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नेशनल इंस्टीट्यूट ऑफ इलेक्ट्रॉनिक्स एंड इंफॉर्मेशन टेक्नोलॉजी, चेन्नई

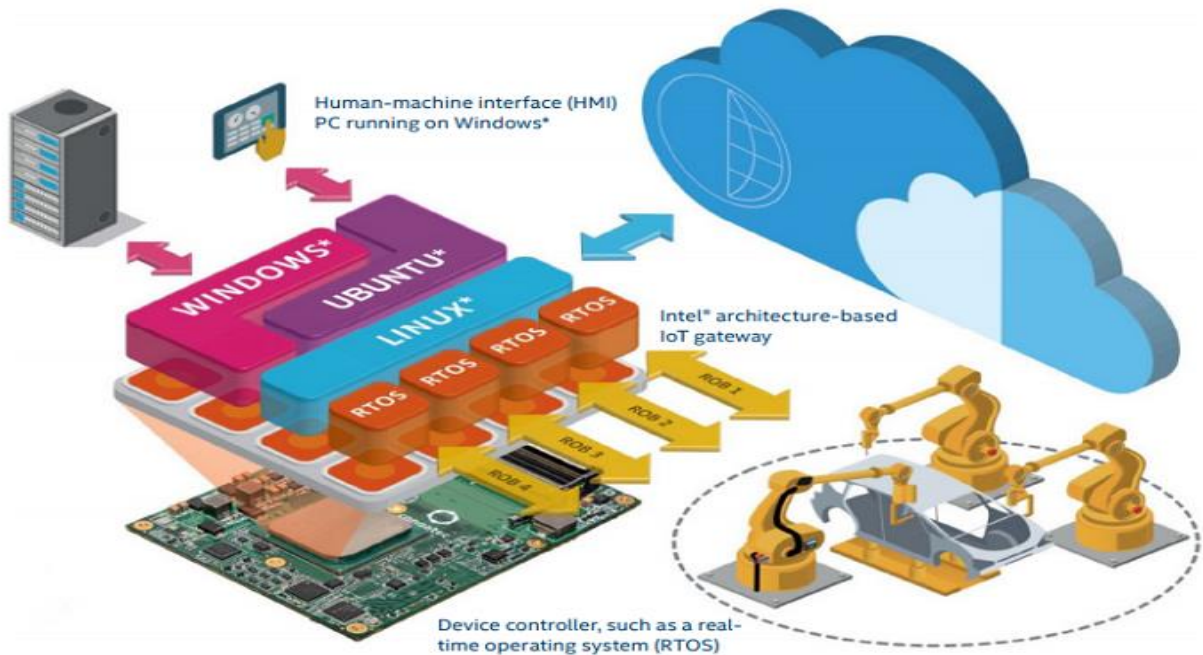**National Institute of Electronics and Information Technology, Chennai**

Autonomous Scientific Society of Ministry of Electronics & Information Technology (MeitY), Govt. of India

ISTE Complex, 25, Gandhi Mandapam Road, Chennai - 600025

# Course Prospectus

# Certified Embedded Software Engineer
# (NSQF Level-7)

# **Mode:** Online



Human-machine interface (HMI)
PC running on Windows*

WINDOWS*  UBUNTU*  LINUX*  RTOS

Intel* architecture-based
IoT gateway

RTOS RTOS RTOS RTOS

ROB 1
ROB 2
ROB 3
ROB 4

Device controller, such as a real-
time operating system (RTOS)

# Index

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# Course Prospectus

**Course Name:** Certified Embedded Software Engineer (Online Mode)

**Course Code:** ED 600

**NSQF Level:** 07

**Duration:** 840 Hours, 6 Months

**Last Date of Registration:** 08-03-2023

**Date of publishing Provisional Selection List:** 09-03-2023

**Payment of first instalment fee:** 09-03-2023 to 14-03-2023

**Course Start Date:** 15-03-2023

**Fee Details:**

❖ Registration Fee- Rs. 1,000 /-
❖ Course Fee- Rs. 51,000 /- (Instalment option mentioned in Course Fee Section)
❖ Total Fee - Rs. 52,000 /-

## 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. We live in the age, where information is just one click away and talking just one touch away. The near future of the age is the Internet of Things (IoT), the IoT is nothing but a computing concept in which everyday objects with embedded hardware/devices are connected to a network or are simply online.

The Embedded and IoT Industry is growing rapidly with the introduction of wide variety of Product for various applications catering to different sector demands. This increases the complexity of embedded system design; currently there is a shortage of qualified engineer with good Embedded and IoT 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, this 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.

