QUALIFICATION FILE–Standalone NOS

Basics of Embedded Linux Internals

☐ Horizontal/Generic ☐Vertical/Specialization

☒ Upskilling ☐ Dual/Flexi Qualification ☐ For ToT ☐ For ToA

☐General ☐ Multi-skill (MS) ☐ Cross Sectoral (CS) ☒Future Skills ☒OEM

NCrF/NSQF Level: 4

Submitted By:

NATIONAL INSTITUTE OF ELECTRONICS AND INFORMATION TECHNOLOGY (NIELIT)

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Section 1: Basic Details

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<tr><td>1.</td><td>NOS-Qualification Name</td><td colspan="2">Basics of Embedded Linux Internals</td></tr>
<tr><td>2.</td><td>Sector/s</td><td colspan="2">Electronics</td></tr>
<tr><td>3.</td><td>Type of Qualification ☒ New ☐ Revised</td><td>NQR Code & version of the existing /previous qualification: NA</td><td>Qualification Name of the existing/previous version: NA</td></tr>
<tr><td>4.</td><td>National Qualification Register (NQR) Code & Version</td><td>NG-04-EH-02889-2024-V1-NIELIT</td><td>5. NCrF/NSQF Level: 4</td></tr>
<tr><td>6.</td><td>Brief Description of the Standalone NOS</td><td colspan="2">The course on Embedded Linux covers theoretical foundations like system calls, memory management, and process synchronization. It delves into Linux kernel basics, device management, networking concepts, and the boot process. Practical labs, case studies, and hands-on projects reinforce learning, preparing students for real-world embedded Linux development. Continuous updates and assessments ensure participants stay current with industry trends and best practices.</td></tr>
<tr><td>7.</td><td>Eligibility Criteria for Entry for a Student/Trainee/Learner/Employee</td><td colspan="2">a. Entry Qualification & Relevant Experience:
<table>
<tr><th>S. No.</th><th>Academic/Skill Qualification (with Specialization - if applicable)</th><th>Relevant Experience (with Specialization - if applicable)</th></tr>
<tr><td>1</td><td>12th or equivalent in Science with Physics and Maths</td><td>NA</td></tr>
<tr><td>2</td><td>2 Years of 3-Years Diploma in Electronics and Communication Engineering/ Electrical Engineering/CS/IT and allied branches after class 10th</td><td>NA</td></tr>
<tr><td>3</td><td>NSQF Level 3.5 in Electronics and Communication Engineering/ Electrical Engineering/CS/IT and allied branches</td><td>1.5 Years</td></tr>
<tr><td>4</td><td>NSQF Level 3 in Electronics and Communication Engineering/ Electrical Engineering/CS/IT and allied branches</td><td>1.5 Years</td></tr>
</table>
b. Age:18 years</td></tr>
<tr><td>8.</td><td>Credits Assigned to this NOS-Qualification, Subject to Assessment (as per National Credit Framework (NCrF))</td><td>2 Credits</td><td>9. Common Cost Norm Category (I/II/III) (wherever applicable):
Category I (Electronics System Design)</td></tr>
</table>

<table>
<tr><td>10.</td><td>Any Licensing Requirements for Undertaking Training on This Qualification (wherever applicable)</td><td>NA</td></tr>
<tr><td>11.</td><td>Training Duration by Modes of Training Delivery (Specify Total Duration as per selected training delivery modes and as per requirement of the qualification)</td><td>☒Offline ☐ Online ☐ Blended
<table>
<tr><th>Training Delivery Mode</th><th>Theory (Hours)</th><th>Practical (Hours)</th><th>Total (Hours)</th></tr>
<tr><td>Classroom (offline)</td><td>30</td><td>30</td><td>60</td></tr>
</table>
Training shall be conducted in any of the 3 modes depending on the regional need.

