

**COURSE PROSPECTUS**

**Name of the Group:** *Embedded System Group*

**Name of the Course:** *PG Diploma in Embedded Real Time systems*

**Course Code:** *ED 600*

**Starting Date:** *22 August 2016*

**Duration:** *24 Weeks*

**Preamble:** *In today's increasing global market place, successful companies are finding that investments in hardware and software are no longer enough to maintain a competitive edge. Human elements with specialized engineering and design skills have become the essential part of the equation.*

*Embedded systems monitor and control everything from Spacecraft to Robots, Microwave ovens, Car engines, VCRs, Television sets and much more. They control virtually everything that is electronic in our lives. Embedded systems are normally built around Microcontrollers, Digital Signal Processors (DSPs) and FPGAs or SOCs. A lot of trained manpower is required in programming of these tools rather than in hardware design.*

*Emergence of Embedded operating systems such as Embedded Linux and Android as well as Real-time operating systems helped in developing many exciting applications in embedded products which were unimaginable till recently. Real-time application with big potential in defense sector is another demand area in embedded domain. Mobile communication is one of the fast growing engineering domain of Embedded systems, a lot of emerging technologies are happening in this area such as GSM, GPRS, CDMA, WCDMA, Zigbee, Bluetooth, RFID etc. They make the products smart and are responsible for differentiating the products in the market.*

*Their huge numbers and new complexity call for a new design approach, one that emphasizes high-level tools and hardware/software tradeoffs, rather than low-level custom programming and logic design. Development of these applications requires sophisticated skills in device driver development, porting etc.*

*Supplying embedded software to multinational semiconductor and systems companies is likely to be a US\$4 billion to \$5 billion opportunity for India, according to a study conducted jointly by the Delhi-based National Association of Software and Service Companies (NASSCOM) and New York-based management consulting firm, McKinsey & Co. Revenues from embedded real-time software design are poised for large growth as applicability of embedded systems increases in industries such as Telecom and Datacom, Consumer Electronics, Industrial Automation, Automobiles and Office Automation. A recent Frost & Sullivan study estimated the Indian embedded software market (exclusive of services) at \$700 million with an annual*

growth forecast of 30 per cent. It is estimated that minimum 5000 highly qualified and trained Embedded System professionals are required per year.

To cater to the growing market demand for trained high caliber professionals in Embedded Systems, the Post Graduate Diploma in Embedded Real-time Systems Course is designed. This course covers the fundamentals of Embedded Programming concepts, Real-time operating systems, Porting of OS to Embedded Processors as well as Device Driver development.

**Objective of the Course:** To mould fresh electronics & computer science engineers and to retrain working engineers into High Caliber Embedded Real-time Application Designers by enhancing their knowledge and skills in various software design aspects of Embedded Real-time Systems. This course offers a range of topics of immediate relevance to industry and makes the students exactly suitable for industries engaged in Embedded System development. This course is also an excellent preparation for those wishing to engage in application research in this rapidly developing area

**Outcome of the Course:** On completion of the Course, the Participants shall get

- i. Expertise in programming language such as C.
- ii. Expertise in real-time programming with industry standard RTOS such as VxWorks and RT Linux.
- iii. Expertise in Embedded Operating system
- iv. Expertise in Device Driver development
- v. Expertise in Porting OS & RTOS to Embedded Processors
- vi. Hands on experience in Operating system (Linux) internals
- vii. Exposure to Embedded Wireless Application development

**Course Structure:** This course contains total eight modules. After completing the first seven modules, the students have to do a six weeks project using any of the topics studied to earn the PG Diploma.