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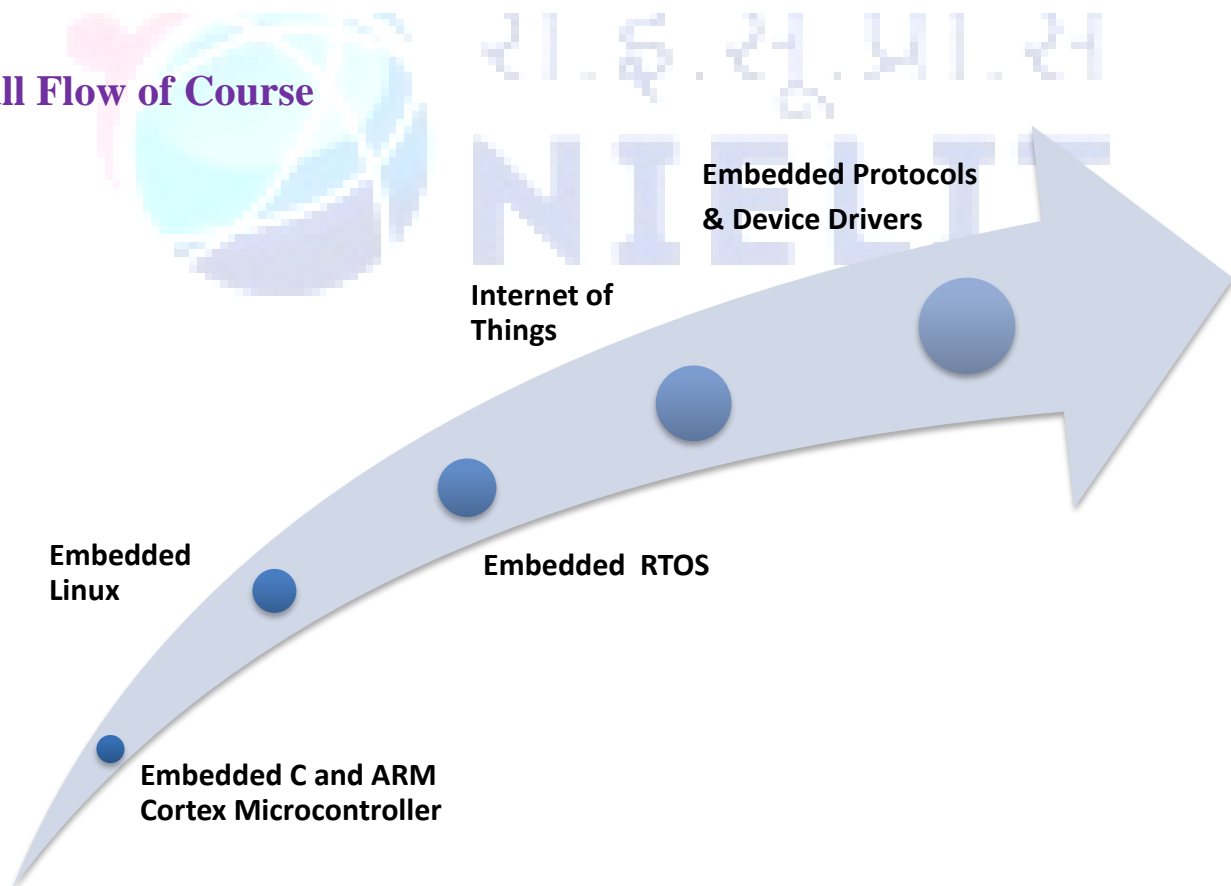Government of India

## Objective of the Course:

To develop the skillset required for Design and Development of the Embedded System Applications using suitable Hardware and Software tools. This course offers a range of topics (ARM Cortex-M programming and interface, Linux, RTOS, Device Drivers, IoT & Data Analytics) 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 will be able to:

- Develop Embedded Application using ARM Cortex Microcontroller with Embedded- C Programming.
- Build Real-time application using Embedded OS/RTOS and porting it on ARM Platform.
- Develop Device Drivers for Embedded Linux Application.
- Develop IoT applications using proper hardware and software Tools/platforms.
- Analyse, interpret and re-present IoT data and Build enhancement analytics capabilities.

