ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.Tech.
EMBEDDED SYSTEMS

(Applicable for the batches admitted from 2015 - 2016)

VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI
INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institute, Accredited by NAAC with 'A' Grade
NBA Accreditation for CE, EEE, ME, ECE, CSE, EIE, IT B.Tech. Programmes
Approved by AICTE, New Delhi, Affiliated to JNTUH
Recognized as "College with Potential for Excellence" by UGC
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VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
HYDERABAD
An Autonomous Institute

Academic Regulations - M.Tech. Programme
(Applicable for the batches admitted from the academic year 2015-2016)

1. **Introduction**

   Academic programmes of the institute are governed by rules and regulations as approved by the Academic Council of the institute.

   These academic rules and regulations are effective from the academic year 2015-16, for the students admitted into two year post graduate programme offered by the college leading to Master of Technology (M. Tech.) degree in different specializations offered by the departments of Civil Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer Science and Engineering, Information Technology and Electronics and Instrumentation Engineering.

   The M.Tech. degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on students who are admitted to the programme after fulfilling all the requirements for the award of the degree.

1.1 Eligibility for Admissions

   Admission to the above program shall be made subject to the eligibility and qualifications prescribed from time to time. Admissions shall be made on the basis of GATE Rank and merit rank obtained at an Entrance Test conducted by the TSSCHE or as decided by TSSCHE subject to reservations prescribed by the university/ State Government from time to time.

2. **Programmes of study**

   The following two year M.Tech. degree programmes of study are offered by the departments at VNR VJIET.

Department	Specializations
ME	1. Advanced Manufacturing Systems 2. Automation 3. CAD/CAM
CE	1. Highway Engineering 2. Structural Engineering 3 Geotechnical Engineering
EEE	1. Power Electronics 2. Power Systems
CSE	1. Software Engineering 2. Computer Science and Engineering
ECE	1. VLSI System Design 2. Embedded Systems
EIE	Electronics and Instrumentation
IT	Computer Networks and Information Security

- **'ENGLISH'** language is used as the medium of instruction in all the above programmes.

3. Attendance requirements

Each academic year shall be divided into two semesters, each of 90 Instructions days, excluding examination, evaluation, declaration of results etc.

3.1 A student shall be eligible to appear for the semester end examinations in subject if he / she acquire a **minimum of 75% of attendance in that subject.**

3.2 Shortage of attendance up to 10% in any subject (i.e., attendance of 65% and above and below 75%) in a semester may be condoned by the Institute Academic Committee based on the rules prescribed by the Academic Council of the Institute from time to time.

3.3 A student shall get **minimum required attendance in at least three (03) theory subjects** in the present semester to get promoted to the next semester. In order to qualify for the award of the M.Tech. degree, the student shall complete all the academic requirements of the subjects, as per the course structure.

3.4 Shortage of **attendance below 65% shall in NO case be condoned**.

3.5 A stipulated fee shall be payable towards condonation of shortage of attendance.

3.6 In case the student secures less than the required attendance in any subject(s), he shall not be permitted to appear for the semester end examination in that subject(s). He shall re-register for the subject when offered next.

4. Evaluation

i.   The performance of a student in each semester shall be evaluated subject–wise with a maximum of **100 marks for theory** and **100 marks for practical subjects**. In addition, **mini-project** and **comprehensive viva-voce** shall be evaluated for **100 marks** respectively.

ii.   For theory subjects, the distribution shall be **40 marks for mid-term evaluation** and **60 marks for the semester end examination**.

❖ **Mid-Term Evaluation (40 M):**
Mid-term evaluation consists of **mid-term examination (30 M)** and **assignment/objective test/ case study/course project (10 M).**

➢ **Mid-term examination (30 M):**
- For theory subjects, two mid-term examinations shall be conducted in each semester as per the academic calendar. Each mid-term examination shall be evaluated for 30 marks.
- Pattern of Mid-term examination:
  3 X 10M = 30 M (three internal choice questions one from each UNIT shall be given, the student has to answer ONE question from each UNIT)
- There shall be TWO mid-term examinations for each subject and the average of two mid-term examinations shall be considered for calculating final mid-term examination marks in that subject.

➢ **Assignment/objective exam/ case study/course project (10 M):**
- Two assignment/objective exam/ case study/course project shall be given to the students covering the syllabus of first mid-term and second mid-term examinations respectively and evaluated for 10 marks each.
- The first assignment/objective exam/ case study/course project shall be submitted before first mid-term examination and the second one shall be submitted before second mid-term examination.
- The average of 2 assignments shall be taken as final assignment marks.

iii.   For practical subjects, there shall be a **continuous evaluation during the semester for 40 marks and 60 marks for semester end examination**. Out of the 40 marks, **day-to-day work in the laboratory shall be evaluated for 10 marks**, and **15 marks for practical examination** and **15 marks for laboratory record**.

❖ **Semester End Examination (60 M):**
(a) Theory Courses
Question paper pattern for semester end examination (60 Marks)
- Paper shall consist of 05 questions of 10 marks each. (05X12M = 60 M)
- There shall be 01 question from each unit with internal choice.

(b) Practical Courses
Each laboratory course shall be evaluated for 60 marks. The semester end examination shall be conducted by two examiners, one Internal and other external concerned with the subject of the same / other department / Industry. The evaluation shall be as per the standard format.

4.1. Evaluation of Mini-Project: There shall be two presentations during the first year, one in each semester. For mini-project 1 and mini-project 2, a student under the supervision of a faculty member, shall collect the literature on a topic, critically review the literature, carry out the mini-project, submit it to the department in a report form and shall make an oral presentation before the departmental Project Review Committee (PRC). The Departmental PRC consists of Head of the Department, supervisor and one senior faculty member of the department. For each mini-project there shall be only internal evaluation of 100 marks. A student has to secure a minimum of 50% to be declared successful.

4.2. There shall be a comprehensive viva-voce in II year I semester. The comprehensive viva- Voce shall be conducted by a committee consisting of Head of the Department and two senior faculty members of the department. The comprehensive viva-voce is aimed to assess the students' understanding in various subjects studied during the M.Tech. programme of study. The comprehensive viva-voce shall be evaluated for 100 marks by the committee. There are no internal marks for the comprehensive viva-voce. A student must secure a minimum of 50% to be declared successful.

4.3. A student shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the semester end examination and a minimum aggregate of 50% of the total marks in the semester end examination and mid-term evaluation taken together.

4.4. A student shall be given one chance to re-register, after completion of the course work, for each subject, provided the internal marks secured by a student are less than 50% and he has failed in the semester end examination. In such a case student may re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end examination in the re-registered subject(s). Re-registration for the subjects is allowed only if that particular re-registration subjects are the hindrance for the award of Degree. Re-registration is allowed in this case provided the student doesn't have any subject(s) yet to pass other than the re-registration subjects where the internal marks are less than 50% with prior permission.

4.5. Laboratory examination for M.Tech. courses must be conducted with two examiners, one of them being laboratory class teacher and second examiner shall be a teacher of same specialization either external or a teacher from the same department other than the teacher who conducted laboratory classes for that batch.

5. Evaluation of Project / Dissertation Work.

5.1 Registration of Project Work: A student shall be permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

5.2 A Project Review Committee (PRC) shall be constituted with at least four members namely HOD, PG coordinator of the M.Tech. programme, project supervisor and one senior faculty member of same specialization.

5.3 After getting permission as per 5.1, a student has to submit, in consultation with the project supervisor, the title, objective and plan of action of his project work to the Departmental PRC for its approval. Only after obtaining the approval of PRC, the student can initiate the project work.

5.4 If a student wishes to change his supervisor or topic of the project he can do so with the approval of PRC. However, the committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project

proposal. If so, the date of registration for the project work shall be the date of change of supervisor or topic as the case may be.

5.5 Internal evaluation of the project shall be on the basis of the seminars (Project reviews) conducted during the second year by the PRC. A student shall submit draft report in a spiral bound copy form.

5.6 The work on the project shall be initiated in the beginning of the second year and the duration of project is for two semesters. A student is permitted to submit Project work only after successful completion of theory and practical course with the approval of PRC not earlier than 240 days from the date of registration of the project work. For the approval of PRC the student shall submit the draft copy of thesis to the Head of the Department (Through project supervisor and PG coordinator) and shall make an oral presentation before the PRC.
The student is eligible to submit project work if he has published at least one paper covering 70% of the project work and presented his project work in Show and Tell activity.

5.7 After approval of PRC, every student has to submit three copies of the project dissertation certified by the supervisor to the Department.

5.8 The dissertation shall be adjudicated by one examiner selected by the Chief Superintendent. For this, HOD shall submit a panel of 3/ 5 examiners, who are eminent in that field with the help of the concerned guide.

5.9 If the report of the examiner is not favourable, the student shall revise and resubmit the Dissertation, within the time frame as prescribed by PRC. If the report of the examiner is unfavourable again, the dissertation shall be summarily rejected.

5.10 If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the project supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly report students work as:

A. **Excellent**
B. **Good**
C. **Satisfactory**
D. **Unsatisfactory**

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. The student has to secure any one of the grades as Excellent, Good or Satisfactory on his dissertation and viva-voce. If the report of the viva-voce is unsatisfactory, the student shall retake the viva-voce examination after three months, making modifications as suggested. If he fails to get a satisfactory report at the second viva-voce examination, he has to re-register for the project work as mentioned in clause 5.1. However, the student may select a new guide or new topic or both with the approval of the PRC and submit the project dissertation with a minimum of 240 days from the date of re-registration. Of course, this shall not prejudice the clause 6.1 below.

6. Award of Degree and Class
A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and complete it successfully for **not less than two academic years** and **not more than four academic years**.

6.1 A student, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of his admission, for any reason whatsoever, shall forfeit his seat in M.Tech. Course.

6.2 A student shall register and put up **minimum academic requirement in all 84 credits** and earn **84 credits.** Marks obtained in all 86 credits shall be considered for the calculation of Cumulative Grade Point Average (CGPA).

6.3 CGPA System:
Method of awarding absolute grades and grade points in two year M.Tech. degree programme is as follows:
Absolute Grading Method is followed, based on the total marks obtained in mid-term evaluation and semester end examinations.

- Grades and Grade points are assigned as given below.