<b>ED 600</b>	<b>Module Name</b>	<b>Weeks</b>
ED601	Embedded C and ARM Cortex Microcontrollers	4
ED602	Embedded Linux	2
ED603	Embedded RTOS	4
ED604	Porting on ARM Cortex Microcontrollers	2
ED605	Internet of Things (IoT)	2
ED 606	Embedded Protocols & Device Drivers	3
ED607	Seminar and Case Study	1
ED 608	Project Work	6
	<b>Total</b>	<b>24</b>

a. **Course Fees :**

**General Candidates:** Course fee is **Rs 70,000** + Service Tax at actual

**SC/ST Candidates:** Tuition Fees/Examination fees are waived for SC/ST students admitted under SCSP/TSP. However they are required to remit an amount of **Rs 8,050/- as Advance caution/security deposit**. This amount will be considered as caution/security deposit and will be refunded after successful completion of the course. If the student fails to complete the course successfully this amount along with any other caution/security deposits by the student will be forfeited.

**Modular wise Course Fee:** Not Applicable for this course

b. **Registration Fee:** An amount of Rs 1000/- should be paid at the time of registering for the course. The same will be considered as caution deposit on student joining the course. This advance deposit will not be refunded for a selected candidate who does not join the course.

c. **Course Fee Installment Structure:**

Students can pay the full fees of **Rs 80,500/- (Rs 70,000/- + Service Tax)** in advance or as installments as given below

<b>Fees</b>	<b>*Amount for General Candidates</b>	<b>Amount for SC/ST Candidates</b>	<b>Due Date (on or before)</b>
**Advance Fee	Rs.10,000 /-	<b>Rs 8050/-</b> (refundable after successful completion of course)	11/08/2016
1 <sup>st</sup> Installment	Rs 30250/- (if advance deposit paid) else Rs 40250/-	Nil	22/08/2016
2 <sup>nd</sup> Installment	Rs 40250/-	Nil	17/11/2016

\* Above fees is inclusive Service Tax @actuals (15%) and revision if any will be applicable at the time of payment.

\*\* Advance fee - After publication of first selection list, the students in the first selection list have to pay the Advance Deposit within one week to take the provisional admission. Students in the additional selection should pay both Advance and First installment fee together on or before counseling day

Fine will be applicable to late fee payment as given below

Sl. No.	Description	Fine
---------	-------------	------

1.	Late fee payment within two weeks after due date	18% (annually) of the outstanding dues
2.	After second week of due date the candidate has to pay readmission fees along with the fine	Readmission fee Rs 250/- plus fine of 18% (annually) of the outstanding dues
3.	The candidate has to discontinue the course after third week from the due date	

d. 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.*
- iii. *On the date of counseling/admission, the candidate must produce the original mark lists up to the last semester/year of examination.*

e. Number of Seats : 40

f. How to Apply :

Students are advised to apply online or in the prescribed Application Form available with the course brochure/course prospectus or downloaded from our website. Filled-in application forms along with a Demand Draft (or proof of payment through any of the following modes) towards advance fee of Rs.1,000/- *drawn in favour of* Director, NIELIT, Calicut, *Payable at* State Bank of India, NIT Campus Branch (code: 2207), Chathamangalam should be sent to the **Training Officer, NIELIT, P. B. No. 5, NIT Campus Post, CALICUT – 673 601, Kerala. The Name of the Course Applied for should be super scribed on the top of the cover in which the application form is forwarded.**

Rs.1000/- will be considered as refundable caution deposit on student joining the course. This advance deposit will not be refunded for a selected candidate who does not join the course.

**Modes of Payment:** The course fee can be paid by one of the following methods as per your convenient.

1	Demand Draft to be drawn in favor of Director, NIELIT, Payable at State Bank of India, Calicut NIT Branch (2207). The DD should reach here before the last date to apply.
2	Through any branch of SBI (where this format is accepted) using the pay in slip available in our web site. The <b>original counterfoil</b> should reach here before the last date to apply.