## Full Flow of Course



Embedded Protocols
& Device Drivers

Internet of
Things

Embedded Linux

Embedded  RTOS

Embedded C and ARM
Cortex Microcontroller

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## Course Structure

This course contains totally seven modules. After completing the first six modules, the students have to do a six weeks project using any of the topics studied to earn the Certified Embedded Software Engineer.

| Module Code | Module Name | Duration (in Hours) |
|---|---|---|
| ED 601 | Embedded C and ARM Cortex Microcontroller | 140 |
| ED 602 | Embedded Linux | 70 |
| ED 603 | Embedded RTOS | 70 |
| ED 604 | Internet of Things | 210 |
| ED 605 | Embedded Protocols and Device Drivers | 105 |
| ED 606 | Seminar and case study | 35 |
| ED 607 | Project Work | 210 |
| | **Total Duration** | 840 |

## Course Fees

**Registration Fee – Rs. 1000/-**

**Tuition Fee (Including NSQF Registration & Examination Fee) – Rs. 51,000/-**

Total Course fee is Rs. 52,000/- Including GST which can be paid as given in the Table below.

| Registration Fee | Rs. 1000/- Adjustable with total fee | |
|---|---|---|
| **Instalment No.** | **Fee including GST in Rs.** | **Last Date** |
| 1 | 25,500.00 | 14-03-2023 |
| 2 | 25,500.00 | 15-06-2023 |
| Total | 52,000.00 | |

*GST is Applicable as per Govt. Norms GST (currently it is 18%).*

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## Registration Fee.

**(Non-Refundable if candidate is selected for admission but did not join and if a candidate has applied but not eligible.)**

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

- ✓ Candidates are eligible but not selected for admission.
- ✓ Course postponed and new date is not convenient for the student.
- ✓ Course cancelled.

## Eligibility

- ✓ B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control /Biomedical /Computer Science/Information Technology /M.Sc. (Electronics)/AMIE in Electronics/ Electronics & Communication.

## Number of Seats:  30 – Total

Note: Seats are allocated based on the merit of the Qualification.

## How to Apply?

Candidates can apply online in our website http://reg.nielitchennai.edu.in. Payment towards non-refundable registration fee can be paid through any of the following modes:

- ✓ Online transaction: Account Name: NIELIT CHENNAI, Account No: 31185720641, Bank name: State Bank of India (SBI), Branch: Kottur (Chennai), IFSC Code: SBIN0001669.
- ✓ Pay through UPI Mobile Apps

**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: 08ᵗʰ March, 2023

## Registration Procedure

All interested candidates are required to fill the Registration form online with registration fees before 08ᵗʰ March, 2023 with all the necessary information.

## Selection Criteria of candidates

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

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

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✓ The first list of Provisionally Selected Candidates will be published on NIELIT Chennai website ([www.nielit.gov.in/chennai](www.nielit.gov.in/chennai) ) **09ᵗʰ March, 2023 by 5:00 PM**. In case of vacancy, an additional selection list will be prepared and the selection will be intimated by email only.

✓ Provisionally selected candidate has to upload their document on registration portal for online verification.

   Following documents of candidates will be verified:
   - Original Copies of Proof of Age, Qualifying Degree (Consolidated Mark sheet & Degree Certificate/Course Completion Certificate), 10th and 12th mark sheet.
   - One passport size photograph.
   - Self-attested copy of Govt. issued photo ID card.
   - AADHAR Copy

✓ After document verification, selected candidates have to pay first instalment of **Rs. 25,500/-** or as applicable on or before **14ᵗʰ March, 2023** by payment mode mentioned above.

✓ Selected candidates are requested to upload the proof of remittance of fee on registration portal and also send the proof of remittance of fee as email to shoukath[at]nielit[dot]gov[dot]in / trng[dot]chennai[at]nielit[dot]gov[dot]in.

**Admission**: All provisionally selected candidates whose documents are verified and paid the fees (full or first instalment) and verified by accounts section of NIELIT Chennai will get a welcome message in his/her login ID provided during registration. The Credential and URL for online portal will be shared through WhatsApp or email.

# Discontinuing the course

✓ No fees (including the security deposit) under any circumstances, shall be refunded in the event of a student who have completed the process of admission or discontinuing the course in between. No certificate shall be issued for the classes attended. Only Grade Sheet will be issued.

✓ If candidates are not uploading consecutive 3 assignments within assigned time their candidature will be cancelled without any notice and all fees paid will be forfeited.

✓ If candidates are not appearing for any internal examinations/practical their candidature will be cancelled without any notice and all fees paid will be forfeited

# Course Timings: This program is a practical oriented one and hence there shall be more lab than theory classes. The classes and labs are online cloud based from 9.30 am to 5:30 pm and Monday to Friday.

