National Institute of Electronics and Information Technology, Chennai

COURSE PROSPECTUS

Name of the Group:	VLSI/ES/AE
Name of the Course:	PG Diploma in Embedded System Design
Course Code:	ED 500
Starting Date:	**16/07/2019**
Duration:	840 Hrs (24 Weeks)
Course Coordinator:	Ripunjay Singh
Last date of Registration:	**01/07/2019**

Preamble:

In today's world, embedded systems are all over, homes, offices, cars, factories, hospitals and consumer electronics. The inherent value of embedded systems lies in its pervasiveness. They are literally embedded in all electronic products, from consumer electronics to office automation, automotive, medical devices and communications. They make the products smart, connected and are responsible for differentiating the products in the market. Embedded systems are normally built around Microcontrollers and ARM Processor based SOCs.

The Embedded Industry is growing rapidly with introduction of wide variety of Product for various applications catering to different sector demands. This increases the complexity of embedded system design, which in turn also increases the demands placed on the effective design, development, verification and validation of application & product. Currently there is a great shortage of qualified engineer with good Embedded Design and Development skills. Sector will continue to grow with introduction of new innovative products & application; therefore, the need for Skilled Engineers will continue to grow. Hence there need an advanced training program in Embedded Field with emphasis on the o Design & Development skills.

This Embedded System Design course focuses on the architecture and programming of embedded processors, development of applications using Embedded/Real-Time Operating Systems and porting the applications on ARM.

Objective of the Course:

To develop the skillset required for Design and Development of the Embedded System Applications / Product using suitable Hardware (Interface / Peripherals) and Software tools. This course offers a range of topics of immediate relevance to industry and makes the participants exactly suitable for Embedded Industry

Outcome of the Course: After successful completion of this Course, students can able to:

- Proficiency required to design any embedded system (H/w or S/w or both) based on different families and architectures of Embedded System tools such as Microcontrollers, ARM Processors, Open Source Hardware etc.
- Expertise in developing applications using Embedded OS/RTOS and porting it on ARM Platform.

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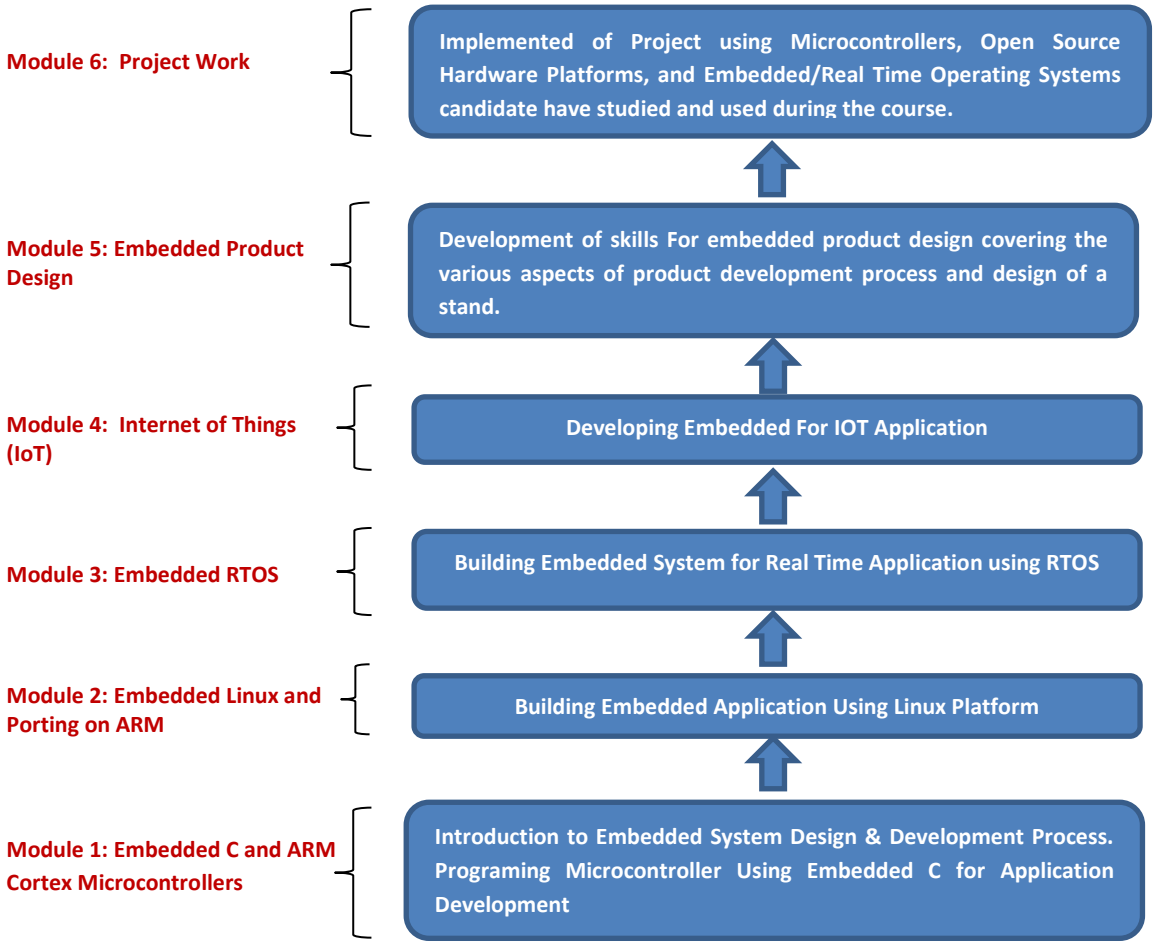
Course Overview: Functional Point of View