(Refer Blended Learning Annexure-V for details)</td></tr>
<tr><td>12.</td><td>Assessment Criteria</td><td>
<table>
<tr><th>Theory (Marks)</th><th>Practical (Marks)</th><th>Project/ Presentation /Assignment (Marks)</th><th>Viva/ Internal Assessment (Marks)</th><th>Total (Marks)</th><th>Passing %age</th></tr>
<tr><td>100</td><td>60</td><td>20</td><td>20</td><td>200</td><td>50</td></tr>
</table>
The centralized online assessment is conducted by the Examination Wing, NIELIT Headquarters.</td></tr>
<tr><td>13.</td><td>Is the NOS Amenable to Persons with Disability</td><td>☒ Yes ☐ No
If “Yes”, specify applicable type of Disability:

a. Locomotor Disability: Leprosy Cured Person, Dwarfism, Muscular Dystrophy and Acid Attack Victims
b. Visual Impairment: Low Vision</td></tr>
<tr><td>14.</td><td>Progression Path After Attaining the Qualification, wherever applicable</td><td>Embedded System Developer (A-Level 'Embedded System Design')</td></tr>
<tr><td>15.</td><td>How will the participation of women be encouraged?</td><td>Participation by women can be ensured through Government Schemes. Occasionally, exclusive batches for women would be run for the proposed courses. Funding is available for women’s participation under other schemes launched by the Government from time to time.</td></tr>
<tr><td>16.</td><td>Other Indian languages in which the Qualification & Model Curriculum are being submitted</td><td>Qualification file available in English & Hindi Language</td></tr>
<tr><td>17.</td><td>Is similar NOS available on NQR-if yes, justification for this qualification</td><td>☐Yes ☒ No</td></tr>
</table>

18.	**Name and Contact Details Submitting / Awarding Body SPOC** *(In the case of CS or MS, provide details of both Lead AB & Supporting ABs)*	**Name:** Rajesh M **Email:** rajesh.m@nielit.gov.in **Website:** https://nielit.gov.in/ **Name:** Prashant Pal **Email:** prashantpal@nielit.gov.in **Website:** https://nielit.gov.in/ **Name:** Anirban Jyoti Hati **Email:** anirban@nielit.gov.in **Website:** https://nielit.gov.in/ **Name:** Ankit Kumar **Email:** ankit@nielit.gov.in **Website:** https://nielit.gov.in/	
19.	**Final Approval Date by NSQC: 25.07.2024**	**20. Validity Duration: 3 years**	**21. Next Review Date:25.07.2027**

Section 2: Training Related

1.	**Trainer's Qualification and experience in the relevant sector (in years) (as per NCVET guidelines)**	B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control /Computer Science/Information Technology Minimum 2 year of experience in the field of Embedded Systems Development
2.	**Master Trainer's Qualification and experience in the relevant sector (in years) (as per NCVET guidelines)**	B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control /Computer Science/Information Technology Minimum 3 year of experience in the field of Embedded Real Time systems
3.	**Tools and Equipment Required for the Training**	☒ Yes ☐No Available at Annexure-II
4.	**In Case of Revised NOS, details of Any Upskilling Required for Trainer**	Not Applicable

Section 3: Assessment Related

1.	**Assessor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines)*	B.Tech or Equivalent as per NCrF + 3 years relevant experience
2.	**Proctor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines), (wherever applicable)*	The assessor carries out theory online assessments through the remote proctoring methodology. Theory examination would be conducted online and the paper comprises MCQ. Conduct of assessment is through trained proctors. Once the test begins, remote proctors have full access to the candidate's video feeds and computer screens. Proctors authenticate the candidate based on registration details, pre-test image captured and I-card in possession of the candidate. Proctors can chat with candidates or give warnings to candidates. Proctors can also take screenshots, terminate a specific user's test session, or re-authenticate candidates based on video feeds.
3.	**Lead Assessor's/Proctor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines)*	External Examiners/ Observers (Subject matter experts) are deployed including NIELIT scientific officers who are subject experts for evaluation of Practical examination/ internal assessment / Project/ Presentation/ assignment and Major Project (if applicable). Qualification is generally B.Tech
4.	**Assessment Mode***(Specify the assessment mode)*	Centralized online examination will be conducted
5.	**Tools and Equipment Required for Assessment**	Same as for training ☒ Yes ☐ No