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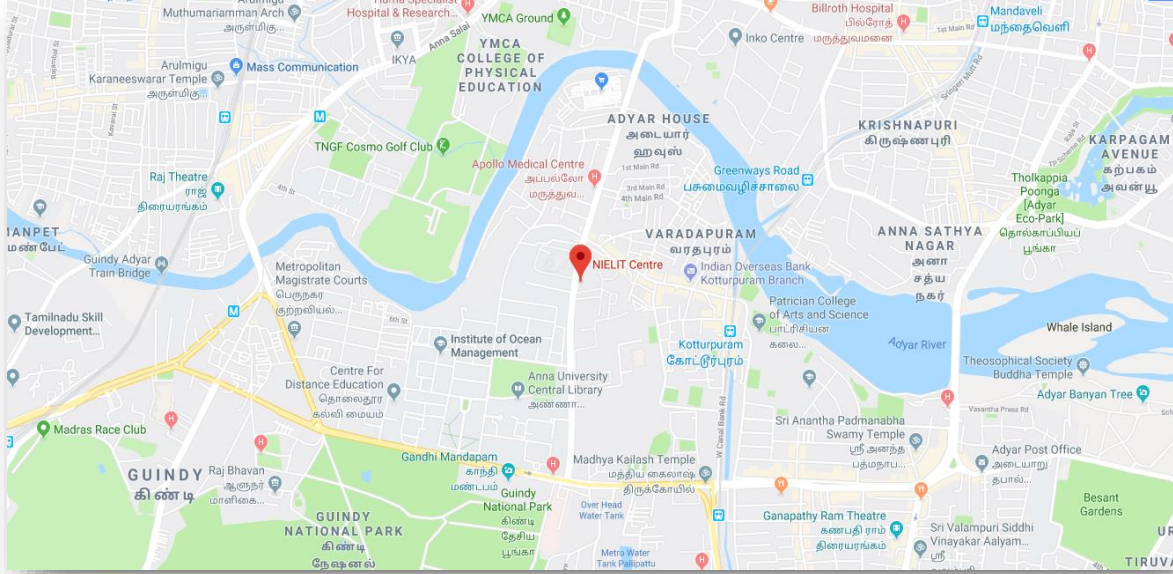


**Address**:

> **National institute of Electronics and Information Technology**
>
> **ISTE Complex, No. 25, Gandhi Mandapam Road, Chennai – 600025**
>
> **E-mail: shoukath[at]nielit[dot]gov[dot]in/ Phone: 044-24421445**
>
> **Contact Person: Mr. Shoukath Cherukat    Mobile: 94474 23306 (Call @ 9 AM to 6 PM)**

## 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.

## Placement:

Students who have completed the course successfully and qualified, will be given placement guidance and career counselling to crack the interviews.

## Important Dates

> ➢ **Last Date of Registration:** 08-03-2023
> ➢ **Display of Provisional Selection List:** 09-03-2023
> ➢ **Payment of first instalment fee:** 09-03-2023 to 14-03-2023
> ➢ **Course Start Date:** 15-03-2023
> ➢ **Payment of second instalment fee:** 15-06-2023

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# Examination & Certification

✓ Final Certificates will be issued after successful completion of all the modules including mini project. For getting certificate a candidate has to pass each module individually with minimum required marks of 50%.

## NSQF Examination Pattern:

| Theory (Each Question will carry 1 mark) Duration (in Min): 90 | | Practical Duration (in Min): 180 | | Internal Assessment (Marks) | Project/ Presentation/ Assignment (Marks) | Major Project/ Dissertation | | Total |
|---|---|---|---|---|---|---|---|---|
| Papers | Marks / Paper | Papers | Marks/ Paper | | | No. Of Projects | Marks | |
| 3 | 100 | 2 | 90 | 60 | 60 | 1 | 100 | 700 |

**Theory Papers:**

1. **Theory Paper 1 – Embedded Programming and ARM Architecture**

2. **Theory Paper 2 – Embedded Linux and RTOS**

3. **Theory Paper 3 – Embedded Driver and IoT with Analytics**

**Practical Papers:**

1. **Practical Paper 1- Embedded Programming for ARM, Linux & RTOS**

2. **Practical Paper 2 - Device Driver and IoT**

| Means of Assessment | | | | | | |
|---|---|---|---|---|---|---|
| | Theory | Practical | Internal Assessment | Project/ Presentation/ Assignment | Major Project/ Dissertation | |
| **No of Papers** | 03 | 02 | 01 | 01 | 01 | |
| **Marks Each Paper** | 100 | 90 | 60 | 60 | Presentation | Projects |
| | | | | | 40 | 60 |
| **Total Marks** | 300 | 180 | 60 | 60 | 100 | |
| | | | | | **700** | |

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## Grading Scheme

✓ Following Grading Scheme (on the basis of total marks) will be followed:

| Grade | S | A | B | C | D | Fail |
|---|---|---|---|---|---|---|
| **Marks Range (in %)** | 85 to 100 | 75 to 84 | 65 to 74 | 55 to 64 | 50 to 54 | Below 50 |

✓ Final Grading as per above grading scheme will be given on the basis of total marks obtained in all modules. For last module (ED607) grade will be given on the basis of project demonstration.