Course Structure:

ED 500	Module Name	Duration (in Hrs. & Weeks)
ED 501	Embedded C and ARM Cortex Microcontrollers	175 (5 Weeks)
ED 502	Embedded Linux and Porting on ARM	105 (3 Weeks)
ED 503	Embedded RTOS	105 (3 Weeks)
ED 504	Internet of Things (IoT)	105 (3 Weeks)
ED 505	Embedded Product Design	105 (3 Weeks)
ED 506	Project Work	245 (7 Weeks)
	Total	**840** (24 Weeks)

Other Details:

Course Fees:

For General Candidates: Course fee is **Rs.70, 000/- plus GST@18%**

For SC/ST Candidates: No Fee

However they are required to remit an amount of **Rs.7, 000/-** as advance security deposit. This amount will be considered as security deposit and will be refunded after completion of the course. If the student fails to complete the course successfully this amount along with any other security deposits will be forfeited.

Module Wise Course Fee:

Modules		Module Name	Duration (in Hrs.)	Fees	Fees for SC/ST Candidates
Module I	ED 501	Embedded C and ARM Cortex Microcontrollers	175	Rs.16800/- + GST at actual	Rs.1680/- (Refundable after successful completion of course)
Module II	ED 502	Embedded Linux and Porting on ARM	105	Rs.16800/- + GST at actual	Rs.1680/- (Refundable after successful completion of course)
Module III	ED 503	Embedded RTOS	105	Rs.16800/- + GST at actual	Rs.1680/- (Refundable after successful completion of course)
Module IV	ED 504	Internet of Things (IoT)	105	Rs.12600/- + GST at actual	Rs.1260/- (Refundable after successful completion of course)
Module V	ED 505	Embedded Product Design	105	Rs.8400/- + GST at actual	Rs.840/- (Refundable after successful completion of course)

Registration Fee: Non-refundable

SC/ST: No registration fee

Others: Rs.1000/-. (Including GST)

However the above registration fee shall be refunded on few special cases as given below:

1. If course postponed and new date is not convenient for the student.

2. If course cancelled.

Payment schedule: Students can pay the full fees of Rs.82, 600/- (Rs.70, 000/- + GST) or as instalments as given below with GST at Actuals:

Instalment No.	Last Date for Payment	Amount (in Rs.)	Amount for SC/ST Candidates
1.	08/07/2019	10000/- incl. of GST	Rs.7,000/- (Refundable after successful completion of course)
2.	15/07/2019	37200/- incl. of GST	
3.	18/09/2019	35400/- incl. of GST	

Eligibility:

i) M.E./M.Tech or B.E./B.Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Biomedical /Computer Science/Information Technology or MSc in Electronics/ Instrumentation/ Computer Science/Information Technology.

ii) Candidates who have appeared in the qualifying examination and awaiting results may also apply.