Marks Obtained	Grade	Description of Grade	Grade Points(GP) Value Per Credit
>=90	O	Outstanding	10.00
>=80 and <89.99	A	Excellent	9.00
>=70 and <79.99	B	Very Good	8.00
>=60 and <69.99	C	Good	7.00
>=50 and <59.99	D	Pass	6.00
<50	F	Fail	
Not Appeared the Exam(s)	N	Absent	

The student is eligible for the award of the M.Tech degree with the class as mentioned in the following table.

CGPA	Class
>= 8.0	First Class with Distinction
>= 7.0 and <8.0	First Class
>= 6.0 and < 7.0	Second Class

➢ **Calculation of Semester Grade Points Average (SGPA):**
- The performance of each student at the end of the each semester shall be indicated in terms of SGPA. The SGPA shall be calculated as below:

$$SGPA = \frac{\text{Total earned weighted grade points in a semester}}{\text{Total credits in a semester}}$$

$$SGPA = \frac{\sum_{i=1}^{p} C_i * G_i}{\sum_{i=1}^{p} C_i}$$

Where C_i = Number of credits allotted to a particular subject 'i'
G_i = Grade point corresponding to the letter grade awarded to the subject 'i'
i = 1,2,…..p represent the number of subjects in a particular semester

Note: SGPA is calculated and awarded for the students who pass all the courses in a semester.

➢ **Calculation of Cumulative Grade Point Average (CGPA):**
The CGPA of a student for the entire programme shall be calculated as given below:

- Assessment of the overall performance of a student shall be obtained by calculating Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all subjects during the course of study.

$$CGPA = \frac{\text{Total earned weighted grade points for the entire programme}}{\text{Total credits for the entire programme}}$$

$$CGPA = \frac{\sum_{j=1}^{m} C_j * G_j}{\sum_{j=1}^{m} C_j}$$

Where C_j = Number of credits allotted to a particular subject 'j'
G_j = Grade Point corresponding to the letter grade awarded to that subject 'j'
j = 1,2,….m represent the number of subjects of the entire program.

- Grade lower than D in any subject shall not be considered for CGPA calculation. The CGPA shall be awarded only when the student acquires the required number of credits prescribed for the program.

> **Grade Card**
> The grade card issued shall contain the following:
> a) The credits for each subject offered in that semester
> b) The letter grade and grade point awarded in each subject
> c) The SGPA/CGPA
> d) Total number of credits earned by the student up to the end of that semester.

7. **Withholding of Results**

If the student has not paid dues to the Institute, or if any case of indiscipline is pending against him, the result of the student may be withheld and he shall not be allowed into the next higher semester. The award or issue of the provisional certificate and the degree may also be withheld in such cases. This delay shall not prejudice clauses Nos.6.0 and 6.1.

8. **Transitory Regulations**

Students who have discontinued or have been detained for want of attendance or any other academic requirements, may be considered for readmission as and when they become eligible. They have to take up Equivalent subjects, as substitute subjects in place of repeated subjects as decided by the Chairman of the BoS of the respective departments. He/She shall be admitted under the regulation of the batch in which he/she is readmitted.

9. **Minimum Instruction Days**

The minimum instruction days for each semester shall be **90 instruction days.**

10. **General**

10.1 The academic regulations should be read as a whole for purpose of any interpretation.

10.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

10.3 The Institute may change or amend the academic regulations and syllabi at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the Institute.

10.4 Wherever the words he, him or his occur, they shall also include she, her and hers.

11. **Supplementary Examination**

Supplementary examinations shall be conducted along with regular semester end examinations. (During even semester regular examinations, supplementary examinations of odd Semester and during odd semester regular examinations, supplementary examinations of even semester shall be conducted).

M.TECH. (EMBEDDED SYSTEMS)

Vision and Mission Statement of Institute

Vision

To be a World Class University providing value-based education, conducting interdisciplinary research in cutting edge technologies leading to sustainable socio-economic development of the nation.

Mission

- To produce technically competent and socially responsible engineers, managers and entrepreneurs, who will be future ready.
- To involve students and faculty in innovative research projects linked with industry, academic and research institutions in India and abroad.
- To use modern pedagogy for improving the teaching-learning process.

Vision and Mission Statement of Department

Vision

A resource center of academic excellence for imparting technical education with high pattern of discipline through dedicated staff which shall set global standards, making National and International students technologically superior and ethically strong, who in turn shall improve the quality of life.

Mission

- To provide quality education in the domain of Electronics and Communication Engineering through effective learner centric process
- To provide industry specific best of breed laboratory facilities beyond curriculum to promote diverse collaborative research for meeting the changing industrial and societal needs

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD

M.Tech. – Embedded Systems

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1:
Demonstrate outstanding analytical & technical skills to evaluate analyze and solve real time problems in Embedded Systems.

PEO2:
Apply the acquired knowledge to solve engineering problems to suit multi-disciplinary situations.

PEO3:
Undertake research and development projects in the field of Embedded Systems.

PEO4:
Continue the personal development through professional study and self- learning.

PEO5:
Demonstrate their professional, ethical and social responsibilities and contribute their part for addressing various global issues.

PROGRAM OUTCOMES (PO's)

The Student of Embedded Systems will be able to:

a) **Apply the acquired** knowledge from undergraduate engineering and other disciplines to identify, formulate and present solutions to technical problems related to various areas of Embedded Systems.
b) **Learn** advanced technologies and analyze complex problems in the fields of Embedded System design along with the fundamental concepts of engineering.
c) **Addressing** specific problems in the field of Embedded System in the form of mini projects, analysis, and interpretation of data and synthesis of information to provide valid conclusions by considering societal and environmental factors in the core areas of expertise.
d) **Plan** and conduct systematic study on a significant research topic effective to the societal, health, legal and environmental issues in the field of Embedded Systems.
e) **Use** the techniques, skills, modern Integrated Development Environment (IDE) tools, Operating systems, software and equipment necessary to evaluate and analyze the systems in Real time environments.
f) **Ability** to manage team effectively and become good leaders.
g) **Understand** the scenario of global business.
h) **Demonstrate** effective oral and written communication skills in accordance with technical standards.
i) **Develop** confidence and motivation for self-education and imbibe professional values for lifelong learning.
j) **Understand** and commit to professional ethics, social responsibilities and norms of engineering practice.
k) **Become** knowledgeable about contemporary developments by self -learning.

Mapping of PEOs and POs

	Program Educational Objectives	Program Outcomes
PEO1	Demonstrate outstanding analytical & technical skills to evaluate, analyze and solve real time problems in Embedded Systems.	PO-a To PO-e
PEO2	Apply the acquired knowledge to solve engineering problems to suit multi-disciplinary situations..	PO- a, PO- c to PO-e and PO- g to PO-i
PEO3	Undertake research and development projects in the field of Embedded Systems.	PO-b to PO- k
PEO4	Continue the personal development through professional study and self- learning.	PO- d and PO- f to PO-k
PEO5	Demonstrate their professional, ethical and social responsibilities and contribute their part for addressing various global issues..	PO-a To PO- f and PO-j

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (EMBEDDED SYSTEMS)

(R15 Regulation)

I YEAR I SEMESTER   **COURSE STRUCTURE**

Code	Group	Subject	L	T/P/D	Credits
ESS01	Core	System Design using Embedded Processors	3	1	4
ESS02		Real Time Operating Systems	3	1	4
ESS03		Embedded Programming	3	1	4
VSD11	Elective – I & Elective-II Basket	Digital System Design	3	0	3 + 3
VSD12		Scripting Languages for VLSI	3	0	
VSD13		Full Custom IC Design and FPGA Architectures	3	0	
ESS11		Advanced Computer Architecture	3	0	
ESS12		Digital Control Systems	3	0	
ESS13		Wireless Communications and Networks	3	0	
ESS31	Open Elective -I	Internet of Things	3	0	3
VSD31		Advanced Digital Signal Processing	3	0	
ESS32		Mobile Computing	3	0	
ESS51	Lab	Embedded Programming Lab	0	3	2
ESS61		Mini Project -I	0	0	4
Total			**18**	**6**	**27**

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (EMBEDDED SYSTEMS)

(R15 Regulation)

I YEAR II SEMESTER   **COURSE STRUCTURE**

Code	Group	Subject	L	T/P/D	Credits
ESS 04	Core	Adhoc Wireless and Sensor Networks	3	1	4
ESS 05		Digital Signal Processors And Architectures	3	1	4
ESS 06		Embedded Networking	3	1	4
ESS21	Elective – III & Elective-IV Basket	SOC and NOC Architectures	3	0	3 + 3
VSD21		Speech Signal Processing	3	0	
VSD22		Image and Video Processing	3	0	
ESS22		Hardware Software Codesign	3	0	
ESS25		Network Security and Cryptography	3	0	
ESS26		Sensors and Actuators	3	0	
ESS41	Open Elective -II	Cloud Computing	3	0	3
ESS42		Soft Computing Techniques	3	0	
VSD41		Software Define Radio	3	0	
ESS52	Lab	Embedded Systems Lab	0	3	2
ESS62		Mini Project -II	0	0	4
Total			**18**	**6**	**27**

II YEAR I SEMESTER   **COURSE STRUCTURE**

Subject Code	Subject Name	Lectures	T/P	Credits
ESS63	Comprehensive viva - voce	0	0	4
ESS71	Internship/Dissertation Phase – I	0	0	8
Total		**0**	**0**	**12**

II YEAR II SEMESTER   **COURSE STRUCTURE**

Subject Code	Subject Name	Lectures	T/P	Credits
ESS72	Dissertation Phase – II	0	0	18
Total		**0**	**0**	**18**

*T/P : Tutorial / Practical

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
	3	1	4

(ESS01) SYSTEM DESIGN USING EMBEDDED PROCESSORS

Pre-requisites:
- Working knowledge of microprocessor and microcontrollers
- Basic programming concepts of C

Course Objectives:
Graduates will
- Understand about Embedded systems, its design challenges and optimization
- Develop innovative thinking capabilities to foster research in Embedded System areas
- Demonstrate the ability to design a Embedded system that meets desired specifications within the realistic constraints.

Course Outcomes:
After going through this course the student will be able to
- Outline various building blocks and applications of embedded systems
- Differentiate the architectural features of the popular ARM micro controllers
- Analyze an embedded system using ARM processor.
- Develop source code in terms of increased speed, reduced code size and optimization of performance and power.

UNIT I:
Embedded Concepts: Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems.