3	<p>The fees can be paid directly into our account from any bank where core banking facility is available. The details required for direct payment are as given below.</p> <ul style="list-style-type: none"> <li>• Savings Account No: <b>31329537747</b></li> <li>• Bank Name: SBI, NIT Chathamangalam</li> <li>• Bank Code: 2207</li> <li>• IFSC No: SBIN0002207</li> <li>• MICR : <b>673002012</b></li> </ul> <p>The depositor should obtain the UTR Number/Journal No from the branch while depositing cash directly into our account. Depositor should also obtain the counterfoil duly filled up and signed by the staff with seal of the bank through which the amount was deposited. The following details should reach here before the last date to apply.</p> <ol style="list-style-type: none"> <li>1. Name of the Depositor</li> <li>2. Name of the Student</li> <li>3. Date of Payment</li> <li>4. Amount Deposited</li> <li>5. Name of Bank/branch through which amount deposited</li> <li>6. Purpose – Course ID – Advance Deposit/Hostel Rent/Installment Fee etc.</li> <li>7. Proof of Deposit (counterfoil/acknowledgement <b>in original</b>)</li> <li>8. UTR Number</li> </ol>
4	<p>The fees can be paid through the <b>SBI Collect</b> Payment Gateway as well:</p> <ol style="list-style-type: none"> <li>1. Please click the SBI Collect hyper link to enter the payment gateway.</li> <li>2. Select State of Corporate/Institution as <i>Kerala</i></li> <li>3. <i>Select</i> Type of Institution <i>Educational Institutions</i> and click on <i>Go</i> button</li> <li>4. <i>Select Educational Institutions Name as NIELIT and click Submit button</i></li> <li>5. Select Payment Category as <i>Course Fee</i></li> <li>6. Enter all the fields including amount payable and follow the instructions</li> </ol> <p>The following details should reach here before the due dates.</p> <ol style="list-style-type: none"> <li>1. Name of the Depositor</li> <li>2. Name of the Student</li> <li>3. Date of Payment</li> <li>4. Amount Deposited</li> <li>5. Purpose – Course Name:</li> <li>6. UTR Number</li> </ol>
5	<p>POS Facility</p> <p>Point of Sale (POS)/Card Swiping Machine facility is available at Accounts section for the purpose of remittance of amount dues to the Centre.</p> <p>As of now, there may not be any additional charge for usage of SBI / SB Group's Debit/ATM Cards, while making payment. However there could be additional charges (up to 2% of payment) for cards of other banks depending on the policy of the card issuing bank/type of card.</p>

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.

g. Selection of candidates :

*The selection to the course shall be based on the following criteria:*

- i. *Selection of candidates will be based on their marks in the qualifying examination and the on-line admission test conducted by NIELIT subject to eligibility and availability of seats. Knowledge in C Programming and Basic Electronics is a pre-requisite of this course.*
- ii. *The First list of Provisionally Selected Students will be published in our website <http://nielit.gov.in/calicut/> on 3<sup>rd</sup> August 2016.*
- iii. *All candidates who ho appear in selection list may pay Rs.10,000/- on or before 11<sup>th</sup> August 2016 by DD (Drawn in favor of Director, NIELIT, Calicut, Payable at State Bank of India, NITC Branch, Chathamangalam.) or by **direct payment into our account** from any bank where core banking facility is available. Selected candidates are requested to send the proof of remittance of fee, so as to reach the centre by 12<sup>th</sup> August 2016.*

h. Test/Interview:

