PG Diploma in Embedded System Design
(Certified Embedded System Engineer)

Preamble:

In today's world, embedded systems are all over, homes, shops, offices, cars, factories, hospitals and consumer electronics. The inherent value of embedded systems lies in its pervasiveness. They are literally embedded in all the 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. 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. An overview of Internet of Things (IoT) and Embedded Product Design is included in the course.

As part of project work, a proof-of-concept prototype design of an embedded system is also included in the course to make the participants industry ready.

Objective:

The objective of the course is to provide understanding of the techniques essential to the design and implementation of embedded systems using suitable hardware and software tools. This course offers a range of topics of immediate relevance to industry and makes the participants exactly suitable for Embedded Industry.

Expected Job Roles:

- Embedded Design Engineer
- Embedded Software Engineer
- Embedded Hardware Engineer
- Embedded System Engineer

Duration:

720 Hours - (Theory: 203 hrs + Practical: 307 hrs+ Project: 210hrs)

This course shall be offered as full time intensive course.

Course Outline:

Sl. No	Module Title	Duration (Hours)			Credit	
		Theory	Lab	Total	Theory (hr/15)	Lab (hr/30)
1	**Embedded C and ARM Cortex Microcontroller**	50	70	120	3	2
2	**Embedded Linux and Porting on ARM**	48	72	120	3	2

	Board					
3	**Embedded RTOS**	50	70	120	3	2
4	**Internet of Things (IoT)**	35	50	90	2	2
5	**Embedded Product Design**	20	40	60	1	1
6	**Project Work**	0	210	210	0	7
	Total Duration/ Credit	**203**	**517**	**720**	**28**	

Prerequisites:

Knowledge in concepts of Basic Electronics, C Programming and Microprocessors/ Microcontrollers

Eligibility:

B.Tech/BE in ECE/EEE/AEI/CSE/IT/Biomedical and allied branches / M.Sc (Electronics). Students undergoing BTech/ MSc are also eligible, however they will be issued course certificate only on production of their degree certificate.

Detailed Syllabus and Learning Outcome:

S. No	Module Title	Topics	Duration (Hours)		Learning Outcome
			Theory	Lab	
1	**Embedded C and ARM Cortex Microcontroller**	• Embedded Concepts • 'C' and Embedded C • Introduction to ARM Cortex Architecture • Cortex Mx Microcontrollers & Peripherals • Cortex Mx Microcontrollers & Peripherals Programming • Mini Project	50	70	After successful completion of the module, the students shall be able to: • Develop Embedded application using Embedded C Programming • Use ARM Cortex M with Embedded C Programming for Application Development
2	**Embedded Linux and Porting on ARM Board**	• Introduction to OS • 'System Architecture of a Basic OS - Linux Internals • Inter Process Communication • Linux Building and	48	72	After successful completion of the module, the students shall be able to: • Implement embedded systems with Embedded

		Booting • Porting OS on ARM Board • Practical Sessions with Porting			operating systems • Develop applications with Embedded Linux • Port Linux OS on ARM Boards
3.	**Embedded RTOS**	• Introduction to Real Time System and RTOS • VxWoks RTOS • Multitasking and Scheduling Concepts • Task Creation and Management • Intertask Communication Mechanisms • Semaphores, Message queues, Pipes • Interrupts and Tornado Tools • Introduction to Free RTOS • Task Management in Free RTOS • Synchronization in FreeRTOS • Peripheral Interfacing and porting freeRTOS on ARM	50	70	After successful completion of the module, the students shall be able to: • Develop an Embedded Real Time software that is required to run embedded systems • Apply the FreeRTOS RTOS for real-time application development • Develop real-time applications using VxWorks RTOS • Build real-time embedded systems using FreeRTOS and VxWorks RTOSes
4.	**Internet of Things (IoT)**	• Introduction to IoT • IoT Platforms • Sensors & Interfaces • Wireless PAN (Bluetooth & Zigbee), GSM, Wifi • Wireless Sensor Networks • Linux Scripting for IoT • Python Programming	35	50	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 various platforms

5.	**Embedded Product Design**	• Product Development Process • Programming Aids • Embedded Protocols and Interfacing – I2C & CAN • Microcontroller Based Design • Practical Sessions with Design	20	40	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, Testing and Integration.
6.	**Project Work**	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.	0	210	After successful completion of the module, the participants shall be able to design any embedded system (H/w or S/w or both) based on different families and architectures of Embedded Systems.
Total Hours = 720			203	517	

Examination & Certification:

NIELIT's NSQF Examination pattern will be followed for Examination & Certification.

