand written digit and character recognition-Traveling sales man problem, a neuro-controller.	06
V	**Fuzzy Set Theory:** Introduction to fuzzy set theory: Fuzzy set vs Crisp set, properties of fuzzy sets, operations on fuzzy set – fuzzy compliments, fuzzy intersection- T-norms, fuzzy union- t- co-norm, fuzzy relations.	06
VI	**Fuzzy Logic and Systems:** Fuzzy Logic: Classical logic, multi valued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges and their inferences. Fuzzy systems: fuzzy controllers, fuzzy systems and neural networks, fuzzy neural networks, fuzzy automata, fuzzy dynamic system.	05

References

1. G.J.Klir & Bo Yuan, "Fuzzy Sets and Fuzzy Logic Theory and Applications", Prentice Hall of India, 2009.
2. Timothy S.Ross, "Fuzzy Logic with engineering applications", Weily India Pvt. Ltd., 2011..
3. Kosko B, "Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence", Prentice Hall of India, 2009.
4. R Beale & T Jackson, "Neural Computing, An Introduction", Adam Hilger, 1990.
5. Rao V.B and Rao H.V., "C++, Neural Networks and Fuzzy Logic", BPB Publications, 2003.
6. Simon Kendal, Malcolm Creen, "An Introduction to Knowledge Engineering", Springer-Verlag Limited, 2007.

EES 509.3: Optimization Techniques

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Linear programming-extensions:** Revised simplex method, Dual Simplex method, Bounded variables method, primal-dual relationships, duality theorems, economic interpretation of dual, dual of transportation model, sensitivity analysis in LPP and transportation models, Karmarkar's interior point algorithm	10
II	**Dynamic programming:** Formulation, recursive approach, Goal programming: formulation, graphical solution, algorithm, Integer programming: Formulation, Cutting plane algorithm, Branch and bound algorithm	06
III	**Classical Optimization:** Single and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers, Kuhn-Tucker Conditions **Single-variable:** Optimization: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method	09
IV	**Multi-variable Optimization:** Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method	04
V	**Conjugate Direction Method:** Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method	04
VI	**Introduction to Constrained Optimization :** Interior Penalty Function Method, Exterior Penalty function Method	04

References

1. Hillier and Lieberman, Introduction to Operations Research, Tata McGraw Hill
2. N D Vora, Quantitative techniques in Management, Tata McGraw Hill
3. Deb K. (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
4. Rao S. (1996), Engineering optimization, Theory and Practice, New Age International Publishers
5. Ravindran A., Ragsdell K. and Reklaitis G. (2006), Engineering Optimization: Methods and Applications, 2/e, John Wiley and Sons Inc.

EES 511: Automotive Embedded Systems – I Lab

(Ver 1.0, Program Core, School of Technology)

To be provided by TATA Technologies Ltd.

EES 513: Automotive Electrical & Electronic Systems Lab

(Ver 1.0, Program Core, School of Technology)

To be provided by TATA Technologies Ltd.

EES 515: Seminar I

(Ver 1.0, Program Core, School of Technology)

(i) Students shall carryout an exhaustive literature review (research articles, technical articles, white papers, books etc.), on a chosen topic under the supervision of a Guide and present the findings in the form of a review paper in the department in front of a departmental faculty committee, as a part of the term work / POE.

(ii) The article must be published in a National / International Conference/Journal as a part of the term work / POE.