UNIT II:
ARM Architecture: RISC Design Philosophy, ARM Design Philosophy, Registers, Current Programme Status Register, Pipeline, Exceptions, Interrupts and Vector Table, Architecture Revision, ARM Processor Families.

UNIT III:
ARM Programming Model: Instruction Set: Data Processing Instructions, Branch, Single and Multiple register Load/Store Instructions, Software Interrupt Instructions, PSR Instructions, Conditional Execution.
Thumb Instruction Set: Register Usage, ARM-Thumb Interworking, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions

UNIT IV:
ARM Programming: Efficient C Programming: Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Writing and Optimizing ARM Assembly Code: Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops.

UNIT V:
Overview of the Cortex-M3: Fundamentals, Registers, Operation Modes, Built-In Nested Vectored Interrupt Controller, Memory Map, Bus Interface, The MPU, Instruction Set, Interrupts and Exceptions, Debugging Support

Text Books:
1. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.

2. ARM Systems Developer's Guides- Designing & Optimizing System Software – Andrew N. Sloss, Dominic Symes, Chris Wright, 2008, Elsevier.
3. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.

References:
1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.
2. Embedded Systems – Raj Kamal, TMH

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I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
	3	1	4

(ESS02) REAL TIME OPERATING SYSTEMS

Pre-requisites:
- Working knowledge of microprocessor and computer architecture
- Basic programming concepts of C
- Basic concepts of operating system

Course Objectives:
- To understand the importance of an embedded system
- To learn the concepts of various operating systems
- To identify the need of Real time operating systems
- To build embedded applications using real time operating systems

Course Outcomes:
After going through this course the student will be able to
- Understand the various services of Operating systems.
- Know various Inter Process Communication mechanisms
- Analyze real time challenges in embedded applications.
- Applying OS services for meeting the real-time constraints in embedded system design.

UNIT I:
Introduction: Introduction to UNIX/LINUX, Overview of Commands, File I/O (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec), Library and System calls, POSIX thread programming

UNIT II:
Real Time Operating Systems: Brief History of OS, Defining RTOS, The Scheduler & Scheduling algorithms (Clock Driven, Round Robin, Priority based preemptive scheduling, RMA, DMA, EDF), Objects, Services, Characteristics of RTOS.
Task - Types of tasks (Periodic and Aperiodic), Task specifications (Periodicity, Deadline, Release time, Execution Time), Task States, Task Operations, Structure

UNIT III:
Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use
Objects, Services and I/O: Pipes, Event Registers, Signals, Problem of Sharing data by multiple tasks & routines (Priority Inversion, Priority inheritance, Priority ceiling), Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem

UNIT IV:
Exceptions, Interrupts and Timers: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations, Basics of device drivers

UNIT V:
Case Studies of RTOS: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.

Text Books:
1. Advanced UNIX Programming, Richard Stevens
2. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011
3. Real Time Systems- Jane W. S. Liu- PHI.

References:
1. Embedded Systems- Architecture, Programming and Design by Rajkamal, 2007, TMH.
2. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh
3. Real Time Systems- C.M.Krishna, KANG G. Shin, 1996, TMH
4. VX Works Programmers Guide

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
	3	1	4

(ESS03) EMBEDDED PROGRAMMING

Pre-requisites:
- 8051 microcontroller architecture and its features.
- Knowledge of basic C programming.

Course Objectives:
- To identify the choice of programming language for embedded systems
- To show how simple C programs can be developed and tested using the software tools.
- To learn the techniques for reading port pins and working with mechanical switches.
- Techniques to create more flexible operating systems for 8051 and other processors.

Course Outcomes:
After going through this course the student will be able to
- Create executable code for an embedded processor on a desktop PC.
- Create a simple but functional code framework for an embedded application
- Assemble a range of complete embedded projects
- Apply the techniques to design and develop operating systems for different processors

UNIT I:
Programming Embedded Systems in C: Introduction , Introducing the 8051 Microcontroller Family, The external interface of the Standard 8051, Reset requirements, Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption .
Reading Switches: Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats.

UNIT II:
Adding Structure to the Code: Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the „Hello Embedded World" example, Example: Restructuring the goat-counting example, Further examples.

UNIT III:
Meeting Real-Time Constraints: Introduction, Creating, hardware delays" using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, Why not use Timer 2?, The need for, timeout" mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout.

UNIT IV:
Embedded Programming Issues: Interfacing C with Assembly. Embedded programming issues - Reentrancy, Portability, Optimizing and testing embedded C programs, JTAG based debugging, Software breakpoints, Modelling Language for Embedded Systems: Modeling and Analysis of Real-Time and Embedded systems, Hyper terminal-Based Control, Embedding Microcontroller in Routine Applications, Microcontroller-based Measurement and Control Applications, Securing Your Embedded System Application.

UNIT V:
Creating an Embedded Operating System: Introduction ,Boot loaders, The basis of a simple embedded OS , Introducing sEOS, Using Timer 0 or Timer 1 , Alternative system architectures , Important design considerations when using sEOS, Example: Milk pasteurization .

Multi-state systems and function sequences , Implementing a Multi-State (Timed) system Example: Traffic light sequencing Case Study: Intruder Alarm System : Introduction, The software architecture, Key software components used in this example, running the program, the software.

Text Books:
1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008
2. "Exploring C for Microcontrollers- A Hands on Approach", Jivan S. Parab, Vinod G. Shelake, Rajanish K. Kamot, and Gourish M.Naik, Springer.

References:
1. PIC micro MCU C-An introduction to programming, The Microchip PIC in CCS C – Nigel Gardner
2. C Programming language, Kernighan, Brian W, Ritchie, Dennis M 2. "Embedded C", Michael J. Pont, Addison Wesley
3. David E. Simon, "An Embedded Software Primer", Pearson Education, 2003.
4. Embedded Systems , Raj Kamal, Second Edition, McGraw Hill Education.
5. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet", Pearson Education, 2002.

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
Elective 1 & 2	3	0	3

(VSD11) DIGITAL SYSTEM DESIGN

Pre-requisites:
- Basic Concepts of Digital Systems.

Course Objectives:
- To learn the simplification of sequential machines
- To know design of data path circuits and control circuits.
- To study fault modeling and test pattern generation methods.
- To discuss the design of state and machine identification experiments.

Course Outcomes:
After going through this course the student will be able to
- Design and develop real time applications using programmable devices.
- Develop skills in modeling, analyzing faults and test pattern generation.
- Design state and machine identification circuits.
- Apply various techniques for designing circuits in electronics and communication systems.

UNIT I:
Minimization and Transformation of Sequential Machines: The Finite State Model – Capabilities and limitations of FSM – State equivalence and machine minimization – Simplification of incompletely specified machines. Fundamental mode model – Flow table – State reduction – Minimal closed covers – Races, Cycles and Hazards.

UNIT II:
Digital Design: Digital Design Using ROM's, PAL's and PLA's , BCD Adder, 32 – bit adder, State graphs for control circuits, Scoreboard and Controller, shift and add multiplier, Array multiplier, Keypad Scanner, Binary divider.

UNIT III:
SM Charts: State machine charts, Derivation of SM Charts, Realization of SM Chart, Implementation of Binary Multiplier, dice game controller.

UNIT IV:
Fault Modeling, Test Pattern Generation: Logic Fault model – Fault detection & Redundancy, Fault diagnosis of combinational circuits by conventional methods – Path sensitization techniques, Boolean Difference method – Kohavi algorithm – D-algorithm, Random testing, Transition count testing, Signature analysis.

UNIT V:
Fault Diagnosis in Sequential Circuits: Circuit Test Approach, Transition Check approach- State identification and Fault detection experiment, Machine identification, Design of fault detection experiment

Text Books:
1. Fundamentals of Logic Design – Charles H. Roth, 5th Ed., Cengage Learning.
2. Digital Systems Testing and Testable Design – Miron Abramovici, Melvin A.Breuer and Arthur D. Friedman- John Wiley &
3. Sons Inc.
4. Logic Design Theory – N. N. Biswas, PHI
5. Switching and Finite Automata Theory – Z. Kohavi , 2nd Ed., 2001, TMH

References:

1. Digital Design – Morris Mano, M.D. Ciletti, 4th Edition, PHI.
2. Digital Circuits and Logic Design – Samuel C. Lee , PHI

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
Elective 1 & 2	**3**	**0**	**3**

(VSD12) SCRIPTING LANGUAGES FOR VLSI

Pre-requisites:
- Java script, C programming languages.

Course Objectives:
- To explain the characteristics and uses of scripting languages.
- To describe the various PERL concepts used in VLSI design.
- To learn the concepts of TCL.
- To Interpret JavaScript, Python language, Python web system Design

Course Outcomes:
After going through this course the student will be able to
- Interpret typical scripting languages for system applications
- Create software systems using scripting languages, including Perl and Python.
- Write server-side scripts using Perl and Python's CGI facilities.
- Develop Java scripts, Python web systems

UNIT I:
Introduction to Scripts and Scripting: Characteristics and uses of scripting languages, Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, Control structures, Built-in functions, Collections of Data, Working with arrays, Lists and hashes, Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments.

UNIT II:
Advanced PERL: Finer points of Looping, Subroutines, Using Pack and Unpack, Working with files, Navigating the file system, Type globs, Eval, References, Data structures, Packages, Libraries and modules, Objects, Objects and modules in action, Tied variables, Interfacing to the operating systems, Security issues.

UNIT III:
TCL: The TCL phenomena, Philosophy, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures, Working with Strings, Patterns, Files and Pipes, Example code.

UNIT IV:
Advanced TCL: The eval, source, exec and up-level commands, Libraries and packages, Namespaces, Trapping errors, Event-driven programs, Making applications 'Internet-aware', 'Nuts-and-bolts' internet programming, Security issues, running untrusted code, The C interface.

UNIT V:
TK and JavaScript: Visual tool kits, Fundamental concepts of TK, TK by example, Events and bindings PERL-TK. JavaScript – Object models, Design Philosophy, Versions of JavaScript.
Python: Introduction to Python language, python-syntax, statements, functions, Built-in-functions and Methods, Modules in python, Exception Handling, Integrated Web Applications in Python - Building Small, Efficient Python Web Systems ,Web Application Framework.

Text Books:
1. The World of Scripting Languages- David Barron, Wiley Student Edition, 2010.2.
2. Practical Programming in Tcl and Tk - Brent Welch, Ken Jones and Jeff Hobbs., Fourth edition.