## Placement Assistance & Student Testimonials

NIELIT Chennai is providing placement assistance to all the candidates who have undergone the training program by linking or inviting companies for interview.

In the last batch, 75% of candidates got successfully placed in various companies. The student's testimonials can be referred for feedback.

**Placement Drive Conducted with following Companies:**

1. Wipro
2. Cybermotion Technologies
3. BlueBinaries
4. Foneally Technologies
5. E-con Systems
6. Zilogic Systems

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## Student's testimonials:

### SONA R

**CERTIFIED EMBEDDED SOFTWARE ENGINEER**

**COURSE COMPLETED: NOVEMBER 2021**

**Job Placement**

### Graduate Engineer Trainee
### Continental Automotive Components (India) Pvt. Ltd.

#### Message

I am delightful to tell that I am hired by Continental Automotive India as Post Graduate Engineer Trainee which started my new phase of life. NIELIT Chennai offers good placement support and counseling to attend the same. I am really thankful to staffs of NIELIT Chennai for helping me to achieve this success. All the staffs are so helpful and patient in handling their modules and clearing our queries. Certified Embedded Software Engineer is really a good course for graduates whom wanted a good career in the field of Embedded Systems/IoT/Data Analytics. Since the course was completely hands-on, it was easier for us to work on the project. What I like the most in the course is the project work where we got opportunities to develop the embedded product using the concepts learned under supervised guidance. My technical interview was very much about the project work done on this course. I really felt more confident in answering the same. Thanks to NIELIT Chennai team once again.

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## ELAVAZHAGAN A

**CERTIFIED EMBEDDED SOFTWARE ENGINEER**

**COURSE COMPLETED: NOVEMBER 2021**

**Job Placement**

**Embedded Engineer**
**Cyber Motion Technologies Pvt. Ltd.**

### Message

First of all, I would really like to thank NIELIT Chennai, faculties and all others who supported me in successfully completing the course and getting placed as Embedded Engineer in Cyber Motion Technologies Private Limited. Certified Embedded Software Engineer at NIELIT Chennai is really a great course for skilling up our knowledge in Embedded, IoT and Linux domains. The most important thing about the training is that topics in the training are more relevant to industrial skills needs. The way of teaching was good where equal importance was given to theory as well as practical. Also, recording session was very useful which helped me a lot in revising the concepts and preparing for placements.

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## DIVYA K

**CERTIFIED EMBEDDED SOFTWARE ENGINEER**

**COURSE COMPLETED: NOVEMBER 2021**

**Job Placement**

**Graduate Embedded Trainee**
**PixelExpert Texhnology and Services Pvt. Ltd.**

### Message

I am very happy that I chose NIELIT Chennai for doing Certified Embedded Software Engineer course in online mode. I had a great learning experience with the curriculum covered that really helped me in getting industrial oriented career. I got my job offer from PixelExpert Technology and Services Private Limited with the role of Graduate Embedded Trainee. I am thankful to all the faculties; they were so dedicated, knowledgeable and interactive to make our concepts clear. Thanks to NIELIT Chennai for conducting such a wonderful course in Online blended mode.

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# Lab Infrastructure Details:

## Hardware Facilities:

- ✓ Development Boards - STM32, ARM Cortex-M4, Arduino Uno, NodeMCU, MSP430, Beagle Bone Black, Raspberry Pi
- ✓ Shields – Ethernet, CAN, Wi-Fi, GSM/GPRS, GPS & Bluetooth Shield
- ✓ Sensors–PIR, Ultrasonic, LDR, Soil Moisture, Flame, Accelerometer & Gyro meter
- ✓ Camera Module, Sense Hat, Capacitive Touch Screen
- ✓ Wireless Sensor Network Radio and Related Modules with Integrated Antenna
- ✓ Aardvark I2C/SPI Host adapter, I2C/SPI development board, CAN Development board, Komodu CAN Duo Interface

## Software Facilities:

- ✓ FreeRTOS
- ✓ OpenSTM, CubeMX
- ✓ Segger Timing Analysis Tool
- ✓ Code Composer Studio(CCS)
- ✓ Proteus VSM
- ✓ Arduino IDE
- ✓ Keil Software