Semester II

EES 502: Automotive Embedded Systems - II

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Vehicle Convenience and Security Systems:** Tyre pressure monitoring systems, Two-wheeler and Four-wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies..	05
II	**Safety Systems in Automobiles:** Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle Dynamics Control, accelerators and tilt sensors for sensing skidding and anti-collision - anti-collision techniques using ultrasonic Doppler sensors.	06
III	**MEMS based Automotive Sensors:** Micro systems in Automobiles- an Overview, MEMS sensor over conventional Sensors, different types of MEMS based Sensors for Drive train Control, Safety Systems and Comfort Systems. NOX sensors.	06
IV	**Electronic Ignition systems:** Electronic ignition systems. Types of solid state ignition systems and their principle of operation Digital engine control system. Open loop and closed loop control system, Engine cranking and warm up control. Acceleration enrichment. Deceleration learning and ideal speed control Distributor less ignition – Integrated engine control system, Exhaust emission control engineering. Electronic fuel injection. Variable Valve Timing (VVT).	08
V	**Automotive Embedded System:** Automotive Embedded systems. PIC, Freescale microcontroller based system. Recent advances like GLS, GPSS, GMS. Multiprocessor communication using CAN bus. Case study- cruise control of car. Artificial Intelligence and Body Electronics.	08
VI	**Instrumentation and Advances in Automobile Engineering:** Passenger comfort - Safety and security - HVAC - Seat belts - Air bags - Automotive Electronics - Electronic Control Unit (ECU) - Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP) Traction Control System (TCS) - Xby-wire - Electric - Hybrid vehicle.	10

References

1. "Automotive Electrics, Automotive Electronics: Systems & Components, 4th Ed., BOSCH. 2005
2. Automotive Sensors, BOSCH. 2002
3. Ronald K. Jurgen, "Sensors and Transducers, 2nd Edition, SAE, 2003.
4. Ernest O. Doebelin, "Measurement Systems – Application and Design", 4th Edition, McGraw-Hill, 2000
5. Tai-Ran Hsu, "MEMS & Microsystem, Design and Manufacture", McGraw Hill, 2002.
6. David A. Corolla, (2009), Automotive Engineering: Powertrain, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd.
7. Richard Stone, Jeffrey K. Ball, (2004), Automotive Engineering Fundamentals" SAE International
8. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.

EES 504: Embedded Systems Software

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction To Assembly Language And Data representation In C:** language programming – macros - Data representation – Twos complement, fixed point and floating point number formats –Low level programming in C: Primitive data types – Pointers – Structures – Unions – Dynamic memory allocation – Functions – recursive functions - Linked lists.	08
II	**Programming In C:** Register usage conventions – Typical use of addressing options – Instruction sequencing – Procedure call and return – Functions – recursive functions - Parameter passing – Retrieving parameters – Everything in pass by value – Temporary variables – threads – preemptive kernels – system timer – scheduling.	08
III	**Object Oriented Programming:** Object oriented analysis and design - C++ classes and objects – functions – data structures - examples.	04
IV	**Introduction to Unified Modeling Language:** Connecting the object model with the use case model – Key strategies for object identification – UML basics.	04
V	**Programming of Unified Modelling Language:** Object state behavior – UML state charts – Role of scenarios in the definition of behavior – Timing diagrams – Sequence diagrams – Event hierarchies – types and strategies of operations – Architectural design in UML concurrency design – threads in UML.	05
VI	**Embedded Software Development Tools and RTOS:** The compilation process – libraries – porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – system design using RTOS.	06

References

1. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet", Pearson Education, 2002.
2. Bruce Powel Douglas, "Real time UML, second edition: Developing efficient objects for embedded systems", 3rd Edition 1999, Pearson Education.
3. Steve Heath, "Embedded system design", Elsevier, 2003.
4. David E. Simon, "An Embedded Software Primer", Pearson Education, 2003.
5. E. Balaguruswamy, "Object oriented programming with C++", Tata McGraw Hill, 2011.