- |  |   |
|--|---|
| 1. <i>Online Admission Test<br/>Duration</i> | <i>1 Hour</i>   |
| 2. <i>Online Admission Test<br/>Dates</i>    | <i>21<sup>st</sup>, 26<sup>th</sup>, 28<sup>th</sup> July, 1<sup>st</sup>, 2<sup>nd</sup>, 9<sup>th</sup>, 16<sup>th</sup> and 19<sup>th</sup> August 2016. (Can take test on any one of the dates, however recommended to take on the earliest dates)</i>  |
| 3. <i>Number of Questions</i>                | <i>50</i>   |
| 4. <i>Syllabus</i>                           | <i>The pattern of the test shall be as follows<br/>Aptitude (20%), Logical reasoning (20%)<br/>C Programming (10%) and Basic Electronics (50%).<br/>Basic Electronics includes topics of Digital, Analog, Microprocessor, Computer Organization, Signals and Systems.</i>   |
| 5. <i>Where to take test</i>                 | <i>Candidates can take the online test at home or any place where there is uninterrupted internet facility.</i>   |
| 6. <i>How to take test</i>                   | <i>All candidates who have <b>registered and paid the advance deposit</b> shall be provided with user name and password by e-mail at least two days before the Admission Test. Those students who have not got the user name and password at least two days before the examination may contact the course coordinator immediately. In case of any network failure during test, the same may be intimated to us immediately.</i> |

7. *Mock Test*

*Mock Test shall be available from 1<sup>st</sup> June 2016.  
Duration of the Mock test will be 10 minutes.  
Those desiring to take the Mock test can log in to  
<http://nielit.gov.in/calicut/>*

i. **Counseling/Admission :**

*All candidates **provisionally selected and paid the fees (full or first installment)** will have to be present personally for **counseling and admission on 18<sup>th</sup> or 19<sup>th</sup> or 22<sup>nd</sup> August 2016** with all the necessary documents (originals and attested copies). Working days are from Monday to Friday. Admission timings are from 9.30 am to 4.00 pm. Those who don't bring the necessary documents (originals and attested copies) **by 22<sup>nd</sup> August 2016** are not eligible for admission and counseling.*

j. **Spot Admission:** If spot admission is open, spot admission will close within 15 days of Counseling/Admission of a particular course. On spot admission students should provide an undertaking saying that he/she is fully aware that he/she missed so much days of class and will not ask for extra classes or further extension of course.

k. **Admission Procedure :**

Students who have been selected for test/interview/counseling/admission are required to report to the Institute on the prescribed day by 9:30 hrs along with the following

1. Original and attested Copies of Proof of Age, Qualifications, etc
2. One passport size photograph and one stamp size photograph for identity card.
3. SC/ST Certificate (Original and attested copies, if applicable)
4. Income Certificate (Original and attested copy, if applicable)

The students on reaching the Institute are required to meet the Front Office Councilor (FOC). The FOC then directs the student to the Course Coordinator. The student gets the certificates and enrollment form verified by the Course Coordinator and then meets the FOC who shall direct the student to the Accounts for payment of fees. A student is thus admitted, attested copies of all documents shall be handed over to the Course Coordinator.

l. **Discontinuing the course:** No fees (including the caution deposit) under any circumstances, shall be refunded in the event of a student discontinuing the course. No certificate shall be issued for the classes attended.

A student can however, be eligible for module certificates (applicable only for courses which provide for modular admission) which he has successfully completed provided, he/she has paid the entire course fees. This is not applicable to SC/ST candidates availing fee concession. SC/ST candidates availing fee concession are eligible for module certificates only after completing the full course with required attendance

m. Course Timings :

*This program is a practical oriented one and hence there shall be more lab than theory classes. The classes and labs are from 9.30 am to 12.45 pm and 1.30 pm to 5.30 pm Monday to Friday. During project work, the timings are from 9.15 am to 5.30 pm. The theory to lab proportion is 30:70.*

n. Location and how to reach :

NIELIT Calicut is located very close to NIT campus and is about 22Kms from the Calicut (Kozhikode) city. A number of buses (Buses to NIT via Kunnamangalam) are available from "Palayam Bus Stand and KSRTC Bus Stand". The bus stop at our Institute is called "Panthrand" and is one stop before NIT. The bus fare is around Rs 17/-from Calicut City to NIELIT.

