NATIONAL INSTITUTE OF ELECTRONICS & INFORMATION TECHNOLOGY(NIELIT) AURANGABAD

CEDTI Complex, Dr. B.A.M. University Campus Aurangabad
(Ch.Sambhaji Nagar) Maharashtra-431004
Website:-www.nielit.gov.in/aurangabad
Contact No:-0240-2982021

SIX MONTHS POST-GRADUATE DIPLOMA IN VLSI & EMBEDDED SYSTEMS

Course Prospectus & Detailed Curriculum

COURSE PROSPECTUS

Name of the Department: *Electronics*

Name of the Course: *6 Months PG Diploma in VLSI & Embedded systems*

Course Code: VES 100

Starting Date: *19 Aug 2024*

Duration: *24 Weeks (720 Hours)*

Course Coordinator : Shri. *Saurabh Kesari, 91-7386929670,* saurabhk@nielit.gov.in
Co-Coordinator : Shri. *Shashank Kumar Singh***,** 91-9999026637, shashank@nielit.gov.in

Course Preamble:

The Postgraduate Diploma in VLSI (Very Large Scale Integration) & Embedded Systems is a comprehensive program designed to provide students with in-depth knowledge and practical skills in the fields of VLSI design and embedded systems development. This 6-month diploma course is meticulously crafted to meet the industry demand for skilled professionals proficient in the design, implementation, and testing of complex integrated circuits and embedded systems.

The Postgraduate Diploma in VLSI (Very Large Scale Integration) & Embedded Systems is a rigorous and comprehensive program designed to equip students with the knowledge, skills, and practical experience necessary for a successful career in the dynamic fields of VLSI design and embedded systems development. This six-month diploma course offers a structured curriculum that combines theoretical learning with hands-on laboratory exercises, industry projects, and internship opportunities to ensure holistic skill development and industry readiness.

Objective of the Course:

The primary objective of this PG-diploma course is to prepare students for rewarding careers in the semiconductor industry, consumer electronics, automotive electronics, telecommunications, and IoT applications by providing them with a deep understanding of VLSI design principles, embedded systems development methodologies, and emerging technologies in these domains. Through a blend of theoretical learning, practical exercises, and industry exposure, the course aims to foster critical thinking, problem-solving abilities, and professionalism among students, empowering them to contribute effectively to the advancement of technology and innovation in the global market.

Outcome of the Course: The successful participants will have:-

- **Foundational Knowledge:** Students will demonstrate a solid understanding of the fundamental principles and concepts of VLSI design and embedded systems, including semiconductor devices, digital logic, microcontroller architecture, and embedded systems programming.

- **Digital Design Proficiency:** Students will be proficient in designing and implementing digital circuits using Verilog HDL, including combinational and sequential logic circuits, behavioural modelling, timing analysis, and functional verification.
- **Advanced VLSI Design Skills:** Students will acquire advanced skills in VLSI design, including CMOS fabrication processes, static timing analysis, power optimization techniques, floor-planning, routing, design for testability (DFT), and low-power design techniques.
- **Embedded Systems Development:** Students will be competent in embedded systems development, including microcontroller programming, real-time operating systems (RTOS), device driver development, kernel programming, and interfacing peripherals and sensors.
- **Advanced Topics Mastery:** Students will gain proficiency in advanced topics and emerging trends in VLSI and embedded systems, such as system-on-chip (SoC) design, FPGA prototyping, high-level synthesis (HLS), Embedded Linux, hardware security, cryptography, and digital signal processing (DSP).
- **Problem-Solving and Critical Thinking:** Students will develop problem-solving and critical thinking skills through hands-on projects, industry internships, and exposure to real-world challenges in VLSI and embedded systems design.
- **Project Management:** Students will demonstrate the ability to plan, execute, and manage projects in VLSI and embedded systems, including project proposal development, project planning, implementation, documentation, and presentation.
- **Professionalism and Communication:** Students will enhance their professionalism and communication skills through interactions with industry experts, participation in workshops, seminars, and presentations, and through industry internship experiences.
- **Industry Readiness:** Upon completion of the course, students will be well-prepared to enter the industry as skilled professionals in the fields of VLSI design and embedded systems development, equipped with the knowledge, skills, and practical experience required for successful careers in the semiconductor industry, consumer electronics, automotive electronics, telecommunications, and IoT applications.
- **Lifelong Learning:** Students will cultivate a mindset of lifelong learning and continuous skill development, enabling them to adapt to evolving technologies and pursue further education or professional certifications in VLSI and embedded systems or related fields.