Section 4: Evidence of the Need for the Standalone NOS

1.	Government /Industry initiatives/ requirement (Yes/No): Yes, Available at Annexure-A: Evidence of Need
2.	Number of Industry validations provided: 10
3.	Estimated number of people to be trained: 500 persons per year shall be trained.
4.	Evidence of Concurrence/Consultation with Line/State Departments (In case of regulated sectors): NIELIT is recognized as AB and AA under Government Category. NIELIT is an HRD arm of MeitY, therefore, the Line Ministry Concurrence is not required.
5.	Latest Skill Gap Study (not older than 2 years) (Yes/No): Yes, Available in Annexure-A: Evidence of Need

6.	Latest Market Research Reports or any other source (not older than 2 years) (Yes/No): Yes, Available at Annexure-A: Evidence of Need

Section 5: Annexure & Supporting Documents Check List

Specify Annexure Name / Supporting document file name.

1.	**Annexure:** NCrF/NSQF level justification based on NCrF/NSQF descriptors *(Mandatory)*	*Available at* Annexure-I: Evidence of Level
2.	**Annexure:** List of tools and equipment relevant for NOS *(Mandatory, except in case of online course)*	*Available at* Annexure-II: Tools and Equipment
3.	**Annexure: Industry Validation**	*Available at* Annexure-III: Industry Validation
4.	**Annexure: Training Details**	*Available at* Annexure-IV: Training Details
5.	**Annexure:** Blended Learning *(Mandatory, in case the selected Mode of delivery is Blended Learning)*	*Available at* Annexure-V: Blended Learning
6.	**Annexure/Supporting Document:** Standalone NOS-Performance Criteria Details Annexure/Document with PC-wise detailing as per NOS format (Mandatory- Public view)	*Available at* Annexure-VI: Standalone NOS- Performance Criteria details
7.	**Annexure:** Performance and Assessment Criteria *(Mandatory)*	*Available at* Annexure-VII: Detailed Assessment Criteria
8.	**Annexure:** Assessment Strategy *(Mandatory)*	*Available at* Annexure-VIII: Assessment Strategy
9.	**Annexure:** Acronym and Glossary *(Optional)*	*Available at* Annexure-IX: Acronym and Glossary
10.	**Supporting Document:** Model Curriculum	*Available at* Annexure-C: Model Curriculum

Annexure-I: Evidence of Level

NCrF/NSQF Level Descriptors	Key requirements of the job role/ outcome of the qualification	How the job role/ outcomes relate to the NCrF/NSQF level descriptor	NCrF/NSQF Level
Professional Theoretical Knowledge/Process	• Understanding the structure and organization of the Linux kernel, including its core components and subsystems. • Proficiency in process management, including creation, scheduling, synchronization, and termination of processes. • Proficiency in configuring and managing network interfaces, services, and security within an embedded Linux environment.	1. Theoretical knowledge Includes understanding process creation, scheduling policies, process synchronization using semaphores or mutexes, and termination mechanisms. 2. This knowledge enables effective utilization of system resources and ensures proper coordination among concurrent processes.	4
Professional and Technical Skills/ Expertise/ Professional Knowledge	• Demonstrated expertise in administering Linux-based systems, including installation, configuration, and maintenance. • Proficiency in programming languages such as C and scripting languages like Bash for system-level development and automation. • Experience in developing and optimizing embedded software for resource-constrained environments, leveraging Linux kernel features and tools.	1. Possesses specialized professional and technical skills; displays clarity of professional knowledge and technical skills in a broad range of activities/ tasks. 2. Have knowledge of collecting and interpreting the available information, drawing conclusions & communicating the same	4
Employment Readiness & Entrepreneurship Skills & Mind-set/Professional Skill	• Demonstrate deep understanding of Linux kernel architecture, system calls, and their implementation. • Utilize analytical thinking to diagnose and resolve complex issues in embedded Linux systems. • Conduct market research to identify emerging trends and potential opportunities in embedded systems.	1. Can explain Entrepreneurial Mindset and describe the importance of it in the context of opportunity curation for future jobs. 2. Can comfortably use most of the basic software with proficiency	4