Number of Seats: 30

How to apply:

Candidates are advised to download the Registration from our website www.nielit.gov.in/chennai. After filling the form with all documents and fees, it can be submitted to NIELIT Chennai office in person or through post before staring of the course. Payment towards non-refundable Registration and Course fee can be paid through any one of the following modes:

- ✓ DD drawn from a nationalized bank (preferably SBI) in favour of "NIELIT Chennai" payable at Chennai.
- ✓ Online transaction: Account No: 32558810978 Branch: Kottur (Chennai), IFS Code: SBIN0001669.
- ✓ Pay through Nationalized Bank Debit Card (Service charges applicable)

  Note: The Institute will not be responsible for any mistakes done by either the bank concerned or by the depositor while remitting the amount into our account.

Last date of Registration: 1st July 2019

Selection of candidates: Selection of candidates will be based on first come first serve basis and their marks in the qualifying examination subject to eligibility and availability of seats.

Admission Procedure: All interested candidates are required to fill the Registration form with the fees (Registration and Course fees) before 1st July 2019 with all the necessary following documents.

- Original and self-attested Copies of Proof of Age, Qualifications, etc.
- One passport size photograph and one stamp size photograph for identity card.
- Self-attested copy of Govt. issued photo ID card.
- Self-attested copy of community certificate (if availing SC/ST fee concession)

Note: Working days are from Monday to Friday. Admission timings are from 9:00 AM to 5:30 PM.

Discontinuing the course: No fees under any circumstances shall be refunded in case of a student discontinuing the course. No certificate shall be issued if discontinued.

Course Timings: 9:00 PM to 5:30 PM (Monday to Friday)

Location: NIELIT Chennai is located at Gandhi Mandapam Road, Kotturpuram, Chennai (Landmark: Opp. To Anna Centenary Library)

Address: National Institute of Electronics and Information Technology Chennai Centre,
ISTE Complex, No. 25, Gandhi Mandapam Road, Chennai – 600025
E-mail: trng.chennai@nielit.gov.in / Phone: 044-24421445
Contact Person: Mr. Ripunjay Singh, Mobile: 9445220125

Course enquiries: Students can enquire about the various courses either on telephone or by personal contact between 9:15 AM to 5:15 PM (Lunch time 1:00 PM to 1:30 PM) Monday to Friday.

Annexure

Detailed Syllabus of the Course

Module I - ED 501: Embedded C and ARM Cortex Microcontrollers

Module Duration: 175 Hours

Objective

This module is framed to set the required background in embedded system concepts and 'C' language for the rest of the modules. It aims at familiarizing the students in embedded concepts and programming in 'C'. This module covers the advanced topics in 'C' such as Memory management, Pointers, Data structures which are of

high relevance in embedded software is considered in depth. This module makes use of KEIL C Compiler along with ARM Cortex Microcontrollers.

This module covers the architecture of the popular 32-bit bit Microcontroller such as ARM. The ARM Cortex processor is the industry-leading 32-bit processor for highly deterministic real-time applications, specifically developed to enable partners to develop high-performance low-cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors.

Course Description 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, Hardware architecture, Software architecture, Application Software, Communication Software, Development and debugging Tools.

'C' and Embedded C

Introduction to 'C' programming, Storage Classes, Data Types, Controlling program flow, Arrays, Functions, Memory Management, Pointers, Arrays and Pointers, Pointer to Functions and advanced topics on Pointers, Structures and Unions, Data Structures, Linked List, Stacks, Queues, Conditional Compilation, Preprocessor directives, File operations, Variable arguments in Functions, Command line arguments, bitwise operations, Typecasting.

Introduction to ARM Cortex Architecture

Introduction to ARM Architecture, Overview of ARM, Overview of Cortex Architecture

Cortex M4 Microcontrollers & Peripherals

Cortex M4 based controller architecture, Memory mapping, Cortex M4 Peripherals – GPIOs, Timers, UARTs, ADC, Cortex M4 interrupt handling – NVIC. Application development with Cortex M4 Controllers with standard peripheral libraries.