Calicut (Kozhikode) is well connected by Rail, Road and Air form different parts of the country. The maximum and minimum temperatures range between 35<sup>0</sup>C and 20<sup>0</sup>C.

o. Course enquiries :

Students can enquire about the various courses either on telephone or by personal contact between 9.15 A.M. to 5.15 P.M. (Lunch time 1.00 pm to 1.30 pm) Monday to Friday.

p. Important Dates (if applicable) :

<i>Last date of receiving completed applications</i>	: 2 <sup>nd</sup> August 2016
<i>Dates of Online Admission Test</i>	: 21 <sup>st</sup> , 26 <sup>th</sup> , 28 <sup>th</sup> July, 1 <sup>st</sup> , 2 <sup>nd</sup> , 9 <sup>th</sup> , 16 <sup>th</sup> and 19 <sup>th</sup> August 2016.
<i>Selection lists in website</i>	: 29 <sup>th</sup> July & 3 <sup>rd</sup> August 2016.
<i>Payment of Advance Fee-Rs 10,000/-</i>	: On or before 11 <sup>th</sup> August 2016.
<i>Last date for intimation of proof of fee remittance (Advance Fee-Rs 10,000/-)</i>	: 12 <sup>th</sup> August 2016.
<i>Counseling/Admission</i>	: 18 <sup>th</sup> , 19 <sup>th</sup> & 22 <sup>nd</sup> August 2016.
<i>Payment of first installment fees</i>	: On or before admission date.
<i>Commencement of classes</i>	: 22 <sup>nd</sup> August 2016.
<i>Payment of second installment fees</i>	: 17 <sup>th</sup> November 2016.

q. Placement :

*We have a placement cell, which provides placement assistance to students who qualify our courses. The course improves the knowledge and skill of the students as it deals with the latest technologies and tools used in industries. This helps the student in getting a placement by*

- Campus placement*
- Placement by companies for whom we send the students bio data and they conduct interviews at their site.*
- Students themselves attend interview at different companies and the course helps in the interview.*

r. Hostel facilities :

Hostel accommodation is available for boys and girls on monthly or daily chargeable basis. The hostel fee varies from Rs. 1,000 /- to Rs. 1,600/-- (for



boys) per month and Rs. 1,000/- to Rs. 1,500/- (for Girls) per month depending on the type of accommodation. However, students are required to pay the hostel fees for the duration of the course for which they are seeking admission at the time of joining the course.

An amount of Rs. 3,000/- should be paid as caution deposit (hostel & mess) at the time of joining the hostel which will be refunded/adjusted at the end of the course.

s. Canteen facilities :

Canteen facility is available and students staying in the hostel should pay monthly mess fee of Rs.3000/-. For all inmates, boarding in the mess is compulsory.

An amount of Rs. 1,000/- should be paid as caution deposit to the Canteen Contractor at the time of joining the mess which will be adjusted in the last month mess fee.

t. Lab Facilities

*We have state-of-the-art lab facility in embedded systems which include,*

- *32-bit ARM Microcontroller Development Systems – ARM Cortex-M3/M4 STM32, ATMEL ARM9 EK & CIRRUS LOGIC EDB9315*
- *Friendly ARM, Raspberry PI and Arduino Boards*
- *8-bit &16-bit Microcontroller Dev. Systems - Intel 8051, 80C196, MPLAB for PIC 16 & 18 series, Cygnal etc*
- *VxWorks, RTLinux & QNX RTOS*
- *Xilinx ISE FPGA Design Tools, Model Sim Simulator*
- *'C' compiler for 8051 (KEIL 'C' Development IDE), PIC (CCS), 80C196 (Tasking), ARM Developer Suite (ADS v1.)*
- *Matlab, Simulink, TI 'C6000 target for Matlab, LabView, Wireless LAN*
- *GSM/GPRS/GPS/Zigbee/Bluetooth/WiFi Modems.*
- *Wireless Simulators expertise in Glomosim, NS2, NS3, etc.*
- *Universal DATA I/O programmer, PC Based EDA tools (ORCAD)*
- *Digital Storage & Mixed Signal Oscilloscopes (500, 350, 300, 100 MHz )*
- *EMI Test Setup, Logic Analyzer, SMD Rework station*

u. Course Contents :