		3. Have the ability to relate to the 5 pillars of Social Emotional Skills and describe the similarities between SES and Emotional Intelligence	
Broad Learning Outcomes/ Core Skill	• Ability to navigate and modify the Linux kernel source code for customization and optimization purposes. • Utilize Linux system calls proficiently for managing files, processes, and hardware interactions. • Configure and manage device drivers for various hardware components in embedded Linux systems.	1. Proficient utilization of Linux system calls for managing files, processes, and hardware interactions is a core skill in Linux system programming. 2. Capability to configure and manage device drivers for various hardware components in embedded Linux systems reflects a core skill in embedded systems development.	4
Responsibility	• Responsibility for ensuring the stability, security, and reliability of embedded Linux platforms through effective system configuration, maintenance, and troubleshooting. • Responsibility for designing, implementing, and testing software components to meet project requirements and standards.	1. Takes complete responsibility for delivery and quality of own work and output as also the subordinates. 2. Shares responsibility for the group tasks.	4

Annexure II: Tools and Equipment (lab set-up)

List of Tools and Equipment: **Batch Size: 30**

S. No.	Tool / Equipment Name	Specification	Quantity for specified Batch size
1	Classroom	1 (750 Sq. ft to 1000 Sq. ft.)	30
2	Students Chair	30	30
3	Students Table	15 (2 students sharing 1 table)	15

4	Desktop computer with accessories / Laptop	Laptop with minimum specifications: Intel I3 or Celeron processor with at least 8GB RAM, 512GB SSD Hard disk integrated with graphics card, Display size 15.6-inch, Wi-Fi connectivity and Wired Optical Mouse	15
5	Internet Connectivity	Seamless internet connectivity with at least 100 Mbps without firewall	
6	Development Board	Computer with Linux OS, development board or emulator for embedded Linux, compiler tool chain, and access to documentation on Linux kernel and system calls.	15

Classroom Aids for offline and blended mode of training:

The aids required to conduct sessions in the classroom are:

1. LCD Projector/Smart Board

Annexure III: Industry Validations/ Government Recognition Summary

S. No	Organization Name	Representative Name	Designation	Contact Address	Contact Phone No	E-mail ID
1	AISECT Ltd.	Teena Panthi	Assistant Manager	AISECT Ltd. 1-1-387, 3rd floor, Flat No. 403/404, GNR Heights, Above SBI,Bakaram Road, Musheerabad, Hydrabad-500020	7879982075	teena.panthi@aisect.org
2	NICE SHIKSHA VIKAS KENDRA	Motilal Ohdar	Secretory	Moti House, (Nice Computer Gali), Prince Chowk, Simdega, Jharkhand	7992489955	vtpnice12@gmail.com
3	Aajivika Global Skill Private Limited	Mukesh Kumar Verma	Director	Beside Vishal Trade, dasmile chowk, Khunti Road Ranchi, Jharkhand-835221	9507952882	aajivikaglobal@gmail.com

4	B. G. Infotech	Amal Das	Centre Head	Kakdihi, Mecheda, Purba, Medinipur	9434996748	bginfotech2007@gmail.com
5	Devendra Nath Institute of Information Mation Technology	Amit Kumar Tripathy	Director	Uska Road, Near Naveen Sabji Mandi, Tetari Bazar, Siddharth Nagar-272207	8765562815	aktjob@gmail.com
6	Inditech Software Wizard Pvt. Ltd.	Sandip Ghosh	Course Coordinator	Mohiari Chanpiritala, Po: Andul Mouri, PS: Domjur, Distt: Howrah, West Bengal-711302	9230027415	swizardrecruitment@gmail.com
7	Prasanthi Polytechnic	D. Prasad	Principal	Duppituru (Vill), Atchutapuram (Md). Visakhapatnam (Dist), Andhara Pradesh-531011	9849952573	prasadreddy.1279@gmail.com
8	JAN SAMRIDHI DUMKA	Gobind Nath Maji	Director	Near Gyan School, Dudhani, Dumka, Jharkhand-814101	8789620133	Gobind107@gmail.com
9	Sidhi Vinayak Academy	Neha Verma	Director	Shiv Narayan Kunj, B Block, Shivaji Nagar, Hethu, Ranchi, JH-834002	8789837772	sidhiacadmey@gmail.com
10	Surekha IT Services	Anjani K	Manager	8-3-191/84/302, Sharan Residency, Vengalrao Nagar, Hyderabad-500038, Telangana	8125134134	info@surekhaitservices.com