Expected Job Roles:-

- **VLSI Design Engineer**
- **Embedded Systems Engineer**
- **FPGA Design Engineer**
- **ASIC Design Engineer**
- **Verification Engineer**
- **Physical Design Engineer**
- **System-on-Chip (SoC) Engineer**
- **Embedded Software Engineer**
- **Hardware Engineer**
- **Application Engineer**
- **Product Engineer**
- **Research and Development (R&D) Engineer**
- **Test Engineer**
- **Project Manager**

Course Structure

Module Code	Module Name	Duration (Hrs)			Credits
		Total	Theory	Practical	
VES 100	**Introduction to VLSI and Embedded Systems**	60	20	40	2 (1+1)
VES 101	**Digital Design using Verilog**	120	40	80	5 (2+3)
VES 102	**Advanced VLSI Design Concepts**	120	40	80	5 (2+3)
VES 103	**Embedded Systems Design**	120	40	80	5 (2+3)
VES 104	**Advanced Topics in VLSI and Embedded Systems**	120	40	80	5 (2+3)
VES 105	**Project Work and Industry Exposure**	180	-	180	6 (0+6)
	Total	**720**	**180**	**540**	**28**

Duration:720 Hours

Course Fees: Rs. 60,000/- + GST and other taxes if any as applicable

Registration fee: An amount of Rs.1000/- (including all taxes as applicable) (nonrefundable) should be paid at the time of registering for the course.

This fee shall be considered as part of course fee, if the student joins the course. If a student register and pay for more than one course and join for any one course, all such amount will be adjusted against the course fee payable.

If the student does not join for the registered course / any of the registered courses, fee paid shall be forfeited.

Course Fee Installment Structure:

Students can pay the full fees of Rs. *60,000 + all taxes as applicable* (Rs. 70,800/-)in advance or as installments as given below.

Fee	Amount in Rs.	# Due date
Registration Fee	1,000/-	
**Advance Fee	10,000/-	
1st Installment	35,000/-	
2nd Installment	24,800/-	
Total fee	70,800/-	

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

Fine will be applicable for late payment.

Eligibility: BE/B.Tech (ECE/EEE/AEI/CSE/IT/Biomedical/Medical Electronics, Mechatronics and allied branches) / M.Sc. (Electronics/CS) Completed or *Final Year, NIELIT 'A' Level.

* Upon fulfilling all requirements, final year students will receive a PG Diploma certificate alongside their degree. Submission of proof of degree completion is necessary to obtain the PG Diploma certificate; otherwise, a course completion certificate will be provided.

Number of Seats: *40*

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 subject to eligibility and availability of seats.

*ii. The First list of Provisionally Selected Candidates will be intimated on **15/07/2024** by email only. In case of vacancy, additional selection list will be prepared and the selection will be intimated by email only.*

iii. All candidates who appear in the first selection list may pay Rs.10,000/- *on or before **22nd July 2024** 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 as email, so as to reach the center by **25th Aug 2024.***

Test/Interview: *Not Applicable*

Counselling/Admission:

*All candidates **provisionally selected** and **paid the advance fee** will have to be present personally for **counseling and admission on 20th or 21th Aug 2024** 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.*

Important Dates:

Date	
15th May 2024	**Course Registration opens**
15st July 2024	**First election List**
22th July 2024	**Last date for paying the advance fee**
29th July 2024	**Second selection list**
19th & 20th Aug 2024	**Counselling and admission**
21st Aug 2024	**Commencement of classes**

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 5.15 pm Monday to Friday. During project work, the timings are from 9.15 am to 5.15 pm. The theory to lab proportion is 30:70.

Placement:
We have a placement cell, which provides placement assistance to students who qualify our courses. Internship/Placement/Entrepreneurship support also will be provided under ***Chips to Start up*** *(***https://www.c2s.gov.in) programme of Ministry of Electronics and Information Technology, GoI.**

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

i. Campus placement

ii. Placement by companies for whom we send the students bio data and they conduct interviews at their site.

iii. Students themselves attend interview at different companies and the course helps in the interview.

Lab Facilities ***:*** *NIELIT Aurangabad is a participating institute under C2S Programme of MeitY along with other elite 100 institutions across the country. The VLSI, FPGA and SoC Design Labs are equipped with Industry standard VLSI Design tools from Synopsys, CADENCE, AMD (Xilinx) and SIEMENS-Mentor.*

Detailed Curriculum & Syllabus :

VES 100: Introduction to VLSI and Embedded Systems :

Module Duration: 60 Hours (20 hours theory and 40 hours lab)

Objective:

To provide students with a foundational understanding of VLSI and embedded systems, including basic electronics principles and the architecture of embedded systems.