**ED 601: Embedded C and ARM Cortex Microcontrollers**

**Module Duration: 20 days**

**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 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 32-bit Processors, The ARM Architecture, Overview of ARM, Overview of Cortex Architecture, Cortex M3 Register Set and Modes, Cortex M3 Processor Core, Data Path and Instruction Decoding, ARM Cortex M3 Development Environment, Assembler and Compiler, Linkers and Debuggers, ARM, Thumb & Thumb2 instructions, Mixing ARM & Thumb Instructions, Memory hierarchy, Memory Mapping, Cache.

### **Cortex M3 Microcontrollers & Peripherals**

Cortex M3 based controller architecture, Memory mapping, Cortex M3 Peripherals – RCC, GPIO, Timer, System timer, UARTs, LCD, ADC, Cortex M3 interrupt handling – NVIC. Application development on Cortex M3 controllers using standard peripheral libraries.

## **Learning Outcomes**

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

- Understand the Embedded C Programming
- Understand ARM Cortex M Architecture and Embedded C Programming on ARM
- Build embedded systems using ARM Cortex Microcontrollers

**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, 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. Assembly language Programming ARM Cortex-M3, Vincent Mahout, Wiley
9. Embedded Linux: Hardware, Software, and Interfacing, Hollabaugh, Craig.
10. Embedded/Real-Time Systems: Concepts, Design and Programming: The Ultimate Reference, Dr. K.V.K.K. Prasad, Published by Wiley DreamTech, 2003
11. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; 2004, Elseiver.
12. Cortex M3 Reference manual.
13. STM32Ldiscovery datasheets, reference manuals & Application notes.

**ED602: Embedded Linux**

**Module Duration:** 10 days

**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.

**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, Make  
Process, Multithreading and Synchronization  
Serial port and Network programming with Embedded Linux  
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
- **Practical Sessions**  
Embedded Linux Applications

## Learning Outcomes

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

- Understand the Embedded operating systems that is needed to run embedded systems
- Understand Embedded Linux and its internals
- Build embedded systems using Embedded Linux operating systems

## 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

## ED603: Embedded RTOS

**Module Duration:** 20 days

### Objective

The objectives of the course is to provide the students with an understanding of the aspects of the Real-time systems and 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 two popular real time operation systems VxWorks and RTLinux.

### **Course Description**

- **Introduction**  
Embedded Software – Real-time Vs Non Real-time  
Introduction to Real-time systems and Embedded Real-time Systems  
Discussion of popular RTOS like RTLinux and VxWorks  
Comparison of Embedded RTOSs (RTLinux and VxWorks)  
Design Goals for Real-time software  
Discussion on Embedded Real-time applications  
Considerations for real-time programming
- **System architecture of RTLinux**  
Introduction RTLinux  
Thread Creation and Management  
Thread Synchronization Mechanisms  
IPC – RTFIFO, Shared Memory, Interrupt Handling
- **System architecture of VxWorks**  
Introduction to VxWorks  
Task Creation and management  
Inter Task Communication Mechanisms  
Semaphores, Message Queues, Pipes  
Interrupts, Tornado tools
- **Practical Sessions**  
Application Development under RTLinux and VxWorks

### **Learning Outcomes**

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

- Understand the Embedded Real Time software that is required to run embedded systems
- Understand the RTLinux RTOS and their commands
- Understand the VxWorks RTOS and realtime application programming with it.
- Build real-time embedded systems using RTLinux and VxWorks real-time operating systems

### **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 17th 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 V1 : Introduction and Tools: Ward, Paul T & Mellor, Stephen J
7. Structured Development for Real - Time Systems V2 : Essential Modeling Techniques: Ward, Paul T & Mellor, Stephen J
8. Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques: Ward, Paul T & Mellor, Stephen J
9. Monitoring and Debugging of Distributed Real-Time Systems: TSAI, Jeffrey J P & Yang, J H
10. Embedded Software Primer: Simon, David E.