3. Java the Complete Reference - Herbert Schildt, 7th Edition, TMH.
4. Python Web Programming, Steve Holden and David Beazley, New Riders Publications

References:
1. Tcl/Tk: A Developer's Guide- Clif Flynt, 2003, Morgan Kaufmann Series.
2. Tcl and the Tk Toolkit- John Ousterhout, 2nd Edition, 2009, Kindel Edition.
3. Tcl 8.5 Network Programming book- Wojciech Kocjan and Piotr Beltowski, Packt Publishing.
4. Tcl/Tk 8.5 Programming Cookbook- Bert Wheeler
5. Programming Python, M.Lutz,SPD
6. Core Python Programming, Chun, Pearson Education.
7. Guide to Programming with Python, M.Dawson, Cengage Learning

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I Year I Sem. M.Tech (Embedded Systems)	3	0	3
Elective 1 & 2			

(VSD13) FULL CUSTOM IC DESIGN AND FPGA ARCHITECTURES

Pre-requisites:
- VLSI Design concepts, PLDs.

Course Objectives:
- To discuss the full custom IC Design flow.
- To understand standard cell design techniques.
- To learn various FPGA architectures based on programming technologies.
- To know performance analysis based on FPGA architectures.

Course Outcomes:
After going through this course the student will be able to
- Describe Full Custom CMOS VLSI fabrication Process.
- Analyze standard cell interconnect routing and layout design.
- Comprehend various FPGA architectures.
- Analyze logic block and speed performance.

UNIT I:
Introduction: Schematic fundamentals, Layout design, Introduction to CMOS VLSI manufacturing processes, Layers and connectivity, Process design rules Significance of full custom IC design, layout design flow.

UNIT II:
Advanced techniques for specialized building blocks Standard cell libraries, Pad cells and Laser fuse cells, Advanced techniques for building blocks, Power grid Clock signals and Interconnect routing, Interconnect layout design

UNIT III:
Field Programmable Gate Arrays: Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs

UNIT IV:
Special Purpose Processors: Commercially available FPGAs, Xilinx's Vertex and Spartan, Actel's FPGA, Altera's FLEX 10k.

UNIT V:
Logic Block Architectures: Logic block functionality versus area-efficiency, Logic block area and routing model, Impact of logic block functionality on FPGA performance, Model for measuring delay.

Text Books:
1. CMOS IC Layout Concepts Methodologies and Tools, Dan Clein, Newnes, 2000.
2. The Art of Analog Layout, 2nd Edition, Ray Alan Hastings, Prentice Hall, 2006
3. Field Programmable Gate Arrays - John V. Oldfield, Richard C. Dorf, Wiley India.
4. Michel John Sebastian Smith, Application Specific Integrated Circuits, Addison Wesley Professional, 2008.

References:
1. Field Programmable Gate Array Technology - Stephen M. Trimberger, Springer International Edition.
2. Digital Design Using Field Programmable Gate Arrays - Pak K. Chan/Samiha Mourad, Pearson Low Price Edition.

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
Elective 1 & 2	3	0	3

(ESS11) ADVANCED COMPUTER ARCHITECTURE

Pre-requisites:
- Computer architecture
- microprocessors

Course Objectives:
- Understand the different instruction set formats, RISC and CISC and various design issues for computers
- Discuss instruction level parallelism using software and hardware approaches.
- Explain multiprocessors and thread level parallelism.
- Describe the important concepts for interconnection networks and cluster.

Course Outcomes:
After going through this course the student will be able to
- Compare different types of instruction sets
- Know the parallelism concepts used for increasing the efficiency of the computer and how it affects the cost of the system.
- Examine the different types of networks, their interconnection and its components for interconnection.
- Analyse the different types of storage devices and its internal structure.

UNIT I:
Fundamentals of Computer Design: Fundamentals of Computer design, Changing faces of computing and task of computer designer, Technology trends, Cost price and their trends, measuring and reporting performance, Quantitative principles of computer design, Amdahl's law. Instruction set principles and examples- Introduction, classifying instruction set- memory addressing type and size of operands, Operations in the instruction set.

UNIT II:
Pipelines: Introduction, basic RISC instruction set, Simple implementation of RISC instruction set, Classic five stage pipe lined RISC processor, Basic performance issues in pipelining, Pipeline hazards, Reducing pipeline branch penalties.
Memory Hierarchy Design: Introduction, review of ABC of cache, Cache performance, Reducing cache miss penalty, Virtual memory.

UNIT III:
Instruction Level Parallelism (ILP) - The Hardware Approach: Instruction-Level parallelism, Dynamic scheduling, Dynamic scheduling using Tomasulo's approach, Branch prediction, High performance instruction delivery- Hardware based speculation.
ILP Software Approach: Basic compiler level techniques, Static branch prediction, VLIW approach, Exploiting ILP, Parallelism at compile time, Cross cutting issues – Hardware verses Software.

UNIT IV:
Multi Processors and Thread Level Parallelism: Multi Processors and Thread level Parallelism- Introduction, Characteristics of application domain, Systematic shared memory architecture, Distributed shared – Memory architecture, Synchronization.

UNIT V:
Inter Connection and Networks: Introduction, Interconnection network media, Practical issues in interconnecting networks, Examples of inter connection, Cluster, Designing of clusters.
Intel Architecture: Intel IA-64 ILP in embedded and mobile markets Fallacies and pit falls.

Text Books:
1. John L. Hennessy, David A. Patterson – Computer Architecture: A Quantitative Approach, 3rdEdition, an Imprint of Elsevier.

References:
1. John P. Shen and Miikko H. Lipasti -, Modern Processor Design : Fundamentals of SuperScalar Processors
2. Computer Architecture and Parallel Processing – Kai Hwang, Faye A.Brigs., MC Graw Hill.

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I Year I Sem. M.Tech (Embedded Systems)				
Elective 1 & 2		3	0	3

(ESS12) DIGITAL CONTROL SYSTEMS

Pre-requisites:
- Linear control systems
- Z-Transforms

Course Objectives:
- To explain basic and digital control system for the real time analysis and design of control systems.
- To apply the knowledge state variable analysis in the design of discrete systems.
- To explain the concept of stability analysis and design of discrete time systems.

Course Outcomes:
After going through this course the student will be able to
- Illustrate the concepts of Digital control systems.
- Analyze and design discrete systems in state variable analysis.
- Relate the concepts of stability analysis and design of discrete time systems.

UNIT I:
Sampling and Reconstruction: Introduction, sample and hold operations, sampling theorem, Reconstruction of original sampled signal to continuous –time signal.
The Z – Transforms: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms
Z-Plane Analysis of Discrete-Time Control System: Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: primary strips and complementary strips.

UNIT II:
State Space Analysis: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations
Controllability and Observability: Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function

UNIT III:
Stability Analysis: Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems.

UNIT IV:
Design of Discrete Time Control System by Conventional Methods: Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.

UNIT V:
State Feedback Controllers and Observers: Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.
Linear Quadratic Regulators: Min/Max principle**,** Linear Quadratic Regulators, Kalman, state estimation through Kalman filter, Introduction to adaptive controls.

Text Books:
1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition
2. Digital Control and State Variable Methods by M.Gopal, TMH

References:
1. Digital Control Systems, Kuo, Oxford University Press, 2ndEdition, 2003.
2. Digital Control Engineering, M.Gopal,
3. Control Systems Engineering, I.J. Nagrath and Gopal, Prentice Hall, 3rd Edition.

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
Elective 1 & 2	3	0	3

(ESS13) WIRELESS COMMUNICATIONS AND NETWORKS

Pre-requisites:
- Principles of Communication Systems
- Computer Networks

Course Objectives:
- To build understanding of the fundamental concepts of wireless communications and networks.
- To learn mathematical modeling of a wireless communication channel.
- To build basic concepts in designing transmitter and receiver of a wireless communication system.
- To learn different wireless communication network standards.

Course Outcomes:
After going through this course the student will be able to
- Analyze issues in various propagation models .
- Basic design techniques of a wireless communication transmitter and receiver.
- Basic implementation of algorithms related to wireless communication concepts
- Analyze design issues of wireless communication networks standards

UNIT I:
The Cellular Concept-System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies- Prioritizing Handoffs, Practical Handoff Considerations ,Interference and system capacity – Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference , Power Control for Reducing interference, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems- Cell Splitting, Sectoring .

UNIT II:
Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics, Brewster Angle, Reflection from prefect conductors, Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry, Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering, Outdoor Propagation Models, Indoor Propagation Models, Signal penetration into buildings, Ray Tracing and Site Specific Modeling.

UNIT III:
Mobile Radio Propagation Small –Scale Fading and Multipath: Small Scale Multipath propagation-Factors influencing small scale fading, Doppler shift, Impulse Response Model of a multipath channel- Relationship between Bandwidth and Received power, Small-Scale Multipath Measurements, Parameters of Mobile Multipath Channels, Types of Small-Scale Fading, Statistical Models for multipath Fading Channels, Level crossing and fading statistics, Two-ray Rayleigh Fading Model.

UNIT IV:
Equalization and Diversity: Introduction, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Non linear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation(MLSE) Equalizer, Algorithms for adaptive equalization, Diversity Techniques, Practical Space Diversity Consideration-Selection Diversity, Feedback or Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.

UNIT V:
Wireless Networks: Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks , WLAN Topologies, WLAN Standard IEEE 802.11,IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, Hiper Lan, WLL.

Text Books:
1. Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2nd Ed., 2002, PHI.
2. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.
3. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.

References:
1. Principles of Wireless Networks – KavehPahLaven and P. Krishna Murthy, 2002, PE
2. Wireless Digital Communications – Kamilo Feher, 1999, PHI.
3. Wireless Communication and Networking – William Stallings, 2003, PHI.
4. Wireless Communication – Upen Dalal, Oxford Univ. Press
5. Wireless Communications and Networking – Vijay K. Gary, Elsevier

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I Year I Sem. M.Tech (Embedded Systems)				
Open Elective - 1		3	0	3

(ESS31) INTERNET OF THINGS (IoT)

Pre-requisites:
- Programming knowledge in languages like Java, C/C++, Embedded C.
- Basic understanding on creating and using databases.
- Basic understanding on Wireless Communication and Networking.