EES 506: Embedded Linux

(Ver 1.0, Program Core, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Linux Fundamentals :** Introduction - host-target development setup - hardware support - development languages and tools – RT Linux.	05
II	**Initialization:** Linux kernel and kernel initialization - system initialization – hardware support – bootloaders.	04
III	**Device Handling:** Device driver basics - module utilities - file systems - MTD subsystems – busybox	04
IV	**Development Tools:** Embedded development environment - GNU debugger - tracing & profiling tools - binary utilities - kernel debugging - debugging embedded Linux applications - porting Linux - Linux and real time - SDRAM interface	08
V	**Shell Programming** Processes – giving more than one command at a time – prioritizing and killing processes – Scheduling Commands – pipes and redirection – regular expression – pattern matching – Scripting using for while, if and other commands.	06
VI	**Device Applications:** Asynchronous serial communication interface - parallel port interfacing - USB interfacing - memory I/O interfacing - using interrupts for timing.	06

References

1. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, “Building embedded linux systems”, O'Reilly, 2008.
2. Christopher Hallinan, “Embedded Linux Primer: A practical real world approach”, Prentice Hall, 2007.
3. Craig Hollabaugh, “Embedded Linux: Hardware, software and Interfacing”, Pearson Education, 2002.
4. Doug Abbott, “Linux for embedded and real time applications”, Elsevier Science, 2003.

Program Elective II

EES 508.1: CMOS- RF & Microwave Electronics

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Performance Parameters of RF Circuits:** Gain Parameters, Non-linearity parameters, Noise figure, Phase Noise, Dynamic range, RF front end performance parameters, performance trade-offs in an RF circuit.	08
II	**Filter Design:** Modern filter design, Frequency and impedance scaling, High Pass filter design, Band pass filter design, Band reject filter design, the effects of finite Q.	06
III	**High Frequency Amplifier Design:** Zeros as Bandwidth enhances, Shunt-series Amplifier, Bandwidth enhancement with frequency Doublers, Tuned amplifiers, Neutralization and uni-lateralization, cascaded Amplifiers, LNA Topologies.	08
IV	**Mixers:** Mixer fundamentals, Non linear systems as Linear mixers, multiplier based mixers, Sub sampling mixers.	04
V	**Oscillators:** Problems with purely linear oscillators, Tuned oscillator, Negative Resistance oscillators, frequency synthesis.	04
VI	**RF Power Amplifiers:** General considerations, Class A, AB, B & C Power amplifier, Class D, E & F amplifiers, modulation of power amplifiers, RF Power amplifier design examples.	06

References

1. RF Microelectronics (2nd Edition) (Prentice Hall Communications Engineering and Emerging Technologies Series from Ted Rappaport)
2. Aleksandar Tasic, Wouter.A.Serdijn, John.R.Long, “Adaptive Low Power Circuits for Wireless Communication (Analog Circuits and Signal Processing)”, Springer, 1st Edition, 2006.
3. Chris Bowick, “RF Circuit design”, Newnes (An imprint of Elesvier Science), 1st Edition, 1997.

EES 508.2: Communication Network Processors

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Overview Of Data Networks:** End point: Data Modems, Serial interfaces, ISDN interface – Communication: Types of switching, Types of error: single and burst error, Error detection, redundancy check: Longitudinal, vertical, and cyclic error correction, architecture of computer network - Overview of OSI reference model – Network components: Routers, Bridges and Gateways.	08
II	**Communication Software Design:** Ecosystem - embedded communications software - software partitioning - module and task decomposition - Partitioning case study - Protocol software - debugging protocols - tables and other data structures - table access routines	06
III	**Communication Software Management:** Buffer and timer management - Management software – device & router management – CLI based management & HTTP based management – Agent to protocol interface – device to manager communication – system setup, boot & post-boot configuration – saving and restoring the configuration.	06
IV	**Multi-Board Design:** Multi board common architectures for communication equipment – Single board, chassis and rack-based designs - Components of a multi board designs– RTOS support for distribution – data structure and state machine changes for distribution – failures and fault tolerance in multi board systems.	06
V	**Design Principles Of Scheduling:** Processor scheduling – Multiprocessor scheduling – Limited packet processing capacity in routers – real time scheduling on multiprocessors – Multithreaded Packet processors – random external memory accesses	06
VI	**Communication Processor Architectures:** The TRIBE Architecture – Tribe pipeline – Quantum Flow Processor - Introduction – Architecture of quantum flow processor – ASR 1000 series router – QFP residing on distributed line cards – High level packet flow –Packet Processors Engines – Packet Processor Engine resources – QFP Buffer, Queue and scheduling.	08