Annexure IV: Training Details

Training Projections:

Year	Estimated Training # of Total Candidates	Estimated training# of Women	Estimated training# of People with Disability
2024-25	500	200	20
2025-26	500	200	20
2026-27	1000	200	20

Data to be provided year-wise for the next 3 years

Annexure V: Blended Learning

Blended Learning Estimated Ratio & Recommended Tools:

S. No.	Select the Components of the Qualification	List Recommended Tools – for all Selected Components	Offline : Online Ratio
1	Theory/ Lectures - Imparting theoretical and conceptual knowledge	Online interaction platforms like JitSi Meet, Bharat VC, Google Meet, MS Teams, etc.	70:30
2	Imparting Soft Skills, Life Skills, and Employability Skills /Mentorship to Learners	Online interaction platforms like JitSi Meet, Bharat VC, Google Meet, MS Teams, etc.	70:30
3	Showing Practical Demonstrations to the learners	Through Virtual Software and Online interaction platforms like JitSi Meet, Bharat VC, Google Meet, MS Teams, etc.	70:30
4	Imparting Practical Hands-on Skills/ Lab Work/ workshop/ shop floor training	Through Virtual Software and Online interaction platforms like JitSi Meet, Bharat VC, Google Meet, MS Teams, etc.	70:30
5	Tutorials/ Assignments/ Drill/ Practice	Online interaction platforms like JitSi Meet, Bharat VC, Google Meet, MS Teams, etc.	70:30
6	Proctored Monitoring/ Assessment/ Evaluation/ Examinations	NIELIT Remote Proctored Software	Online: 100% Theory Offline: 100% Practical
7	On the Job Training (OJT)/ Project Work Internship/ Apprenticeship Training	Simulated Platform	Either 100% online in a virtual environment Or 100% offline in the Industry.

Annexure VI: Standalone NOS- Performance Criteria details

1. Description

The objective is to provide a comprehensive understanding of Embedded Linux, focusing on its architecture, kernel basics, system calls, and file and process management. Students will learn about memory and device management, inter-process communication, multi-threading, synchronization, and networking concepts specific to embedded systems.

2. Scope

This course encompasses the fundamental principles and practical applications of Embedded Linux. It aims to provide students with a thorough understanding of how Linux is integrated into embedded systems. The course covers key aspects of Linux kernel architecture, system calls, file and process management, memory and device management, inter-process communication, multi-threading, synchronization, and networking in embedded environments. By the end of the course, students will be proficient in the concepts and practices necessary for developing and managing embedded systems using Linux.

3. Elements and Performance Criteria

Embedded Linux Architecture and Components:

- Students should be able to explain the overall structure of Embedded Linux and identify its key components.
- Students should accurately describe the differences between Embedded Linux and standard Linux distributions.
- Analyze and discuss case studies where Embedded Linux is used, highlighting its advantages and challenges.

Linux Kernel Basics:

- Students should demonstrate how the kernel manages resources such as processes, memory, and devices.
- Perform practical exercises that involve configuring and optimizing kernel parameters for resource management.
- Write simple programs that make use of system calls to perform basic tasks like file operations or process management.

Inter-process Communication and Multi-threading:

- Write and test programs that utilize IPC to communicate between processes.
- Develop and debug multi-threaded applications, ensuring proper synchronization and resource sharing.

- Analyze and present case studies that involve complex IPC and multi-threading scenarios, discussing the solutions and their impact on system performance.

4. **Knowledge and Understanding (KU):**

The individual on the job needs to know and understand:

Knowledge of Embedded Linux Structure

- Understand the hierarchical structure of Embedded Linux, including the kernel, libraries, and application layers.
- Familiarity with the roles and functions of each component within the Embedded Linux architecture.