Learning Outcomes

After successful completion of the module, the students shall be able to:

- Develop Embedded application using Embedded C Programming
- Use ARM Cortex M4 with Embedded C Programming for Application Development

Text Books:

1. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
2. Let us C by Yashwant Kanetkar.
3. The Definitive Guide to the ARM Cortex M3 and Cortex M4, Joseph Yiu, Newnes.

Reference Books:

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill.
2. Embedded C, Pont, Michael J
3. Embedded Systems an Integrated Approach: Lyla B Das, Pearson
4. C Programming by Worthington, Steve
5. C Programming language, Kernighan, Brian W, Ritchie, Dennis M
6. Art of C Programming, JONES, ROBIN,STEWART, IAN
7. C Programming for Embedded systems, Zurell, Kirk
8. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss,
9. Dominic Symes, Chris Wright; 2004, Elseiver.
10. Cortex M4 Reference manual.
11. STM32Ldiscovery datasheets, reference manuals & Application notes.

Module II - ED 502: Embedded Linux and Porting on ARM

Module Duration: 105 Hours

Objective

The objective of the course is to provide understanding of the techniques essential to the design and implementation of embedded systems with embedded operating systems and to port on ARM Processor based systems.

Course Description

- **Introduction**
  Basic Operating System Concepts, Linux as Embedded Operating System, Comparison of Embedded OS, Embedded OS Tools and Development, Discussion on Embedded OS Applications and Products.
- **System architecture of a Basic OS**
  Internals of Linux OS, System Calls, Linux Compiler options, Process, Multithreading and Synchronization, Serial port and Network programming, Kernel module programming and Device drivers
- **Inter Process Communication**
  Pipe and FIFOs, Shared memory, Sockets
- **Getting Linux on a device**
  Linux boot sequence, Building Kernel, Building Boot image
- **Porting OS on ARM**
  Building root file system, Kernel Compilation for ARM, Porting of OS to ARM
- **Practical Sessions**
  Embedded Linux Applications and Porting on ARM

Learning Outcomes

After successful completion of the module, the students shall be able to:

- Implement Embedded systems with Embedded operating systems
- Develop applications with Embedded Linux
- Port the OS with applications on ARM

Reading List

1. GNU/LINUX Application Programming, Jones, M Tims
2. Embedded Linux: Hardware, Software, and Interfacing, Hollabaugh, Craig,
3. Building Embedded Linux Systems: Yaghmour, Karim
4. Embedded Software Primer: Simon, David E.
5. Linux Kernel Internals: Beck, Michael At Al
6. UNIX Network Programming : Steven, Richard
7. Linux: The Complete Reference: Petersen, Richard
8. Linux Device Drivers: Rubini, Alessandro, Corbet, Jonathan
9. Linux Kernel Programming: Algorithms and Structures of version 2.4: Beck, Michael At Al
10. Linux Kernel Development: Love, Robert
11. Operating System Concepts, Peter B. Galvin, Abraham Silberschatz, Gerg Gagne, Wiley Publishers
12. Embedded/Real-Time Systems: Concepts, Design and Programming: The Ultimate Reference, Dr. K.V.K.K. Prasad, Published by Wiley DreamTech, 2003
13. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; 2004, Elseiver.
14. ARM Reference manual.

Module III - ED 503: Embedded RTOS

Module Duration: 105 Hours

Objective

The objectives of the course is to provide the students with an understanding of the aspects of Real-time Operating Systems and to provide an understanding of the techniques essential to the design and implementation of real- time embedded systems. This course covers popular real time operation systems.