Learning Outcomes:

By the end of this module, students will be able to:

- Explain the fundamental concepts of VLSI and embedded systems.
- Describe the evolution and significance of VLSI and embedded systems.
- Understand basic electronics principles and digital logic.
- Identify different semiconductor devices and their applications.
- Demonstrate introductory knowledge of embedded systems architecture.
- Write simple programs in Verilog HDL.

Prerequisite:

- Understanding of digital logic design principles.
- Basic knowledge of hardware description languages (HDLs) such as Verilog or VHDL.
- Familiarity with sequential and combinational logic circuits.
- Proficiency in using digital design tools (preferred but not mandatory).

Course Description:-

- Overview of VLSI and Embedded Systems
- Evolution of VLSI and Embedded Systems
- Basic Electronics and Digital Logic
- Introduction to Semiconductor Devices
- Introduction to Embedded Systems Architecture
- Introduction to HDL (Hardware Description Language) – Verilog

Reading List:

1."CMOS VLSI Design: A Circuits and Systems Perspective" by Neil H. E. Weste and David Money Harris.
2."Embedded Systems: Architecture, Programming and Design" by Raj Kamal.
3."Digital Design" by M. Morris Mano and Michael D. Ciletti.
4."Verilog HDL: A Guide to Digital Design and Synthesis" by Samir Palnitkar.
5."Introduction to Embedded Systems" by Shibu K. V.
6.Online resources and tutorials for basic electronics and Verilog programming.

VES 101: Digital Design using Verilog:

Module Duration: 120 Hours (40 hours theory and 80 hours lab)

Objective:

To equip students with the knowledge and skills required to design and implement digital circuits using Verilog HDL.

Learning Outcomes:

By the end of this module, students will be able to:

- Understand the basics of Verilog HDL and its syntax.
- Design and implement combinational and sequential logic circuits using Verilog.
- Develop behavioral models and RTL code for digital circuits.
- Perform timing analysis and optimize digital designs.
- Create testbenches for functional verification of Verilog designs.
- Synthesize Verilog code and optimize designs for hardware implementation.

Prerequisite:

- Understanding of digital logic design principles.
- Basic knowledge of hardware description languages (HDLs) such as Verilog or VHDL.
- Familiarity with sequential and combinational logic circuits.
- Proficiency in using digital design tools (preferred but not mandatory).

Course Description:-

- Introduction to Verilog HDL
- Combinational and Sequential Logic Design

- Behavioral Modeling and RTL Coding
- Designing Arithmetic and Logical Circuits
- Timing Constraints and Timing Analysis
- Testbench Development and Functional Verification
- Synthesis and Optimization Techniques

Reading List:

1."Digital Design and Computer Architecture" by David Harris and Sarah Harris.
2."Digital Design using Verilog HDL" by Charles H. Roth, Jr. and Lizy K. John.
3."FPGA Prototyping by Verilog Examples" by Pong P. Chu.
4."RTL Hardware Design Using VHDL: Coding for Efficiency, Portability, and Scalability" by Donald G. Bailey.
5.Online tutorials and documentation for Verilog synthesis tools.

VES 102: Advanced VLSI Design Concepts :

Module Duration: 120 Hours (40 hours theory and 80 hours lab)
Objective:
To explore advanced concepts and methodologies in VLSI design, including CMOS fabrication processes, timing analysis, power optimization, and design for testability.

Learning Outcomes:
By the end of this module, students will be able to:

- Understand CMOS fabrication processes and IC design flow.
- Perform static timing analysis and achieve timing closure.
- Implement power optimization techniques in VLSI designs.
- Apply floor-planning, placement, and routing techniques.
- Design for testability (DFT) and ensure test coverage in VLSI circuits.
- Implement low-power design techniques in VLSI projects.

Prerequisite:

- Sound understanding of CMOS semiconductor devices and basic IC fabrication processes.
- Proficiency in digital design fundamentals, including RTL coding and synthesis.
- Familiarity with timing analysis concepts and tools.
- Knowledge of basic power optimization techniques in digital design.

Course Description:-
- CMOS Fabrication Process and IC Design Flow
- Static Timing Analysis (STA) and Timing Closure
- Power Optimization Techniques
- Floorplanning and Placement
- Routing and Routing Optimization
- Design for Testability (DFT)
- Low Power Design Techniques

Reading List:

1.Digital Integrated Circuit Design" by Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic.
2."ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits" by Keith Barr.
3."Low Power Design Methodologies" by Rabi N. Mahapatra and Anand Raghunathan.
4."CMOS VLSI Design: A Circuits and Systems Perspective" by Neil H. E. Weste and David Money Harris.
5."Introduction to VLSI Circuits and Systems" by John P. Uyemura.
6.Research papers and articles on advanced VLSI design techniques.