Course Objectives:
- Understand about the new paradigm of objects interacting with people,
- Know about the new paradigm of objects interacting with information systems, and with other objects.
- Develop innovative applications of combinations of IoT technologies in real-life scenarios.

Course Outcomes:
After going through this course the student will be able to
- Identifying and describing different kinds of Internet-connected product concepts.
- Analyzing and designing prototypes models of Internet-connected products using various tools.
- Developing prototypes models of Internet-connected products using various tools
- Understanding the challenges and applying right techniques for user-interaction with connected-objects.

UNIT I:
Introduction: IoT overview, The IoT paradigm, Smart objects, IoT Platforms (like Arduino, ARM Cortex, Raspberry Pi / Intel Galileo), Bits and atoms, Convergence of Technologies. Introduction to Internet and web networking basics: HTTP, Rest, JSON, XML, Interfacing to Cloud, Harnessing mobile computing for IoT

UNIT II:
Introduction to Technologies behind IoT: RFID, NFC, Mobil Data Technologies (GPRS, 3G, 4G), Wifi. Powering the IoT using low power wireless technologies like Bluetooth smart technology, Zigbee.
WSN. RTLS + GPS, Agents and Multi-agent systems.

UNIT III:
IoT Architecture: Machine to Machine, Web of Things, IoT protocols (The Layering concepts, IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN - IPv6 over Low power Wireless Personal Area Networks)

UNIT IV:
IoT Applications and Issues: Combination scenarios. Breaking assumptions. IoT in retail, IoT in healthcare, IoT in manufacturing
Prototyping Connected Objects: Open source prototype platforms, Arduino based internet communication. Integrating and accessing Internet services, Raspberry PI / Beagle board based Gateways, Data Analysis Techniques.

UNIT V:
Case Studies and Guest lectures from Industry (for different verticals like Retail, Healthcare, Home Automation etc)

Text Books:
1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
3. Building the Internet of Things. Sara Cordoba, Wimer Hazenberg, Menno Huisman. BIS Publishers. 2011.

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I Year I Sem. M.Tech (Embedded Systems)	**L**	**T/P**	**C**
Open Elective - 1	**3**	**0**	**3**

(VSD31) ADVANCED DIGITAL SIGNAL PROCESSING

Pre-requisites:
- Knowledge of Digital filter design techniques, Digital Signal Processing techniques

Course Objectives:
- To provide in-depth knowledge on methods and techniques in digital filter design, Multi-rate digital signal processing, Applications of Multirate Signal Processing
- To introduce spectrum estimation methods, Power spectrum estimation
- To enhance the awareness of different nonparametric and parametric methods
- To enhance the knowledge of sources of errors and its significance

Course outcomes:
After going through this course the student will be able to
- Apply fundamental principles of signal processing to design multi rate DSP systems.
- Analyze and design optimum filters for better system performance.
- Understand methodologies and techniques of parametric and non-parametric methods for spectral estimation
- Analyze various limitations in implementation of DSPs.

UNIT I:
Review of DFT, FFT, IIR Filters, FIR Filters,
Multirate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion, Applications of Multirate Signal Processing.

UNIT II:
Non-Parametric methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman & Tukey methods, Comparison of all Non-Parametric methods

UNIT III:
Linear Prediction: Forward and Backward Linear Prediction – Forward Linear Prediction, Backward Linear Prediction, Optimum reflection coefficients for the Lattice Forward and Backward Predictors. Solution of the Normal Equations: Levinson Durbin Algorithm, Schur Algorithm. Properties of Linear Prediction Filters.

UNIT IV:
Parametric Methods of Power Spectrum Estimation: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Waker & Burg Methods, MA & ARMA models for power spectrum estimation.

UNIT V:
Finite Word Length Effects: Analysis of finite word length effects in Fixed-point DSP systems – Fixed, Floating Point Arithmetic – ADC quantization noise & signal quality – Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

Text Books:
1. Digital Signal Processing: Principles, Algorithms & Applications - J.G.Proakis & D.G.Manolokis, 4th ed., PHI.
2. Discrete Time signal processing - Alan V Oppenheim & Ronald W Schaffer, PHI.

3. DSP – A Practical Approach – Emmanuel C.Ifeacher, Barrie. W. Jervis, 2 ed., Pearson Education.

References:
1. Modern Spectral Estimation: Theory & Application – S. M .Kay, 1988, PHI.
2. Multirate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education
3. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C.Gnanapriya, 2000,TMH

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I Year I Sem. M.Tech (Embedded Systems)				
Open Elective -1		3	0	3

(ESS32) MOBILE COMPUTING

Pre-requisites:
- Embedded systems
- Operating Systems

Course Objectives:
- Identify the logic components that comprise an embedded system
- Design, code, compile, and test real-time software
- Integrate a fully functional system including hardware and software.

Course Outcomes:
After going through this course the student will be able to
- To discuss the basics of embedded systems and the interface issues related to it.
- To analyze different communication technologies used in embedded applications
- Interpret the intelligent choices between hardware/software tradeoffs

UNIT I:
Programming on Linux Platform: System Calls, Scheduling, Memory Allocation, Timers, Embedded Linux, Root File System, BusyBox.
Operating System Overview: Processes, Tasks, Threads, Multi-Threading, Semaphore, Message Queue.

UNIT II:
Introduction to Software Development Tools: GNU GCC, make, gdb, static and dynamic linking, C libraries, compiler options, code optimization switches, lint, code profiling tools,

UNIT III:
Interfacing Modules: Sensor and actuator interface, data transfer and control, GPS, GSM module interfacing with data processing and display, OpenCV for machine vision, Audio signal processing.

UNIT IV:
Networking Basics: Sockets, ports, UDP, TCP/IP, client server model, socket programming, 802.11, Bluetooth, ZigBee, SSH, firewalls, network security.

UNIT V:
IA32 Instruction Set: application binary interface, exception and interrupt handling, interrupt latency, assemblers, assembler directives, macros, simulation and debugging tools.

Text Books:
1. Modern Embedded Computing - Peter Barry and Patrick Crowley, 1st Ed., Elsevier/Morgan Kaufmann, 2012.
2. Linux Application Development - Michael K. Johnson, Erik W. Troan, Addison Wesley, 1998.
3. Assembly Language for x86 Processors by Kip R. Irvine
4. Intel® 64 and IA-32 Architectures Software Developer Manuals

References:
1. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin and Greg Gagne.
2. The Design of the UNIX Operating System by Maurice J. Bach Prentice-Hall

3. UNIX Network Programming by W. Richard Stevens

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I Year I Sem. M.Tech (Embedded Systems)		**0**	**3**	**2**

(ESS51) EMBEDDED PROGRAMMING LABORATORY

Pre-requisites:
Concepts of
- Micro controller
- Programming Language C

Course Objectives:
- Know the Kiel IDE effectively to create and debug C programs
- Identify various peripherals that can be interfaced to the controller
- Demonstrate RTOS internals, task management, scheduling, communication and synchronization
- Illustrate the communication between PC and 8051 development board

Course Outcomes:
After going through this course the student will be able to
- Create C programs for 8051 controller that complete various tasks using concepts
- Make use of the ports of the controller for parallel and serial communication
- Construct orderly development of the project using 8051 controller
- Compile programs for developing embedded applications on advanced controllers

Compile programs for developing embedded applications on advanced controllers

Embedded C Language on Keil IDE or Equivalent.
1. Program to toggle all the bits of Port P1 continuously with 250 mS delay.
2. Program to toggle only the bit P1.5 continuously with some delay. Use Timer 0, mode 1 to create delay.
3. Program to interface a switch and a buzzer to two different pins of a Port such that the buzzer should sound As long as the switch is pressed.
4. Program to interface LCD data pins to port P1 and display a message on it.
5. Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD.
6. Program to interface seven segment display unit.
7. Program to transmit a message from Microcontroller to PC serially using RS232.
8. Program to receive a message from PC serially using RS232.
9. Program to get analog input from Temperature sensor and display the temperature value on PC Monitor.
10. Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions
11. Program to Sort RTOS on to 89C51 development board.
12. Program to interface Elevator.

I Year I Sem. M.Tech (Embedded Systems)	L	T/P	C
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(ESS61) MINI PROJECT- I

Course Outcomes:

After going through this course the student will be able to

- Identify and formulate problem statement
- Design applications using embedded processors with IDEs
- To communicate effectively
- Implement applications using embedded real time operating systems.
- Present technical report

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I Year II Sem. M.Tech (Embedded Systems)	L	T/P	C
	3	1	4

(ESS04) ADHOC WIRELESS AND SENSOR NETWORKS

Pre-requisites:
- Basic knowledge in computer networks.
- Fundamentals in communication and signal processing.

Course Objectives:
- To understand the different issues in Adhoc wireless network.
- To analyze the design goals of routing protocol for Ad hoc wireless network.
- To learn about the different routing and transport layer protocols in ad hoc wireless network.
- To understand QOS and Energy management in Ad hoc wireless network.

Course Outcomes:
After going through this course the student will be able to
- Student will understand the difference between Adhoc wireless and wireless network.
- Student will implement MAC Protocol in Adhoc wireless networks.
- Student will design routing protocol in Adhoc wireless networks.
- Student will implement QOS and energy management in Adhoc wireless network.

UNIT I:
ADHOC Wireless Networks: Introduction, Issues in Ad Hoc wireless networks, AD Hoc wireless Internet.
MAC Protocols for Ad Hoc Wireless Networks: Introduction, in designing a MAC protocol for Ad Hoc wireless networks, Design goals of MAC protocol for Adhoc wireless network, classification of MAC Protocols, Contention-based protocols with scheduling mechanisms, MAC protocols that use directional antennas, other MAC protocols.

UNIT II:
Routing Protocols: Introduction – Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks – Classifications of Routing Protocols – Table–Driven Routing Protocols, On–Demand Routing protocols, Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical routing protocols, power-aware routing protocols.
Transport Layer Protocols: Introduction – Issues in Designing a Transport Layer Protocol for Ad hoc Wireless Networks – Design Goals of a Transport Layer Protocol for Ad hoc Wireless Networks –Classification of Transport Layer Solutions – TCP over Ad hoc Wireless Networks – Other Transport Layer Protocols for Ad hoc Wireless Networks

UNIT III:
Security in ADHOC Networks: Security in Ad Hoc Wireless Networks – Network Security Requirements – Issues and Challenges in Security Provisioning – Network Security Attacks – Key Management – Secure Routing in Ad hoc wireless networks
Quality of Service: Introduction – Issues and Challenges in Providing QoS in Ad hoc Wireless Networks –Classifications of QoS Solutions – MAC Layer Solutions – Network Layer Solutions – QoS Frameworks for Ad hoc Wireless Networks, Energy Management in Ad hoc Wireless Networks

UNIT IV:
Introduction – Need for Energy Management in Ad hoc Wireless Networks – Classification of Adhoc Wireless Networks – Battery Management Schemes – Transmission Power Management Schemes – System Power Management Schemes.