Course Description

- **Introduction**
  Embedded Software – Real-time **Vs.** Non Real-time
  Introduction to Real-time systems and Embedded Real-time Systems Discussion of RTOS.
  Comparison of Embedded RTOS Design Goals for Real-time software
  Discussion on Embedded Real-time applications Considerations for real-time programming

- **System architecture of RTOS**
  Introduction to RTOS
  Task Creation and management
  Inter Task Communication Mechanisms Semaphores,
  Message Queues, Pipes Interrupts, Tornado tools

Peripheral Interfacing and porting RTOS on ARM

- **Practical Sessions**

  Application Development with RTOS

Learning Outcomes

After successful completion of the module, the students shall be able to:

- Develop Embedded Real Time software that is required to run embedded systems
- Develop real-time applications using RTOS
- Porting RTOS applications on ARM
- Build real-time embedded systems using RTOS

Reading List

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill
2. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK
3. Software Design for Real-Time Systems: Cooling, J E Proceedings of 17the IEEE Real-Time Systems Symposium December 4-6, 1996 Washington, DC: IEEE Computer Society
4. Real-time Systems – Jane Liu, PH 2000
5. Real-Time Systems Design and Analysis : An Engineer's Handbook: Laplante, Phillip A
6. Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques:
7. Ward, Paul T & Mellor, Stephen J
8. Monitoring and Debugging of Distributed Real-Time Systems: TSAI, Jeffrey J P & Yang, J H
9. Embedded Software Primer: Simon, David E.

Module IV - ED504: Internet of Things (IoT)

Module Duration: 105 Hours

Objective

The objective of the course is to provide the students with understanding of Internet of Things (IoT). Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that covers a variety of protocols, domains, and applications. The Internet of Things (IoT, sometimes Internet of Everything) is the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. The participants of this module will learn about IoT Architecture, IoT platform, wireless sensor networks and IoT Application development.

Course Description

- Introduction to IoT
- IoT Platforms
- Sensors & Interfaces

- Wireless PAN (Bluetooth & Zigbee), GSM, Wifi
- Wireless Sensor Networks
- Linux Scripting for IoT
- Python Programming

Learning Outcomes

After successful completion of this module, students should be able to:

- Apply the concepts of IoT Architecture and Layering
- Implement IoT applications using proper hardware and software platforms
- Develop IoT Applications with Aurdino and other platforms

Reading List

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. OvidiuVermesan, Dr. Peter Friess, River Publishers
3. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
4. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, HuanshengNing
5. Internet of Things (A Hands-on-Approach), Vijay Madisetti , ArshdeepBahga
6. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
7. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
8. Computer Networks; By:Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition
9. Data and Computer Communications; By:Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition
10. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing," McGraw Hill, 2009.

Module V - ED 505: Embedded Product Design

Module Duration: 105 Hours

Objective

The objective of this module is to help fresh graduates and practicing engineers to enhance their knowledge and skills of embedded product design covering the various aspects of product development process and design of a stand- alone embedded system.

Course Description

- **Product Development Process**
  - System level design using hardware and software
  - Hardware and software integration issues and testing
  - Hardware and software co-verification
  - Component cost and costing in product design
- **Programming Aids**
  - Flowchart Techniques

- Flowchart Symbols Meaning
- How to Draw a Flowchart
- Flowchart Best Practices
- Common Mistakes Made when Drawing Flowcharts

- **Embedded Protocols and Interfacing**
  - Overview of Embedded Protocols,
  - I2C protocols, SPI, CAN Processor Bus, USB
  - GSM, GPS, RFID, RF Module, zigBee and Bluetooth Modules Interfacing with
  - Microcontrollers

- **Microcontroller Based Design**
  - ORCAD Schematic and PCB Layout
  - Embedded Hardware Design with Microcontroller

Learning Outcomes

After successful completion of the module, the students shall be able

- Apply product development process for realization of the product
- Design and develop a standalone Embedded System using Microcontrollers through conceptual design, PCB Design, PCB Assembly, Testing, Integration etc.

Reading List

1. Product Design & Development - Karl T Ulrich & Steven D. Eppinger; Mc GrawHill
2. Relevant Data sheets and application notes

Module VI- ED 506: Project Work

Module Duration: 245 Hours

Course Description

The students can select hardware, software or system level projects. The project can be implemented using **Microcontrollers, Open Source Hardware Platforms, and Embedded/Real Time Operating Systems** which students have studied and used during the course. A total product or project can be selected.