VES 103: Embedded Systems Design :

Module Duration: 120 Hours (40 hours theory and 80 hours lab)
Objective:
To introduce students to the principles and practices of embedded systems design, including microcontroller programming, real-time operating systems, and interfacing peripherals.

Learning Outcomes:
By the end of this module, students will be able to:

- Understand the architecture and programming of microcontrollers.
- Develop applications using real-time operating systems (RTOS).
- Write embedded C programs for microcontroller-based systems.
- Develop device drivers and kernel modules for embedded systems.
- Interface various peripherals and sensors with microcontrollers.
- Design and implement embedded systems using industry-standard development tools.

Prerequisite:

- Understanding of microcontroller architecture and programming.
- Familiarity with real-time operating systems (RTOS) concepts.
- Proficiency in C programming language.
- Knowledge of interfacing techniques for peripherals and sensors.

Course Description:-

- Micro-controller Architecture and Programming (e.g., ARM Cortex-M)
- Real-time Operating Systems (RTOS) Concepts
- Embedded C Programming
- Device Drivers and Kernel Development
- Interfacing Peripherals and Sensors
- Embedded System Design Practices and Methodologies
- Introduction to Internet of Things (IoT) and Wireless Communication Protocols

Reading List:

1."Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers" by Jonathan Valvano.
2."Embedded Systems: Architecture, Programming and Design" by Raj Kamal.
3."Embedded C Programming and the Microchip PIC" by Richard H. Barnett, Sarah Cox, and Larry D. O'Cull.
4."ARM Cortex M4 Cookbook" by Dr. Mark Fisher.
5."The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors" by Joseph Yiu.
6.Datasheets and reference manuals for microcontrollers and peripheral devices.

VES 104:Advanced Topics in VLSI and Embedded Systems:

Module Duration: 120 Hours (40 hours theory and 80 hours lab)

Objective:

To explore advanced topics and emerging trends in VLSI and embedded systems, including system-on-chip (SoC) design, FPGA prototyping, and hardware security.

Learning Outcomes:

By the end of this module, students will be able to:

- Understand the concepts and challenges of system-on-chip (SoC) design.
- Implement FPGA-based prototypes for VLSI designs.
- Apply high-level synthesis (HLS) techniques using SystemC.
- Explore advanced embedded systems concepts such as Embedded Linux.
- Understand hardware security principles and cryptography.
- Apply advanced digital signal processing (DSP) techniques in embedded systems.

Prerequisite:

- Proficiency in VLSI design fundamentals, including floorplanning, placement, and routing.
- Understanding of FPGA architecture and programming methodologies.
- Familiarity with high-level synthesis (HLS) techniques.
- Knowledge of embedded systems development, including device drivers and kernel programming.

Course Description:-

- System-on-Chip (SoC) Design Concepts
- FPGA (Field Programmable Gate Array) Design and Prototyping
- High-Level Synthesis (HLS) and SystemC
- Advanced Embedded Systems Concepts (e.g., Embedded Linux)
- Hardware Security and Cryptography
- Advanced Topics in Digital Signal Processing (DSP)
- Project Work and Case Studies

Reading List:

1."Digital System Design with FPGA: Implementation Using Verilog and VHDL" by Cem Unsalan and Bora Tar.
2."FPGA Prototyping by Verilog Examples" by Pong P. Chu.
3."SystemC: From the Ground Up" by David C. Black and Jack Donovan.
4."Embedded Linux Primer: A Practical, Real-World Approach" by Christopher Hallinan.
5."Introduction to Cryptography with Coding Theory" by Wade Trappe and Lawrence C. Washington.
6.Research papers and articles on advanced VLSI and embedded systems topics.

VES105: Project Work and Industry Exposure:

Module Duration: 180 Hours (180 hours lab Practical and employability skills)

- Hands-on project work in VLSI and Embedded Systems
- Industry visits and guest lectures
- Resume building and interview preparation
- Presentation and communication skills development
- Final project presentation and evaluation

Additional Activities:

- Guest lectures from industry experts.
- Workshops on emerging trends in VLSI and Embedded Systems.

Assessment Method:

- Regular quizzes, assignments, and End-term exams.
- Final project evaluation and viva voce.