References

1. Behrouz A. Forouzan, "Data Communications and Networking", 4th Edition, Mc-Graw Hill.
2. T. Sridhar, "Designing Embedded Communications Software", CMP books, 2003.
3. Mark A. Franklin, Patrick Crowley, Haldun Hadimioglu and Peter Z. Onufryk., "Network Processor Design – Issues and Practices",Elsevier, 2005.
4. "The CISCO Quantum Flow Processor", CISCO's Next Generation Network Processor Manual.

EES 508.3: Remote Sensing & Network

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Overview of Remote sensing: Definition of Remote sensing:** Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction of EM Radiation with atmosphere, and target, Atmospheric Widows, imaging spectrometry, Spectral signature of various land cove features.	08
II	**Platforms And Sensors:** Platforms: Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana)	08
III	**Data reception, Data processing & Data generation:** Ground station, Data generation, Data processing & correction Radiometric and Geometric corrections Radiometric corrections Random noise correction, Atmospheric correction, Geometric errors and corrections, Distortion evaluated from tracking data, distortion evaluated from ground control Image correction.	06
IV	**Ground Investigation in support of Remote sensing:** Uses of ground data, calibration correction, Interpretation of properties, Training sets, Accuracy evaluation, test sites Ground truth Instruments and spectral signature, Spectral Reflectance and spectral signature of vegetation, Sources of RS data: Global and Indian data products Visual Image Interpretation Introduction to Visual Interpretation, Basic principles of Visual Interpretation Elements of Visual Interpretation, Techniques of Visual Interpretation Interpretation Keys, Methods of searching and sequence of Interpretation Methods of analysis and Reference levels Computer compatible tapes – Band sequential format, Band interleaved by Line format, Run-length encoding format.	10

V	**Thermal Imaging system:** Thermal Imaging System: Introduction - IR region of the Electromagnetic spectrum, Atmospheric transmission, Kinetic and radiant temperature, Thermal properties of materials, Emissivity, Radiant temperature. Thermal conductivity. Thermal capacity, thermal inertia, apparent thermal inertia, Thermal diffusivity. Radiation principles (Plank's Law, Stephen Boltzman law).	08
VI	**Thermal Imaging Application:** Interaction of EMR with earth surface, Wien's displacement law, Kirchoffs Law). IR - radiometers, Airborne and Satellite TTR scanner system Characteristics of IR images Scanner distortion, ii) image irregularities, iii) Film density and recorded iv) Temperature ranges Effects of weather on images. I)Clouds, ii) Surface winds, iii) Penetration of smoke plumes Interpretation of thermal imagery Advantages of Thermal imagery	

References

1. Floyd, F. Sabins, Jr: Remote Sensing Principles and Interpretation, Freeman and Co., San Franscisco, 1978.
2. Illesand and Kiefere: Remote Sensing and Image interpretation, John qwiley, 1987.
3. Manual of Remote Sensing Vol. I&II, 2nd Edition, American Society of Photogrammetry.
4. Remote Sensing: The quantitative approach, P.H. Swain and S.M. Davis, McGraw Hill.
5. Introductory Digital Image Processing: A remote sensing perspective, John R. Jensen, Prentice Hall.
6. Imaging Radar for Resource Survey: Remote Sensing Applications, 3, W Travelt, Chapman & Hall.
7. Remote sensing Notes –Edited by Japan Associates of Remote sensing- JARS 1999

