

<b>Module Title:</b>	Embedded Linux Development
<b>Language of Instruction:</b>	English
<b>Credits:</b>	5
<b>NFQ Level:</b>	8
<b>Module Delivered In</b>	No Programmes
<b>Teaching &amp; Learning Strategies:</b>	Teaching will be a blend of lectures, tutorials and practical classes.
<b>Module Aim:</b>	To equip students with the knowledge and skills required to design, build, administer and evaluate a Linux based embedded system which is interfaced to the internet (IoT).
<b>Learning Outcomes</b>	
<i>On successful completion of this module the learner should be able to:</i>	
LO1	Design and build a customised Linux image which is optimized for an embedded system.
LO2	Design scripts to administer a Linux based embedded system.
LO3	Configure a system by adding or removing device drivers (modules) from the Linux kernel.
LO4	Install, configure and harden a webserver.
LO5	Plan, design and implement a system that will interface sensor(s) to the cloud. (Internet of Things (IoT) based application).
LO6	Evaluate the performance of an embedded system using specified metrics & constraints (power, speed/latency, etc.)
<b>Pre-requisite learning</b>	
<b>Module Recommendations</b>	
<i>This is prior learning (or a practical skill) that is recommended before enrolment in this module.</i>	
No recommendations listed	
<b>Incompatible Modules</b>	
<i>These are modules which have learning outcomes that are too similar to the learning outcomes of this module.</i>	
No incompatible modules listed	
<b>Co-requisite Modules</b>	
No Co-requisite modules listed	
<b>Requirements</b>	
<i>This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed.</i>	
No requirements listed	

## Module Content & Assessment

### Indicative Content

**(a) Linux architecture**

Linux architecture, embedded Linux, installing Linux & the bootloader.

**(b) Linux as an Embedded OS**

Advantages and limitations of Linux as an embedded operating system. Introduction to real time systems.

**(c) System Administration**

System administration, configuring a static IP address, superuser, adding users, Linux file system, file system commands.

**(d) Security considerations**

User and process permissions. System security.

**(e) Processes**

Foreground & background processes. I/O redirection, interprocess communication, pipes, sockets, filters, etc.

**(f) Utilities**

Shell commands and shell scripts.

**(g) Firmware development**

Programming in C using gcc, gdb, make file, etc. System call interface, introduction to writing device drivers. Loading, unloading, blocking & blacklisting device driver modules (lsmod, insmod, rmmod, etc)

**(h) Hardware interfacing**

Hardware interfacing - GPIO, Analog I/O, I2C, SPI, sensors, etc.

**(i) Networking**

Communications & Networking - SSL, SSH, Bluetooth, Ethernet & Wi-fi.

**(j) Webserver configuration**

Install, configure and harden a webserver (e.g. Apache).

**(k) System performance profiling**

Performance metrics & constraints (power, speed/latency, etc.)

**(k) Mini-projects**

Mini projects - which may include developing an Internet of Things (IoT) application, video streaming & audio streaming.

Assessment Breakdown	%
Continuous Assessment	20.00%
Practical	40.00%
End of Module Formal Examination	40.00%

### Continuous Assessment

Assessment Type	Assessment Description	Outcome addressed	% of total	Assessment Date
Examination	Students will be assigned an number of assignments and/or class tests as part of the assessment of this module. Students may be asked to complete assignments during class or as homework.	1,2,3,5,6	20.00	Week 7

No Project

### Practical

Assessment Type	Assessment Description	Outcome addressed	% of total	Assessment Date
Practical/Skills Evaluation	Students will complete a number of mini projects, each of which may be completed over several weeks in the laboratory.	1,2,3,4,5,6	40.00	n/a

### End of Module Formal Examination

Assessment Type	Assessment Description	Outcome addressed	% of total	Assessment Date
Formal Exam	A written examination, at the end of the module, will examine the extent of the student's achievement of the learning outcomes.	1,2,3,5,6	40.00	End-of-Semester

**Module Workload**

<b>Workload: Full Time</b>		
<i>Workload Type</i>	<i>Frequency</i>	<i>Average Weekly Learner Workload</i>
Lecture	Every Week	1.00
Laboratory	Every Week	1.50
Independent Learning	Every Week	1.00
Total Hours		3.50