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## Director, NIELIT Chennai



## Dr. Pratap Kumar S

Director

**Dr. Pratap Kumar S**, is B.Tech (Electrical Engineering), M.Tech (Digital Electronics), MBA (Marketing) and PhD (Strategic Management). He has More than 29 years' experience in planning and execution of industrial consultancy projects, and capacity building projects funded by both industry and central & state ministries. Executed 7 major industrial consultancy projects and associated with the development of more than 50 product technologies, empowered more than 10,000 candidates through various capacity building programs and facilitated more than 40,000 job seekers through various job fairs and outreach programs. He has expertise in Strategy, Product Development, Automotive Electronics, Embedded Systems, and Power Electronics.

## Faculty Profile:
## Programme Co-Ordinator:



## Shoukath Cherukat

Scientist 'E'

**Shoukath Cherukat**, Scientist 'E', NIELIT Chennai has more than 21 years of Experience in Training and Consultancy Projects. He has successfully completed Consultancy Activities such as Collimator Test JIG for OEN, Technology Development of Wireless Token Display System for Keltron, Integrated Microcontroller Development Systems for 8051 & 80C196 Microcontrollers (IMDS-51, IMDS-196 & IMDS-196D) supplied to various industries. He is having wide hands-on experience in Embedded Controllers (8, 16 & 32-bit), Digital Signal Processors, FPGAs, IoT, Embedded OS and Real Time Operating Systems (RTOS).

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## Ishant Kumar Bajpai

### Scientist 'C'

**Ishant Kumar Bajpai**, Scientist 'C', NIELIT Chennai Has more than 8 years' experience in Coordination and Implementation of funded projects in the area of IoT and VLSI with the application in Biomedical & Automotive. He has successfully executed 1 funded capacity building project in Karnataka & Kerala State and involved in the implementation of 4 skill development /capacity building projects funded by MeitY in the states of Tamil Nadu, Andhra Pradesh and Telangana. Before joining the NIELIT, he was working as a Scientific Officer in the IT Research Academy Division of Digital India Corporation (erst. Media Lab Asia), where he was involved in the Project Planning, Design and Implementation of projects in the domain of Mobile Computing, Networking & Applications.

## S. Raghavendra

### Resource Person-RPA

**Raghavendran. S**, Resource Person-RPA having 3 years of experience in Robotics and automation and handing training session and Labs on UiPath studio with the background of electronics and instrumentation.

## ESAKKI DEVI R

### Resource Person- EMBEDDED & VLSI

**ESAKKI DEVI. R,** Resource Person-EMBEDDED & VLSI having 3 years of experience in Embedded C on ARM based Microcontroller and handing training sessions and Labs on Embedded Linux, IoT and Python with the background of electronics and communication.

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## Annexure

## Detailed Syllabus of the Course

**Module-1: Embedded C and ARM Cortex Microcontroller**

**Objectives:**

To set the required background in embedded system concepts, Embedded 'C' language such as Memory management, Pointers, Data structures and architecture of the ARM Cortex processor for highly deterministic real-time applications.

**Outcomes:**

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

- Develop embedded application using Embedded C Programming
- Choose right ARM Cortex controller with Embedded C Programming for various Applications

**Duration:** 140 Hours

**Module topics:**

**'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
- ✓ Pre-processor directives
- ✓ File operations
- ✓ Bitwise operations
- ✓ Typecasting

**Embedded Concepts**

- ✓ Introduction to embedded systems

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- ✓ 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

## Introduction to ARM Cortex

- ✓ Architecture Introduction to 32-bit Processors
- ✓ The ARM Architecture
- ✓ Overview of ARM
- ✓ Overview of Cortex Architecture
- ✓ Cortex M4 Register Set and Modes
- ✓ Cortex M4 Processor Core
- ✓ Data Path and Instruction Decoding
- ✓ ARM Cortex M4 Development Environment
- ✓ Assembler and Compiler
- ✓ Linkers and Debuggers
- ✓ ARM-Thumb & Thumb2 instructions
- ✓ Mixing ARM & Thumb Instructions
- ✓ Memory hierarchy
- ✓ Memory Mapping
- ✓ Cache

## Cortex M4 Microcontrollers & Peripherals

- ✓ Cortex M4 based controller architecture
- ✓ Memory mapping, Cortex M4 Peripherals – RCC
- ✓ GPIO
- ✓ Timer, System timer
- ✓ UARTs, LCD,ADC & PWM
- ✓ Cortex M4 interrupt handling – NVIC
- ✓ Application development with Cortex M4 controllers using standard peripheral libraries

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**Module-2: Embedded Linux**

**Objective of the Course:**

To Skilling the students in Configure, Deploying and Debugging the Linux OS onto a Target Board to build a complete Embedded Product using Linux Kernel.