Program Elective-III

EES 510.1: Internet of Things

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**IoT & Web Technology:** The Internet of Things Today, Time for Convergence, Towa the IOT Universe, Internet of Things Vision, IOT Strategic Research and Innovation Directions, Future Internet Technologies, Infrastructure, Networks and Communication. Processes, Data Management. Device Level Energy Issues.	06
II	**IoT Applications for Value Creations:** IOT applications for industry: Future Factory concepts, Brownfield IOT. Smart Objects, Smart Applications, IOT for Retailing Industry, IOT for Oil and Gas Industry, Home Management.	06
III	**Internet of Things Privacy, Security and Governance:** Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IOT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IOT in Smart Cities, Security	06
IV	**Architectural Approach for IoT:** Defining a Common Architectural Ground, IOT Standardization, M2M Service Liver Standardization. IEEE. IETF and ITU-T standardization activities, Interoperability Challenges, Physical vs Virtual, Data Interoperability, Semantic Interoperability, Organizational Interoperability, Eternal Interoperability, Importance of Standardization, Plan for validation and testing	08
V	**Identity Management Models in IoT:** Vulnerabilities of IOT, Security requirements, Challenges for a secure Internet of Things, Identity portrayal, Different identity Management Model; Local identity, Network identity, Global web identity, User-centric identity management, Device centric identity management, Hybrid identity management.	05

VI	**Trust Management in IoT:** Trust management life cycle, Identity and trust, Third party app Public key infrastructure, Attribute certificates, Of trust models, Web services security, SAML approach, Fuzzy approach for Trust, Access control in LOT, Different access control schemes, Authentication and Access control policies modeling.	05

References

1. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013.
2. Vijay Medishctti. Arshadeep Bahga. Internet Of Things; A Hands-On Approach
3. Clino Pfister, Getting Started with the Internet of Things. O'Reilly Media, 2011.
4. Poonam Railkar, Identity Management for Internet of Things, Publishers. 2015.

EES 510.2: Embedded Wireless Sensor Networks

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**Introduction to WSN:** Introduction to WSN-Challenges for WSNs-Characteristic requirements - Required mechanisms - Single-node architecture -Hardware components- Energy consumption of sensor nodes -Operating systems and execution environments-Some examples of sensor nodes.	08
II	**Network Architecture:** Sensor network scenarios- Optimization goals and figures of merit- Design principles for WSNs, Service interfaces of WSNs- Gateway concepts.	06
III	**Sensor Network Implementation:** Sensor Programming- Introduction to TinyOS Programming and fundamentals of Programming sensors using nesC- Algorithms for WSN – Techniques for Protocol Programming.	07
IV	**Programming Models:** An Introduction to the Concept of Cooperating Objects and Sensor Networks- System Architectures and Programming Models.	06
V	**Simulators for WSN:** Necessity of simulation, Types of simulations, Generic network simulators, code level simulators, Firmware level simulators, algorithm level simulators, Packet level simulators, limitations of WSN simulators	08
VI	**Case Studies:** Wireless sensor networks for environmental monitoring, Wireless sensor networks with mobile nodes, Autonomous robotic teams for surveillance and monitoring, Inter-vehicle communication networks.	06

References

1. Holger karl, Andreas Willig, "Protocols and architectures for wireless sensor networks", John Wiley,2005.
2. Liljana Gavrilovska, Srdjan Krco, Veljko Milutinovic , Ivan Stojmenovic,Roman Trobec, "Application and Multidisciplinary Aspects of Wireless Sensor Networks", Springer-Verlag, London Limited 2011.
3. Michel Banâtre, Pedro José Marrón, Anibal Ollero, Adam Wolisz, "Cooperating Embedded Systems and Wireless Sensor Networks ", John Wiley & Sons, Inc .2008.
4. Seetharaman Iyengar, Nandhan, "Fundamentals of Sensor Network
5. Programming Applications and Technology", John Wiley & Sons, Inc.2008.