### **ED604: Porting on ARM Cortex Microcontrollers**

**Module Duration:** 10 days

#### **Objective**

ARM is a family of instruction set architectures for computer processors based on a reduced instruction set computing (RISC) architecture developed by British company ARM Holdings. In 2005, about 98% of all mobile phones sold used at least one ARM processor. The low power consumption of ARM processors has made them very popular: 37 billion ARM processors have been produced as of 2013, up from 10 billion in 2008. The ARM architecture (32-bit) is the most widely used architecture in mobile devices, and most popular 32-bit one in embedded systems 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.

The processor delivers outstanding computational performance and exceptional system response to events while meeting the challenges of low dynamic and static power constraints. The processor is highly configurable enabling a wide range of implementations from those requiring memory protection and powerful trace technology to cost sensitive devices requiring minimal area. In this module the development of Application on ARM Cortex Microcontrollers by porting chibi-OS is detailed.

#### **Course Description**

##### **Porting RTOS to ARM Cortex Microcontrollers**

Building root file system, Kernel Compilation for ARM, Porting of OS to ARM. Overview of open source RTOS (Chibi-OS / FreeRTOS / MicroC-OS etc.), Porting open source - Embedded OS (Linux) & other RTOS (Chibi-OS / FreeRTOS / MicroC-OS etc.) on ARM Cortex Microcontrollers. RTOS based applications development on Cortex Microcontrollers.

## Learning Outcomes

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

- Understand the Kernel Compilation for ARM
- Understand Porting of Open Source Operating Systems on ARM Cortex Microcontrollers
- Build embedded systems with Operating Systems ported on ARM Cortex Microcontrollers

## Text Books:

1. The Definitive Guide to the ARM Cortex M3, Joseph Yiu, Newnes
2. Real-Time Embedded Multithreading, Edward L Lamie, CMP Books

## Reference Books:

1. Assembly language Programming ARM Cortex-M3, Vincent Mahout, Wiley
2. Embedded Linux: Hardware, Software, and Interfacing, Hollabaugh, Craig.
3. Embedded/Real-Time Systems: Concepts, Design and Programming: The Ultimate Reference, Dr. K.V.K.K. Prasad, Published by Wiley DreamTech, 2003
4. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; 2004, Elseiver.
5. Cortex M3 Reference manual.
6. STM32Ldiscovery datasheets, reference manuals & Application notes.
7. Chibi-OS / RT API reference manuals & documents.

## ED605: Internet of Things (IoT)

**Module Duration:** 10 days

### Objective

The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. 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. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

The participants of this module will learn about IoT Architecture and Layering Concepts, IoT platform, Wireless sensor networks and IoT Application development.

## Course Description

- Introduction to IoT, WoT and M2M
- Basics of Internet & Review of Internet protocols
- Data logging /IoT Layering concepts
- Wireless PAN (Bluetooth & Zigbee), GSM, Wifi
- Introduction to Wireless Sensor Networks
- Routing Protocols in WSN
- Database Management

## Learning Outcomes

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

- Understand the IoT Architecture and Layering Concepts.
- Understand the IoT platform hardware and software.
- Understand how to Implement IoT Applications.

## 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. Ovidiu Vermesan, 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, Huansheng Ning
5. Internet of Things (A Hands-on-Approach) , Vijay Madiseti , Arshdeep Bahga



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, 4<sup>th</sup> Edition
9. Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6<sup>th</sup> Edition
10. F. Adelstein and S.K.S. Gupta, “Fundamentals of Mobile and Pervasive Computing,” McGraw Hill, 2009.
11. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
12. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

**ED606: Embedded Protocols & Device Drivers**

**Module Duration:** 10 days

**Objective**

Today, at the low end of the communication protocols, we find I<sup>2</sup>C (for 'Inter-Integrated Circuit', protocol) and SPI (for 'Serial Peripheral Interface'). Both protocols are well-suited for communications between integrated circuits, for slow communication with on-board peripherals. This module will brief the basics of protocols and programming aspects.