**Outcome of the Course:**

After successful completion of this module, Students will be able to:

1. Configure Linux environment for ARM based Target Boards.
2. Configure Tool-Chain for ARM Platforms.
3. Demonstrate Linux Booting Process and to configure Linux Kernels on ARM based Embedded Boards.
4. Develop ARM based Embedded Applications with Linux OS.

**Duration:** 70 Hours

**Module topics:**

**1. Introduction:**

✓ Basic Operating System Concepts
✓ History& Benefits of Linux
✓ Fundamentals of Embedded Linux OS
✓ Comparison of Embedded OS
✓ Embedded OS Tools and IDE
✓ Embedded Linux Applications and Products.

**2. Architecture of Embedded Linux:**

✓ What is Kernel?
✓ Task of kernels
✓ Types of kernels
✓ Kernel Architecture Overview
   ➤ User Space
   ➤ Kernel Space
✓ Kernel Functional Overview
   ➤ File System
   ➤ Process Management
   ➤ Address Spaces and Privilege Levels
   ➤ Memory Management
   ➤ System Calls

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> ➢ Inter Process Communication (IPC) – Pipes, FIFO & Shared Memory
> ➢ Device Drivers
> ➢ Network

## 3. Commands in Linux:

- ✓ Log In Linux system and Log in Remote Linux Systems- Getting Help
- ✓ Accessing & Working with the Command Line and Shell
- ✓ System Access, Entering Commands
- ✓ Boot Methods-Creating User Accounts &Managing Users
- ✓ Creating Groups & Managing Groups
- ✓ Directory Management
- ✓ File Permissions and Ownership
- ✓ vi Text Editor

## 4. Configuring the Linux Environment:

- ✓ Linux environment
- ✓ Types of Hosts
- ✓ Types of Host/Target Development Setups
- ✓ Types of Host/Target Debug Setups
- ✓ Embedded Environment Tools
- ✓ GNU Tool-chain Cross Compilers

## 5. Tool-chain: Configuration and Cross-Compilation:

- ✓ What is a tool-chain?
- ✓ Native vs. cross-compilation
- ✓ Toolchain Components
- ✓ Toolchain choices
- ✓ Using build root to build the toolchain
- ✓ Configuration options
- ✓ Adding path variables to startup scripts (.bashrc)
- ✓ The CROSS_COMPILE variable
- ✓ Validating the cross-compiler

## 6. Linux Bootloader & U-Boot:

- ✓ Boot-loader Phases
- ✓ U-boot – Embedded boot loader
- ✓ What does u-boot do?
- ✓ Navigating the u-boot sources
- ✓ Configuring and Cross-compiling u-boot
- ✓ Installing u-boot on the target
- ✓ Understanding u-boot commands
- ✓ Changing environment variables to setup kernel booting
- ✓ Transferring files to the target using tftp

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## 7. Embedded Linux Kernel:

- ✓ Kernel Features
- ✓ Kernel Subsystems
  - ▪ Memory Manager
  - ▪ Scheduler
  - ▪ Embedded Storage
  - ▪ I/O Subsystem
  - ▪ Network Subsystem
- ✓ Navigating the kernel sources
- ✓ Kernel Configuration
- ✓ Kernel Compilation
- ✓ Booting the kernel using u-boot
- ✓ Module compilation and Installation to RootFS
- ✓ Procedure for adding a new driver to the kernel
- ✓ Applying patches

## 8. Building Root File System:

- ✓ Introduction to File system
- ✓ Linux directory structure
  - ▪ Organization and Important directories
  - ▪ /dev file system
- ✓ What next after kernel booting
  - ▪ init and startup scripts
- ✓ Downloading & Compiling RootFS
- ✓ RootFS in Flash/SD Card Storage

## 9. Porting OS in ARM Board:

- ✓ Kernel Compilation
- ✓ Booting the kernel using u-boot
- ✓ Porting Linux in ARM Board

## 10. Embedded Linux Application Programming

- ✓ Application Developments using Input Devices
- ✓ Application Developments using Output Devices
- ✓ Application Developments using Peripherals

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## Module-3: Embedded RTOS

### Objectives:

To demystifying RTOS concept practically using Free RTOS and STM32 MCUs by
1. Understanding of RTOS concepts
2. Use cases for tasks, semaphores, queues, event flags and timers
3. Better insights of RTOS internal design and implementation
4. Design concepts needed to build an embedded system using RTOS
5. Applying taught concepts using one of the famous commercial open source RTOS.