Kernel Architecture

- Comprehensive understanding of the Linux kernel architecture, including its layers and modules.
- Knowledge of how different parts of the kernel interact and function together.

Multi-threading Concepts and Techniques

- Comprehensive knowledge of multi-threading concepts and techniques in Linux.
- Skills to develop, debug, and optimize multi-threaded applications.

5. Generic Skills (GS):

User/individual on the job needs to know how to:

- Skills in presenting technical concepts and solutions to diverse audiences, including non-technical stakeholders.
- Strong ability to identify, diagnose, and resolve issues within embedded Linux systems.
- Proficiency in using debugging tools and techniques to fix kernel, application, and system-level problems.

Annexure VII: Assessment Criteria

Detailed PC-wise assessment criteria and assessment marks for the NOS are as follows:

NOS/Module Name	Assessment Criteria for Performance Criteria	Theory Marks	Practical Marks	Project /Presentation /Assignment Marks	Viva/ Internal Assessment (Marks)
NOS1: Basics of Embedded Linux Internals **NOS Code: NIE/ELE/N0224**	*Embedded Linux Architecture and Components*	**30**	**20**	**-**	**6**
	• Students should be able to explain the overall structure of Embedded Linux and identify its key components.	-	-	-	-
	• Students should accurately describe the differences between Embedded Linux and standard Linux distributions.	-	-	-	-
	• Analyze and discuss case studies where Embedded Linux is used, highlighting its advantages and challenges.	-	-	-	-
	Linux Kernel Basics:	**30**	**20**	-	**7**
	• Students should demonstrate how the kernel manages resources such as processes, memory, and devices.	-	-	-	-
	• Perform practical exercises that involve configuring and optimizing kernel parameters for resource management.			-	-
	• Write simple programs that make use of system calls to perform basic tasks like file operations or process management.	-	-	-	-
	Inter-process Communication and Multi-threading:	**40**	**20**	-	**7**
	• Write and test programs that utilize IPC to communicate between processes.	-	-	-	-
	• Develop and debug multi-threaded applications, ensuring proper synchronization and resource sharing.	-	-	-	-
	• Analyze and present case studies that involve complex IPC and multi-threading scenarios, discussing the solutions and their impact on system performance.				
		100	**60**	**20**	**20**
	NOS Total	**200**			

Annexure VIII: Assessment Strategy

This section includes the processes involved in identifying, gathering, and interpreting information to evaluate the Candidate on the required competencies of the program.

Assessment of the qualification evaluates candidates to ascertain that they can integrate knowledge, skills and values for carrying out relevant tasks as per the defined learning outcomes and assessment criteria.

The underlying principle of assessment is fairness and transparency. The evidence of the outcomes and assessment criteria. Competence acquired by the candidate can be obtained by conducting Theory (Online) examination.

About Examination Pattern:

1. The question papers for the theory exams are set by the Examination wing (assessor) of NIELIT HQS.

2. The assessor assigns roll number.

3. The assessor carries out theory online assessments. Theory examination would be conducted online and the paper comprise of MCQ

4. Pass percentage would be 50% marks.

5. The examination will be conducted in English language only.

Quality assurance activities: A pool of questions is created by a subject matter expert and moderated by other SME. Test rules are set beforehand. Random set of questions which are according to syllabus appears which may differ from candidate to candidate. Confidentiality and impartiality are maintained during all the examination and evaluation processes.

Annexure IX: Acronym and Glossary

Acronym

Acronym	Description
AA	Assessment Agency
AB	Awarding Body
NCrF	National Credit Framework
NOS	National Occupational Standard(s)
NQR	National Qualification Register
NSQF	National Skills Qualifications Framework

Glossary

Term	Description
National Occupational Standards (NOS)	NOS define the measurable performance outcomes required from an individual engaged in a particular task. They list down what an individual performing that task should know and also do.
Qualification	A formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards.
Qualification File	A Qualification File is a template designed to capture necessary information of a Qualification from the perspective of NSQF compliance. The Qualification File will be normally submitted by the awarding body for the qualification.
Sector	A grouping of professional activities on the basis of their main economic function, product, service, or technology.