The CAN Protocol section in this module gives an overview of the ISO 11898-1 and ISO 11898-2 standards. This provides a great introduction to the fundamentals of CAN as it is used in automotive design, industrial automation controls, and many, many more applications.

Device drivers take on a special role in the Linux kernel. They are distinct "blackboxes" that make a particular piece of hardware respond to a well-defined internal programming interface; they hide completely the details of how the device works. This module will brief the programming aspects of Linux device driver.

**Course Description**

**. Embedded Protocols**

Overview of Embedded TTY, I2C protocols, SPI, CAN Processor Bus, USB.

**Overview of Linux Device drivers**

Linux Drivers overview, Review of Kernel 'Embedded C' Programming, Device driver developing environment, The First driver.

The Character driver: Name vs Number, Registration & the Cleanups, Kernel Data Structures & File Operations, Linux Device Model & Bus Architectures, Analog & Digital I/Os

Low-level Accesses: Memory Access, Hardware Access.

USB Drivers: Device & Driver Layout, USB Core, Driver & Device Registration, USB & its Functionalities.

Interrupts: Interrupts & IRQs, Soft IRQs, and Exceptions.

Block Drivers: Driver & Device Registration, Kernel Data Structures & Device File Operations, Request Queue Ecosystem

File System Modules: Virtual File System, The Five Operation Sets, Interaction with the Block Device

Network Drivers: OSI Layers & the Network (TCP/IP) Stack Placement, Driver & Device Registration, Kernel Data Structures & Device File Operations

**Learning Outcomes**

After successful completion of the module students should be able to:

- Understand the Embedded protocols and its application level programming.
- Understand the Linux device driver development process.

**Reading List:**

1. Linux Device Drivers: Rubini, Alessandro, Corbet, Jonathan
2. Dr. K.V.K.K. Prasad, Embedded/Real-Time Systems: Concepts, Design and Programming: The Ultimate Reference, Published by Wiley DreamTech, 2003

3. W. Richard Stevens, Unix Network Programming, Addison – Wesley Professional Computing Series, 2003
4. Embedded Software Primer: Simon, David E.
5. UNIX Network Programming : Steven, Richard
6. Embedded Linux Primer: A Practical Real-World Approach: Christopher Hallinan
7. Application Notes : CAN, USB, I2C, SPI protocols
8. Linux Kernel Development: Love, Robert
9. Linux Kernel Programming: Algorithms and Structures of version 2.4: Beck, Michael At Al

**ED 607: Seminar & Case study**

**Module Duration:** 5 days

**Course Description:**

**Seminar**

Each Student is required to choose a topic of their interest for seminar from any Embedded domain which is not covered under the course curriculum. The duration of the seminar is about 20 minutes with the support of power point presentations.

A committee consisting of at least two faculty members (preferably specialized in Embedded Systems) shall assess the presentation of the seminar and award marks to the students.

Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the course coordinator. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

**Case Study**

Example :Embedded System for an Adaptive Cruise Control (ACC) System in a Car.

**ED 608: Project Work**

**Module Duration**

- 30 Days

**Course Description**

The students can select hardware, software or system level projects. The project can be implemented using **Microcontroller or IoT or Device Driver Development or RTOS** tools which students have studied and used during the course. A total product or project can be selected.

*This approval is valid for uploading to NIELIT, Calicut website as well.*

Signature of the Course Coordinator:

Signature of Training Officer:

Accounts:

Approved/Not Approved

Executive Director

Guidelines:

1. All Text in Italics are to be entered by the course coordinator
2. All text in Italics and underlined are only instructions, should not be displayed finally.
2. The Course Prospectus to be put to Director for approval through Training Officer and Accounts before uploading to website.