UNIT V:

Wireless Sensor Networks: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC protocols for Sensor Networks, Location discovery, Quality of Sensor network, Evolving standards, other issues

Text Books:
1. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks Architectures and Protocols", Prentice Hall, PTR, 2004.
2. Wireless Adhoc and Sensor Networks: Protocols, Performance and control – Jagannathan Sarangapani, CRC Press

References:
1. C. K. Toh, "Ad Hoc Mobile Wireless Networks Protocols and Systems", Pearson Education
2. Wireless Sensor Networks – C.S. Raghavendra, Krishna M. Sivalingam, 2004, Springer

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(ESS05) DIGITAL SIGNAL PROCESSORS AND ARCHITECTURES

Pre-requisites:
Concepts of
- Digital Signal Processing
- Microprocessors and Microcontrollers

Course Objectives:
- To study the Architectural details of TMS320C54xx DSPs and the concepts involved in execution control and pipelining
- To analyze the importance of numeric formats and sources of errors in DSP implementation
- To understand the concepts of Memory & I/O interfacing
- Develop various algorithms

Course Outcomes:
After going through this course the student will be able to
- Compare various architectures
- Design systems and role sampling rate
- Interface different devices to the processor.
- Design and implement real time signal processing algorithms and applications based on   DSP processors.

UNIT I:
Introduction to DSP Processors: Digital Signal Processors, various architectures: VLIW Architecture, Multiprocessor DSPs, SHARC, SIMD, MIMD, RISC and CISC.
Execution Control and Pipelining: Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branch effects, Interrupt effects, Pipeline Programming models.

UNIT II:
Typical Real-time DSP Systems: Data representations and arithmetic, Analog - to – digital conversion process, Uniform and non-uniform quantization and encoding, Oversampling in A/D conversion, Digital to analog conversion process: signal recovery, the DAC, Anti-imaging filtering, Oversampling in D/A conversion, Analog I/O interface for real-time DSP systems, sources of errors in DSP implementation, real time implementation considerations.

UNIT III:
Fixed-Point DSP Processors: Architecture of TMS 320C 5X, C54X Processors, addressing modes, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX Processors, speed issues.

UNIT IV:
Memory and I/O Interfacing: External bus interfacing signals, Memory interface, Parallel I/O interface: Programmed I/O, Interrupts and I/O, Direct memory access (DMA). Hardware interfacing, Multichannel Buffered Serial Port (McBSP), McBSP Programming, CODEC interface circuit.

UNIT V:
Implementation of DSP Algorithms: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing.
An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX.

Text Books:
1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. Digital Signal Processing: A Practical approach, Second Edition, Emmanuel C. Ifeachor, Barrie W Jervis,Pearson Publications. 2002.

References:
1. Digital Signal processors Architectures, implementations and Applications-SenM.Kuo, Woon-SengS.Gan, Pearson Publications, 2009.
2. Digital Signal Processors, Architecture, Programming and Applications – B. VenkataRamani and M. Bhaskar,TMH,2004.
3. Digital Signal Processing – Jonatham Stein, John Wiley, 2005.
4. DSP Processor Fundamentals, Architectures and Features – Lapsley , S. Chand, 2000.
5. DSP Applications with TMS 320 Family, K. Shin ,Prentice Hall, 1987.

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(ESS06) EMBEDDED NETWORKING

Pre-requisites:
- Concepts of Embedded Systems
- Computer Network protocols

Course Objectives:
- To understand the concepts of networking in embedded systems.
- To gain knowledge about fundamental design requirements of embedded networks
- To design range of networked embedded systems
- To explore various research development methods in wireless sensor networks

Course Outcomes:
After going through this course the student will be able to
- Learn various communication protocols for Embedded Networking
- Evaluate the right communication protocol for embedded system design
- Apply various protocols for exchanging messages over the network in Embedded Systems.
- Design various embedded applications by using various algorithms for wireless sensor networks.

UNIT I:
Embedded Communication Protocols: Embedded Networking: Introduction – Serial / Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface(SPI) – Inter Integrated Circuits (I2C) –PC Parallel Port programming – ISA/PCI bus protocols - Firewire.

UNIT II:
USB and CAN Bus: USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets – Data flow types –Enumeration –PIC 18 Microcontroller USB Interface–A simple application with USB - CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing –PIC microcontroller CAN Interface –A simple application with CAN.

UNIT III:
Ethernet Basics: Elements of a network: The network protocol stack – Inside Ethernet: IEEE 802.3 standard, frames, media access control, physical addresses, cables - connections and network speeds: twisted pair cable, fiber optic cable, coaxial cable, interfacing to Ethernet controllers –Inside the Internet protocol.

UNIT IV:
Embedded Ethernet: Exchanging Messages Using UDP and TCP - Inside UDP and TCP - E-mail for Embedded Systems: How E-mail Works, Using the Simple Mail Transfer Protocol, Sending E-mail with a URL, Using the Post Office Protocol- Using the File Transfer Protocol: Requirements, Transferring a File - Keeping Your Devices and Network Secure: Firewall, User Names and Passwords, Validation, Encryption.

UNIT V:
Wireless Embedded Networking: Wireless sensor networks – Introduction – Applications – Network Topology – Localization: Overview, Key issues, Localization approaches: Coarse-grained node localization: binary proximity, centroid calculation, identifying codes- Fine-grained node localization: radio signal based distance estimation, distance estimation using time differences, RF sequence decoding –Time Synchronization: Overview, Key issues, Fine-grained clock synchronization: reference broadcast synchronization, pair-wise sender receiver synchronization, flooding time

synchronization, predictive time synchronization – Energy-efficient MAC protocols: Sensor MAC –Data Centric routing: direct diffusion, pull vs. push diffusion.

Text Books:
1. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, TonyGivargis, John & Wiley Publications, 2002
2. Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port -Jan Axelson, Penram Publications, 1996.

References:
1. Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series -Dogan Ibrahim, Elsevier 2008.
2. Embedded Ethernet and Internet Complete - Jan Axelson, Penram publications, 2003.
3. Networking Wireless Sensors – Bhaskar Krishnamachari, Cambridge press 2005.

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I Year II Sem. M.Tech (Embedded Systems)			
Elective 3 & 4	3	0	3

(ESS21) SOC AND NOC ARCHITECTURES

Pre-requisites:
- Digital Electronics/Systems.
- Electronic components and circuits.

Course Objectives:
- To learn System on chip fundamentals, their applications.
- To gain knowledge on NOC design.
- To learn the various computation models of SOC and NOCs

Course Outcomes:
After going through this course the student will be able to
- Ability to analyze and Design a system architecture for key performance indicators like Power, Performance, Area.
- To learn the basic concepts of NoC design by studying the topologies, router design and MPSoC styles.
- To learn sample routing algorithms on a NoC with deadlock and livelock avoidance.
- To understand the role of system-level design and performance metrics in choosing a SoC/NoC design.

UNIT I:
Introduction to SoC Design. Multiprocessor SoC and Network on Chip. Low-Power SoC Design.

UNIT II:
System Design: Co-Design using System Models Validation and Verification, Hardware/Software Codesign Application Analysis, Synthesis.

UNIT III:
Communication System: Separation of Coputation and Communication. Communication-Centric SoC Design, Communication Synthesis. Network-Based Design, Network on Chip, Architecture of NoC

UNIT IV:
NOC Design: Design of NoC, NoC Topology, Energy Exploration, NoC Protocol Design
Low-Power Design for NoC: Low-Power Signaling, On-Chip Serialization, Low-Power Clocking, Low-Power Channel Coding, Low-Power Switch, Low-Power Network on Chip Protocol.

UNIT V:
Example SOC/NOC Designs: Real Chip Implementation, Industrial Implementations, Intel's Tera-FLOP 80-Core NoC, Intel's Scalable Communication Architecture, Design case studies

Text Books:
1. Hoi-jun yoo, Kangmin Lee, Jun Kyoung Kim, "Low power NoC for high performance SoC desing",CRC press, 2008.
2. Vijay K. Madisetti Chonlameth Arpikanondt, "A Platform-Centric Approach to System-on-Chip (SOC) Design", Springer, 2005.

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Elective 3 & 4	3	0	3

(VSD21) SPEECH SIGNAL PROCESSING

Pre-requisites:
- Signals and Systems
- Digital Signal Processing

Course Objectives:
- To study the mechanisms of speech production, understand time domain and frequency domain representation of speech signal.
- To study various models used for speech processing (analysis, recognition, synthesis)
- To discuss and provide basic hands-on experience on implementation of algorithms, models used in feature extraction and in building speech systems.

Course Outcomes:
After going through this course the student will be able to
- Manipulate and visualize speech signals.
- Analyze speech signals
- Design algorithms for extracting parameters from the speech signal.
- Build a simple speech recognition system using state of the art tools.

UNIT I:
Introduction to speech processing and Speech production mechanism. Classification of vowels and consonants. Sound and its relation with Syllable, Language, Letter and Word

UNIT II:
Basics of digital signal processing, Nature of speech signal, Digital Models for the speech signal, Equivalent representations of signal and systems.

UNIT III:
Time Domain Models for Speech Processing: Feature extraction in time domain - Energy, Zero Crossing, Pitch / Fundamental frequency, Usefulness of Pitch and its Countour.
Frequency Domain Models for Speech Processing: Fourier Transform and its significance, Speech and its Fourier Transform including DFT & FFT, Formants. Feature extraction: Spectogram, Cepstrum, MEL Freq Analysis, Mel-Frequency Cepstral coefficient.

UNIT IV:
Basics of Speech Recognition: Linear Predictive Coding models for Speech recognition, Vector Quantization, Gaussian Mixer Models. Hidden Markov Models, Dynamic Programming
Speech Enhancement, Estimating the parameters, Practical issues.