### Outcome of the Course:

After successful completion of this module, Students will be able to:

- List Step by step method to run RTOS on STM32 MCUs
- Demonstrate RTOS Scheduler with memory Management.
- Choose Right ways of Synchronizing between a task and an interrupt using semaphores.
- apply mutual exclusion between Tasks using Mutex services and semaphores
- Understand complete ARM Cortex M and FreeRTOS Priority model and its configuration related information's.

### Duration: 70 Hours

### Module topics:

- ✓ RTOS Introduction
  - ▪ Setting Up the Environment-Downloading and Installing RTOS
- ✓ Creating RTOS based project for STM32 MCUs
- ✓ RTOS Task Creation
- ✓ Exercise: RTOS Hello World App and Testing on hardware
- ✓ RTOS app debugging using SEGGER System View Tools
- ✓ IDLE Task and Timer Svc Task of RTOS
- ✓ RTOS Scheduler
- ✓ Context switching
- ✓ RTOS Task Notification
- ✓ Overview of RTOS Memory manage, STACK and Synchronization services
- ✓ RTOS Kernel Coding Style
- ✓ RTOS Task Deletion
- ✓ ARM Cortex M Interrupt Priority and RTOS Task Priority
- ✓ Interrupt safe APIs and Task yielding
- ✓ RTOS Task States
- ✓ RTOS : Delay APIs and its Significance
- ✓ RTOS Hook Functions
- ✓ RTOS Scheduling Policies
- ✓ RTOS Queue Management
- ✓ Semaphore for Synchronization, mutual exclusion and Interrupt Management
- ✓ Mutual exclusion

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**Module-4: Internet of Things (IoT)**

**Objectives:**

To equip the students with the information required in deploying and Delivering an IoT Technologies suitable for Smart Industry.

**Outcomes:**

After successful completion of the module, the students will be able to:
- Implement an IoT application using Development Boards
- Develop problem solving capability using python scripts
- Choose right Data Analytic/ Machine learning tool for various IoT application
- Implement Various ML algorithms using Python.

**Duration: 210 Hours**

**Module topics:**

- ✓ IoT Concepts
  - Introduction to IoT, WoT and M2M
  - Basics of Internet & Review of TCP/IP
  - IoT Layering concepts
  - Introduction to Wireless Sensor Networks
  - Routing Protocols in WSN
  - Wireless PAN
  - Different PAN standards - Bluetooth & Zigbee, GSM, Wifi
  - IoT Development Boards
  - Data logging
- ✓ IoT Data Analytics
  - Python Programming
    - o An Introduction to Python
    - o Beginning Python Basics
    - o Python Program Flow
    - o Functions& Modules
    - o Exceptions Handling
    - o File Handling
    - o Classes in Python
  - Data Science and Analytics
    - o An Introduction to Data Science and Analytics
    - o Data Analysis Using NumPy,
    - o Data Analysis Using Pandas
    - o Data Visualization – Pandas, Matplotlib, Seaborne, Plotly and Cufflinks
  - Statistical Learning
    - o Descriptive & Inferential Statistics,

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- Probability Concept: Marginal, Joint & Conditional Probability, Bayes Theorem
- Probability Distributions,
- Entropy &Information Gain,
- Regression & Correlation,
- Confusion Matrix, Bias & Variance
- Machine Learning
  - Introduction to Machine Learning
  - Linear Regression
  - Logistic Regression
  - K-Means Clustering
  - Decision Tree
  - Random Forest
  - K-Nearest Neighbors
  - Support Vector Machine
  - Naive Bayes

## Module-5: Embedded Protocols & Device Drivers

**Objectives:**

To equip the students with the information required in embedded protocols and to implement the device drivers in the Linux kernel.

**Outcomes:**

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

- Demonstrate Different embedded protocols like SPI, I2C, USB and CAN.
- Choose right protocol for the different embedded applications.
- Build driver program for various devices in Linux kernel.

**Duration:** 105 Hours

**Module topics:**

**Embedded Concepts:**

- ✓ 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,

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- ✓ USB & its Functionalities.
- ✓ Interrupts: Interrupts & IRQs, Soft IRQs, and Exceptions.
- ✓ Block Drivers
- ✓ File System Modules: Virtual File System, The Five Operation Sets, Interaction with the Block Device
- ✓ Network Drivers

## Module-6: Seminar and Case Study

**Duration:** 35 Hours

## Module-7: Project Work

**Duration:** 210 Hours