EES 510.3: DSP Integrated Circuits

(Ver 1.0, Program Elective, School of Technology)

Syllabus (Theory)

Units	Description	Hours
I	**DSP IC's And VLSI Circuit Technologies:** Standard digital signal processors, Application specific IC's for DSP, DSP systems, DSP system design, Integrated circuit design. MOS transistors, MOS logic, VLSI process technologies, Trends in CMOS technologies DFT-The Discrete Fourier Transform, FFT-The Fast Fourier Transform Algorithm, Image coding, Discrete cosine transforms.	08
II	**Digital Signal Processing:** Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal-processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms	06
III	**Digital Filters and Finite Word Length Effects:** FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures	08
IV	**Multirate systems**: Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multirate filters. Finite word length effects - Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise	06
V	**DSP Architectures and their Synthesis:** DSP system architectures, Standard DSP architecture, Ideal DSP architectures, Multiprocessors and multicomputers, Systolic and Wave frontarrays, Shared memory architectures.	08
VI	**Arithmetic Units and IC Design:** Conventional number system, redundant Number system, Residue Number System. Bit-parallel and Bit-Serial arithmetic, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift accumulator.	07

References

1. Lars Wanhammer, "DSP Integrated Circuits", Academic press, NewYork, 1999.
2. Robert J. Schilling, "Fundamentals of Digital Singal Processing using MATLAB", Pearson Education, 2010.
3. A.V.Oppenheim et.al, "Discrete-time Signal Processing", Pearson education, 2000.
4. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital signal processing –A practical approach", 2nd Edition, Pearson edition, Asia, 2011.
5. Keshab K.Parhi, "VLSI digital Signal Processing Systems design and Implementation", Wiley India, 2007.

EES 512: Automotive Embedded Systems – II Lab

(Ver 1.0, Program Core, School of Technology)

To be provided by TATA Technologies Ltd.

EES 514: Vehicle Networking & Diagnostics Lab

(Ver 1.0, Program Core, School of Technology)

To be provided by TATA Technologies Ltd.

EES 516: Seminar II

(Ver 1.0, Program Core, School of Technology)

(i) Students shall carryout an exhaustive literature review (research articles, technical articles, white papers, books etc.), on a chosen topic under the supervision of a Guide and present the findings in the form of a review paper in the department in front of a departmental faculty committee as a part of the term work / POE.

Alternatively results of an experimental work for the purpose of research carried out under the supervision of a Guide may be presented in the same manner.

(ii) The article must be published in a National / International Conference/Journal as a part of the term work as a part of the term work / POE.

Semester III

EES 601: Open Elective

(Ver 1.0, University Elective, School of Technology)

Student shall choose an elective course from the declared list and study (self-study course). Evaluation will be through an end of semester examination.

EES 603: Field Training/Mini Project

(Ver 1.0, Program Core, School of Technology)

Student shall undergo Field Training/carry out a Mini Project assigned to the student, between Semester II and III in a relevant industry/ area, under the supervision of a Guide. The report shall be submitted during Semester III and evaluated by the expert committee appointed for this purpose.

EES 605: Dissertation Phase I

(Ver 1.0, Program Core, School of Technology)

Student shall work on a project (sponsored / non-sponsored) under the supervision of a Guide and complete the literature review, submit the synopsis in Phase I and present it in front of an expert committee appointed for this purpose.

EES 607: Dissertation Phase II

(Ver 1.0, Program Core, School of Technology)

Student shall work on the project (sponsored / non-sponsored) selected, under the supervision of a Guide and complete the further work as prescribed by the Guide, submit the work completion report in Phase II in prescribed format and present it in front of an expert committee appointed for this purpose.

Semester IV

EES 602: Dissertation Phase III

(Ver 1.0, Program Core, School of Technology)

Student shall work on the project (sponsored / non-sponsored) selected, under the supervision of a Guide and complete the further work as prescribed by the Guide, submit the work completion report in Phase III in prescribed format and present in front of an expert committee appointed for this purpose.

EES 604: Dissertation Phase IV

(Ver 1.0, Program Core, School of Technology)

(i) Student shall complete the project work undertaken, under the supervision of a Guide and present it in front of a research review (R. R.) committee. Upon approval by the R.R. Committee, the student shall submit the final dissertation report in prescribed format and present it in front of an expert committee appointed for this purpose.
(ii) The dissertation work must be published in the form of a research article in a National / International Journal as a part of the term work / POE.