UNIT V:
Methods for Speech Synthesis. Approaches for speaker recognition.

Text Books:
1. Fundamentals of speech recognition, L.R.Rabiner and B.H Juang, Pearson LPE (1993).
2. Digital processing of speech signals, . L.R.Rabiner and R.W.Schafer, Pearson LPE (1993).

References:

1. Spoken Language Processing: A Guide to Theory, Algorithm and System Development by Xeudong Huang, Alex Acero, and Hsiao-Wuen Hon.
2. Discrete-Time Speech Signal Processing – Principles and Practice, Thomas F Quatieri, Pearson Education, 2004.
3. Speech Recognition, Claudio Becchetti and Lucio Prina Ricotti John Wiley and Sons, 1999.

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Elective 3 & 4	**3**	**0**	**3**

(VSD22) IMAGE AND VIDEO PROCESSING

Pre-requisites:
- Digital Signal Processing

Course Objectives:
- Learn the fundamentals of both image and video processing
- Describe basic image and video filtering operations
- Understand fundamentals of image and video compression
- Know principles and methods of motion/optical flow estimation

Course Outcomes:
After going through this course the student will be able to
- Understand the concepts of image and video processing including image/video representation, image /video filtering, image/video compression.
- Know various basic operations on image/video.
- Apply different transform techniques on image/video
- Implement a complete image processing system to achieve a specific task, and analyze and interpret the results of this system.

UNIT I:
Fundamentals Steps of Image Processing and Image Transforms: Basic steps of image processing system sampling and quantization of an image – basic relationship between pixels.
Image Transforms: 2D-Discrete Fourier Transform, Discrete Cosine transform(DCT), Wavelet Transform: Continous Wavelet Transforms, Discrete Wavelet Transforms

UNIT II:
Image Processing Techniques
Image Enhancement Spatial Domain methods: Histogram Processing, Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters
Frequency Domain Methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering.
Image Segmentation
Segmentation concepts, Point, Line and Edge detection, Thresholding, Region based segmentation

UNIT III:
Image Compression: Image Compression Fundamentals – Coding Redundancy, Spatial and Temporal Redundancy, Compression models: Lossy & Lossless, Huffman coding, Arithmetic coding, LZW coding, Run Length coding, Bit plane coding, Transform coding, Predictive coding, wavelet coding, JPEG standards.

UNIT IV:
Basic Steps of Video Processing:
Analog video, Digital video. Time- varying Image Formation models: Three – dimensional motion models, Geometric Image Formation, Photometric Image Formation, Sampling of video signals, Filtering operations.

UNIT V:

2-D Motion Estimation: Optical flow, General methodologies, Pixel based motion estimation, Block matching algorithm, Mesh-based motion estimation , Global motion estimation, Region based motion estimation, Multiresolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding. Application of motion estimation in video coding

Text Books:
1. Digital Image processing – Gonzaleze and woods,3rd ed., Pearson
2. Video processing and communication – Yao Wang, Joern Ostermann and Ya-Qin Zhang, I Ed Prentice Hall

References:
1. Digital video processing – M. Tekalp, Prentice Hall International

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Elective 3 & 4	3	0	3

(ESS22) HARDWARE SOFTWARE CO-DESIGN

Pre-requisites:
Concepts of
- Embedded System Design
- VLSI Technology and Design
- RTOS & Embedded C

Course Objectives:
- Describe an embedded system design flow from specification to physical realization
- Explain a system development holistically
- Identify contemporary development techniques
- Devise new theories, techniques, and tools in design, implementation and testing

Course Outcomes:
After going through this course the student will be able to
- Gain knowledge of contemporary issues and algorithms used.
- Understand the use of modern hardware/software tools for building prototypes of embedded systems
- Know the interfacing components, different verification techniques and tools.
- Examine different specification languages and integrate embedded hardware, software and operating systems to meet the functional requirements of embedded applications.

UNIT I:
Co- Design Issues: Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.
Co- Synthesis Algorithms: Hardware software synthesis algorithms: hardware – software partitioning distributed system cosynthesis.

UNIT II:
Prototyping and Emulation: Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping.
Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60),Mixed Systems.

UNIT III:
Compilation Techniques and Tools for Embedded Processor Architectures: Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

UNIT IV:
Design Specification and Verification: Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification

UNIT V:

Languages for System – Level Specification and Design-I: System – level specification, design representation for system level synthesis, system level specification languages

Languages for System – Level Specification and Design-II: Heterogeneous specifications and multi language co-simulation, the cosyma system and lycos system.

Text Books:
1. Hardware / Software Co- Design Principles and Practice – Jorgen Staunstrup, Wayne Wolf –2009, Springer.
2. Hardware / Software Co- Design - Giovanni De Micheli, Mariagiovanna Sami, 2002, Kluwer Academic Publishers.

References :
1. A Practical Introduction to Hardware/Software Co-design -Patrick R. Schaumont - 2010 – Springer

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Electives 3 & 4	3	0	3

(ESS25) NETWORK SECURITY AND CRYPTOGRAPHY

Pre-requisites:
- Operating Systems, Networks

Course Objectives:
- Understand security threats, and the security services and mechanisms to counter them
- Learn various approaches to Encryption techniques that provide information and network security
- Learn number theory & modular arithmetic required for security algorithms

Course Outcomes:
After going through this course the student will be able to
- Should be able to identify network security threats and determine efforts to counter them
- understand Network Security & Cryptography concepts and applications
- Analyze and design network security protocols
- familiar with cryptographic techniques for secure communication

UNIT I:
Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security. Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

UNIT II:
Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.
Algorithms: Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block cifers.
Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.
Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.

UNIT III:
Number Theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.
Message Authentication and Hash Functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs.

UNIT IV:
Hash and Mac Algorithms: MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC.
Digital Signatures and Authentication Protocols: Digital signatures, Authentication Protocols, Digital signature standards.
Authentication Applications: Kerberos, X.509 directory Authentication service. Electronic Mail Security: Pretty Good Privacy, S/MIME.

UNIT V:
IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management.
Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction.
Intruders, Viruses and Worms: Intruders, Viruses and Related threats.
Fire Walls: Fire wall Design Principles, Trusted systems.

Text Books:
1. Cryptography and Network Security: Principles and Practice - William Stallings, 2000, PE.

References:
1. Principles of Network and Systems Administration, Mark Burgess, John Wiel

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Electives 3 & 4				

(ESS26) SENSORS AND ACTUATORS

Pre-requisites:
- Engineering Physics
- Electronic Measuring Instruments

Course Objectives:
- To provide basic knowledge to understand the transduction principles, sensors, transducer and measurement systems.
- To provide better knowledge to apply the transduction principles and understand the working of various sensors.
- To analyse different sensors and their application in real time applications
- To sharpen the creative skills so that a complete automated system with sensors, actuators and embedded controllers can be built.

Course Outcomes:
After going through this course the student will be able to
- Understand instrumentation and automation system used in the industry.
- Appreciate the application of the automation with the help of instrumentation and embedded system.
- Apply the knowledge of the sensors and actuators and create an automated system.
- Evaluate an automated system.

UNIT I:
Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization
Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges –Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors

UNIT II:
Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermo sensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQRT Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors
Magnetic Sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors –Anisotropic Magneto resistive Sensing – Semiconductor Magneto resistors– Hall Effect and Sensors –Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros –Synchro-resolvers – Eddy Current Sensors – Electromagnetic Flow meter – Switching Magnetic Sensors SQUID Sensors

UNIT III:
Radiation Sensors: Introduction – Basic Characteristics – Types of Photo sensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors
Electro Analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization–Reference Electrodes – Sensor Electrodes – Electro ceramics in Gas Media .

UNIT IV:
Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters –Compensation– Information Coding/Processing – Data Communication – Standards for Smart Sensor Interface – The Automation
Sensors –Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring

UNIT V:
Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems – Directional Control valves – Pressure control valves – Cylinders – Servo and proportional control valves – Process control valves – Rotary actuators Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection Electrical Actuation Systems-Electrical systems –Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors.

Text Books:
1.   Patranabis – Sensors and Transducers –PHI Learning Private Limited.
2.   W. Bolton – Mechatronics –Pearson Education Limited.

Reference:
1.   Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013.

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Open Elective - 2	**3**	**0**	**3**

(ESS41) CLOUD COMPUTING

Course Objectives:
- Understand cloud computing paradigm, recognize its various forms
- Get a clear understanding of Cloud Computing fundamentals and its importance to various organizations.
- Master the concepts of IaaS, PaaS, SaaS, Public and Private clouds.
- Understand AWS and learn to develop applications in AWS.

Course Outcomes:
After going through this course the student will be able to
- Articulate the main concepts, key technologies, strengths, and limitations of cloud computing
- Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
- Explain the core issues of cloud computing such as security, privacy, and interoperability.
- Identify problems, and explain, analyze, and evaluate various cloud computing solutions

UNIT I:
Systems Modelling, Clustering and Virtualization: Distributed System Models and Enabling Technologies, Computer Clusters for Scalable Parallel Computing, Virtual Machines and Virtualization of Clusters and Data centres.

UNIT II:
Foundations: Introduction to Cloud Computing, Migrating into a Cloud, Enriching the 'Integration as a Service' Paradigm for the Cloud Era, the Enterprise Cloud Computing Paradigm.

UNIT III:
Infrastructure as a Service (IAAS) & Platform and Software as a Service (PAAS / SAAS): Virtual machines provisioning and Migration services, On the Management of Virtual machines for Cloud Infrastructures, Enhancing Cloud Computing Environments using a cluster as a Service, Secure Distributed Data Storage in Cloud Computing. Aneka, Comet Cloud, T-Systems', Workflow Engine for Clouds, Understanding Scientific Applications for Cloud Environments.

UNIT IV:
Monitoring, Management and Applications: An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery networks using Clouds, Resource Cloud Mashups.

UNIT V:
Governance and Case Studies: Organizational Readiness and Change management in the Cloud age, Data Security in the Cloud, Legal Issues in Cloud computing, Achieving Production Readiness for Cloud Services.

Text Books:
1. Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing , Kai Hwang, Geoffery C.Fox, Jack J.Dongarra, Elsevier, 2012.
3. Cloud Computing : A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill, rp2011

References:
1. Cloud Computing : A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill, rp2011.
2. Enterprise Cloud Computing, Gautam Shroff, Cambridge University Press, 2010.