Sl No	Examination Pattern	Modules Covered	Duration in Minutes	Maximum Marks
1	Theory Paper – 1	Module 1	90	100
2	Theory Paper – 2	Module 2 and 3	90	100
3	Theory Paper – 3	Module 4 and 5	90	100
4	Practical -1	Module 1	180	90
5	Practical -2	Module 2 and 3	180	90
6	Internal Assessment	Module 1, 2, 3, 4 and 5	150	60
7	Project/Presentation /Assignment	Module 6	-	60
8	Major Project/Dissertation	Module 6	-	100

	Total			**700**

Note:

1. Pass percentage would be 50% marks in each component, with aggregate pass percentage of 50% and above.
2. Grading will be as under:

Grade	**S**	**A**	**B**	**C**	**D**
Marks Range (in %)	>=85%	>=75%-<85%	>=65%-<75%	>=55%-<65%	>=50%-<55%

3. Theory examination would be conducted online and the paper comprise of MCQ and each question will carry 1 mark.
4. Practical examination/Internal Assessment/ Project/Presentation/Assignment would be evaluated internally.
5. Major Project/Dissertation would be evaluated preferably by External / Subject Expert including NIELIT Officials.
6. Candidate may apply for re-examination within the validity of registration.
7. The examinations would be conducted in English Language only.

Recommended hardware/software tools:

1. 32-bit ARM Microcontroller Development Systems – ARM Cortex-M3/M4 STM32
2. Beagle Bone Black Wireless, Friendly ARM, Rasberry PI , Intel Galileo and Arduino Boards
3. KEIL Microvision, VxWorks, ChibiOS/RT and freeRTOS Tools
4. GSM/GPRS/GPS/Zigbee/Bluetooth/WiFi Modems.
5. Wireless Simulators expertise in Glomosim, NS2, NS3, etc.
6. PC based EDA Tools
7. Digital Storage & Mixed Signal Oscilloscopes
8. EMI Test Setup, SMD Rework stations

Faculty & Support / Lab Instructor:

1. Two Faculties with BTech/BE in ECE/EEE/ CSE or equivalent with good knowledge and Experience in Embedded Systems and Digital Communications.
2. One Support / Lab Instructor with at least Diploma in ECE/EEE/ CSE or equivalent with good knowledge and Experience in Embedded Systems and Digital Communications.

References:

1. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
2. Let us C by YashwantKanetkar.

3. The Definitive Guide to the ARM Cortex M3, Joseph Yiu, Newnes.
4. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill.
5. Embedded Systems an Integrated Approach: Lyla B Das, Pearson
6. C Programming language, Kernighan, Brian W, Ritchie, Dennis M
7. Art of C Programming, JONES, ROBIN,STEWART, IAN
8. C Programming for Embedded systems, Zurell, Kirk
9. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; 2004, Elseiver.
10. Cortex M3 Reference manual.
11. STM32 datasheets, reference manuals & Application notes.
12. ARM Technical Reference manual.
13. GNU/LINUX Application Programming, Jones, M Tims
14. Embedded Linux: Hardware, Software, and Interfacing, Hollabaugh, Craig,
15. Building Embedded Linux Systems: Yaghmour, Karim
16. Embedded Software Primer: Simon, David E.
17. Linux Kernel Internals: Beck, Michael At Al
18. UNIX Network Programming : Steven, Richard
19. Linux: The Complete Reference: Petersen, Richard
20. Linux Device Drivers: Rubini, Alessandro, Corbet, Jonathan
21. Linux Kernel Programming: Algorithms and Structures of version 2.4: Beck, Michael.
22. Linux Kernel Development: Love, Robert
23. Operating System Concepts, Peter B. Galvin, Abraham Silberschatz, Gerg Gagne, Wiley Publishers
24. 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
25. Real-time Systems – Jane Liu, PH 2000
26. Real-Time Systems Design and Analysis : An Engineer's Handbook: Laplante, Phillip A
27. Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques: Ward, Paul T & Mellor, Stephen J
28. Embedded Software Primer: Simon, David E.
29. VxWorks Programmers Guide
30. freeRTOS Users Guide
31. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. OvidiuVermesan, Dr. Peter Friess, River Publishers.
32. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
33. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, HuanshengNing
34. Internet of Things (A Hands-on-Approach), Vijay Madisetti , ArshdeepBahga

35. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
36. Product Design & Development - Karl T Ulrich & Steven D. Eppinger; Mc GrawHill
37. Relevant Data sheets and application notes

Course Name	PG Diploma in Embedded System Design (Certified Embedded System Engineer)	**Vertical**	Embedded Systems
Course Code	ED500	**Rev No**	R4
Prepared By	SHOUKATH CHERUKAT	**Aligned NSQF Level**	6
NIELIT Centre	Calicut	**Last Revised on**	06.05.2019