3. Cloud Computing: Implementation, Management and Security, John W. Rittinghouse, James F.Ransome, CRC Press,
4. rp2012.
5. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, SPD, rp2011.
6. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed
7. Latif, O'Reilly, SPD, rp2011

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Open Elective-2	**3**	**0**	**3**

(ESS42) SOFT COMPUTING TECHNIQUES

Pre-requisites:
Concepts of
- Stastical methods
- Optimization techniques

Course Objectives:
- To familiarize with soft computing concepts.
- To introduce the ideas of Neural networks, fuzzy logic and use of heuristics based on human experience.
- To introduce the concepts of Genetic algorithm and its applications to soft computing using some applications.

Course Outcomes:
After going through this course the student will be able to
- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply neural networks to pattern classification and regression problems.
- Analyze the fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- Design the combinatorial optimization problems using genetic algorithm

UNIT I:
Introduction: Approaches to intelligent control, Architecture for intelligent control, Symbolic reasoning system, Rule-based systems, the AI approach, Knowledge representation - Expert systems.

UNIT II:
Artificial Neural Networks: Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron, Learning and Training the neural network, Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations, Hopfield network, Self-organizing network and Recurrent network, Neural Network based controller.

UNIT III:
Fuzzy Logic System: Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning, Introduction to fuzzy logic modeling and control, Fuzzification, inferencing and defuzzification, Fuzzy knowledge and rule bases, Fuzzy modeling and control schemes for nonlinear systems, Self organizing fuzzy logic control, Fuzzy logic control for nonlinear time delay system.

UNIT IV:
Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, Adjustment of free parameters, Solution of typical control problems using genetic algorithm, Concept on some other search techniques like Tabu search and Ant-colony search techniques for solving optimization problems.

UNIT V:
Applications: GA application to power system optimization problem, Case studies: Identification and control of linear and nonlinear dynamic systems using MATLAB-Neural Network toolbox, Stability analysis of Neural-Network interconnection systems, Implementation of fuzzy logic controller using MATLAB fuzzy-logic toolbox, Stability analysis of fuzzy control systems.

Text Books:
1. Introduction to Artificial Neural Systems - Jacek.M.Zurada, Jaico Publishing House, 1999.
2. Neural Networks and Fuzzy Systems - Kosko, B., Prentice-Hall of India Pvt. Ltd., 1994.

References:
1. Fuzzy Sets, Uncertainty and Information - Klir G.J. &Folger T.A., Prentice-Hall of India Pvt.Ltd. 1993.
2. Fuzzy Set Theory and Its Applications - Zimmerman H.J. Kluwer Academic Publishers, 1994.
3. Introduction to Fuzzy Control - Driankov, Hellendroon, Narosa Publishers.
4. Artificial Neural Networks - Dr. B. Yagananarayana, 1999, PHI, New Delhi.
5. Elements of Artificial Neural Networks – Kishan Mehrotra, Chelkuri K. Mohan, Sanjay Ranka, Penram International.
6. Artificial Neural Network –Simon Haykin, 2nd Ed., Pearson Education.
7. Introduction Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N.Deepa,1/e, TMH, New Delhi.

		L	T/P	C
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Open Electives - 2				

(VSD41) SOFTWARE DEFINED RADIO

Pre-requisites:
Communication fundamentals

Course Objectives:
- To understand the SDR and its architecture
- To understand the system design and signal conversion techniques
- To understand signal processing techniques
- To understand the transmitter and receiver architecture and working principle.

Course Outcomes:
After going through this course the student will be able to
- Conceptualize the SDR and implementation details
- Identify the blocks of SDR for a specific application
- Recognize the challenges in the implementation of SDR
- Analyze the transmitter and receiver architectures in SDR

UNIT I:
Introduction – Software Defined Radio – A Traditional Hardware Radio Architecture – Signal Processing Hardware History – Software Defined Radio Project Complexity.
A Basic Software Defined Radio Architecture – Introduction – 2G Radio Architectures- Hybrid Radio Architecture- Basic Software Defined Radio Block Diagram- System Level Functioning Partitioning-Digital Frequency Conversion Partitioning.

UNIT II:
RF System Design – Introduction- Noise and Channel Capacity- Link Budget- Receiver Requirements- Multicarrier Power Amplifiers- Signal Processing Capacity Tradeoff.
Analog-to-Digital and Digital-to-Analog Conversion- Introduction – Digital Conversion Fundamentals- Sample Rate- Bandpass Sampling- Oversampling- Antialias Filtering – Quantization – ADC Techniques-Successive Approximation- Figure of Merit-DACs-DAC Noise Budget- ADC Noise Budget.

UNIT III:
Digital Frequency Up- and Down Converters- Introduction- Frequency Converter Fundamentals- Digital NCO- Digital Mixers- Digital Filters- Halfband Filters- CIC Filters- Decimation, Interpolation, and Multirate Processing-DUCs - Cascading Digital Converters and Digital Frequency Converters.
Signal Processing Hardware Components- Introduction- SDR Requirements for Processing Power- DSPs- DSP Devices- DSP Compilers- Reconfigurable Processors- Adaptive Computing Machine- FPGAs

UNIT IV:
Software Architecture and Components – Introduction- Major Software Architecture Choices – Hardware – Specific Software Architecture- Software Standards for Software Radio-Software Design Patterns- Component Choices- Real Time Operating Systems- High Level Software Languages- Hardware Languages.

UNIT V:
Smart Antennas for Software Radio- Introduction- 3G smart Antenna Requirements- Phased Antenna Array Theory- Applying Software Radio Principles to Antenna Systems- Smart Antenna Architectures- Optimum Combining/ Adaptive Arrays- DOA Arrays-Beam Forming for CDMA- Downlink Beam Forming.

Text Books:

1. Paul Burns, Software Defined Radio for 3G, Artech House, 2002.
2. Tony J Rouphael, RF and DSP for SDR, Elsevier Newnes Press, 2008

References:

1. Jouko Vanakka, Digital Synthesizers and Transmitter for Software Radio, Springer,   2005.
2. P Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House, 2005.
3. Software Radio: A Modern Approach to Radio Engineering by Jeffrey H. Reed, Prentice Hall PTR; May 2002

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(ESS52) EMBEDDED SYSTEMS LABORATORY

Pre-requisites:

Concepts of
- RTOS
- Embedded C
- Microcontrollers for Embedded System Design

Course Objectives:
- To enable the students to program, simulate and test ARM processor based circuits and their interfaces
- To enable the students to program various devices using KIEL4
- To implement software programs to provide an interface between peripheral and ARM processor
- Testing RTOS environment and system programming KEIL tools

Course Outcomes:

After going through this course the student will be able to
- Apply the concepts of architecture, instruction sets of ARM, I/O ports,I2C for peripheral chip access, PWM and UART to perform various tasks
- Understand operating system architecture and develop RTOS based embedded applications
- Design, simulate and execute various applications using ARM
- Create a subsystem and integrate this with ARM based system to perform a complex task involving networked, mobile, embedded systems.

PART- I

The following Programs are to be implemented on ARM Processor

1. Simple Assembly Program for
    a. Addition | Subtraction | Multiplication | Division
    b. Operating Modes, System Calls and Interrupts
    c. Loops, Branches
2. Write an Assembly programs to configure and control General Purpose Input/Output (GPIO) port pins.
3. Write an Assembly programs to read digital values from external peripherals and execute them with the Target board.
4. Program for reading and writing of a file
5. Program to demonstrate Time delay program using built in Timer / Counter feature on IDE environment
6. Program to demonstrates a simple interrupt handler and setting up a timer
7. Program demonstrates setting up interrupt handlers. Press button to generate an interrupt and trace the program flow with debug terminal.
8. Program to Interface 8 Bit LED and Switch Interface
9. Program to implement Buzzer Interface on IDE environment
10. Program to Displaying a message in a 2 line x 16 Characters LCD display and verify the result in debug terminal.
11. Program to demonstrate I2C Interface on IDE environment
12. Program to demonstrate I2C Interface – Serial EEPROM
13. Demonstration of Serial communication. Transmission from Kit and reception from PC using Serial Port on IDE environment use debug terminal to trace the program.
14. Generation of PWM Signal
15. Program to demonstrate SD-MMC Card Interface.

PART- II

Write the following programs to understand the use of RTOS with ARM Processor on IDE Environment using ARM Tool chain and Library:

1. Create an application that creates two tasks that wait on a timer whilst the main task loops.
2. Write an application that creates a task which is scheduled when a button is pressed, which illustrates the use of an event set between an ISR and a task
3. Write an application that Demonstrates the interruptible ISRs (Requires timer to have higher priority than external interrupt button)
4. a).Write an application to Test message queues and memory blocks.
   b).Write an application to Test byte queues
5. Write an application that creates two tasks of the same priority and sets the time slice period to illustrate time slicing.

Interfacing Programs

6. Write an application that creates a two task to Blinking two different LEDs at different timings
7. Write an application that creates a two task displaying two different messages in LCD displaying two lines.
8. Sending messages to mailbox by one task and reading the message from mailbox by another task.
9. Sending message to PC through serial port by three different tasks on priority Basis.
10. Basic Audio Processing on IDE environment.

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(ESS62) MINI PROJECT- II

Course Outcomes:
After going through this course the student will be able to
- Identify and formulate problem statement
- Design applications using embedded processors with IDEs
- To communicate effectively
- Implement applications using embedded real time operating systems.
- Present technical report

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L	T/P	C
0	0	8

(ESS 71) INTERNSHIP / DISSERTATION PHASE - I

Course Outcomes:
After going through this course the student will be able to
- Identify and formulate real world problems
- Analyse and design using contemporary technologies
- Communicate effectively
- Apply advanced programming techniques for its implementation
- Present technical report

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II Year – I Sem. M.Tech (Embedded Systems)	L	T/P	C
	0	0	4

(ESS63) COMPREHENSIVE VIVA VOCE

Course Outcomes:

After going through this course the student will be able to

- Comprehend the fundamentals of embedded systems and its allied fields
- Analyse and apply Embedded systems concepts in its allied fields
- Communicate effectively

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	0	0	18

(ESS72) DISSERTATION PHASE - II

Course Outcomes:

After going through this course the student will be able to

- Identify and formulate real world problems
- Analyse and design using contemporary technologies
- Communicate effectively
- Apply advanced programming techniques for its implementation
- Present technical report