Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Micro-Credentials

Information Sheet and Descriptor

Definition (working)

A micro-credential *is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards* ***(working definition approved by HCI Steering, 11 February 2021).***

Micro-credentials – range of credits from 2.5* ECTS, 5 ECTS, 10 ECTS.

*Note: for the 2021/22 academic year micro-credentials will consist of 5 ECTS or 10 ECTS.

Micro-credentials:

- Consist of credit offered for continuing/professional development purposes.
- Are specifically designed to upskill the workforce.
- May be stackable.
- Offer flexible delivery to meet the needs of industry, business and employees.

MC = Micro-Credential

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HCI Pillar 3

Micro-Credentials: Descriptor

HCI Cluster and Work Package for the proposed micro-credential:	Cluster 1: Work-package 1
To whom will the module/MC be offered?	Specify the *specific industry/profession targeted:* This MC will be offered to a range of relevant professionals, including mechanical engineers, electronic engineers, process/control engineers and embedded systems professionals.
Micro-credential title:	Cyber-physical Systems and Control
Is the proposed micro-credential a new or existing module (repurposed)?	New module/MC
(For Existing Modules Only)	
Existing module detail	***If this is an existing module to be repurposed as a micro-credential, please respond to the questions below.*** ***If not, proceed to the next section.*** State the name of the module and programme *(and enclose module descriptor if available)*: Click or tap here to enter text. Is the module shared with another discipline/School? If so, name the discipline/School: Click or tap here to enter text. **Existing Module details:** Select UG or PG. State year group. No. of ECTS of module: Click or tap here to enter text. NFQ level: Click or tap here to enter text. School (owner and discipline): Click or tap here to enter text.

	Module coordinator: Click or tap here to enter text. Code in SITS: Click or tap here to enter text. *If changes are required to the existing module so that it can exist coherently as a micro-credential please give details (please also outline how the existing module will meet the criteria of a micro-credential in terms of meeting the needs of industry and, providing flexible delivery):* This is a new module. The experience in delivering practical modules with extensive project work both in person (pre-2020) and online (2020/2021) will help in shaping the delivery of it. The module will be shared with MC students and postgraduate students in larger programmes. With the practical project work as the core of continuous assessment, and enough time for it at 10 ECTS, it is a well-rounded standalone module.

Micro-credential information		
NFQ level (if applicable)	9	PG
ECTS	*Note: 5 ECTS: 100–125 hrs student effort (PG: 1 ECT: 25 hrs student effort)* 10	
School (owner) and discipline	School of Engineering, Discipline of Electronic and Electrical Engineering	
MC Coordinator (name) *(Must be academic / teaching staff)*	Professor Harun Siljak	
State other Schools/external organisations involved in the delivery of the micro-credential (if applicable)	n/a	
Industry/profession	**Specify the industry/profession targeted by the micro-credential:** Mechanical engineers, electronic engineers, process/control engineers, embedded systems professionals.	

	What market need is addressed by the micro-credential: 99% of all microprocessors in the world are put inside embedded systems; cyber-physical systems address the challenge of interaction between various embedded systems; complex communications, computation, and cooperation networks they form in industry, homes, transportation etc. CPS are emerging as an area of engineering with significant economic and societal implications. It includes emerging new technologies such as the Internet of Things (IoT), industrial systems, and limitless "smart" technologies, including smart cars, homes, appliances. Major industrial sectors such as transportation, medicine, energy, defence, and information technology increasingly need a workforce capable of designing and engineering products and services that intimately combine cyber elements (computing hardware and software) and physical components and manage their interactions and impact on the physical environment. **State the industry/employer-related skills addressed by the micro-credential:** The skills acquired through completion of the MC include: • Complex problem solving • Technology design • Technology usage control The knowledge of design, control, and application of cyber-physical systems is an essential skill for Industry 4.0 and the emerging Industry 5.0, where large, distributed industrial cyber-physical systems interact with humans in different contexts. The nuanced approach of complex problem solving is needed for contextualisation, as well as ensuring that the control and communication loops are designed according to industry standards, and easily used by the involved personnel. **How will the delivery of this micro-credential facilitate industry/professional staff participation (flexible delivery – online/blended/face-to-face – evenings/weekends etc)?** The lectures will be delivered live, with real-time streaming and recordings available for later viewing, i.e. blended delivery. Timetables will be prepared with consideration of students' potential professional engagement, and laboratory access times (live or online) will be adjusted accordingly.
Teaching staff & if appropriate institutional/industry affiliation	Name all teaching staff involved and if external, the name of the organisation. Professor Harun Siljak (Discipline of Electronic and Electrical Engineering)
Min./max. number of students	Min. number of students: 0 (Module is to be co-streamed with non-MC students.)

<table>
<tr><td></td><td colspan="3">Max. number of students: 5</td></tr>
<tr><td>Mode of delivery</td><td colspan="3">Blended

Any further details:

This micro-credential can be offered fully online if COVID restrictions deem it necessary.</td></tr>
<tr><td>MC entry & admission requirements/pre-requisites (if applicable)</td><td colspan="3">Level 8 degree. 2.1 grade in Engineering or cognate discipline.</td></tr>
<tr><td>Proposed commencement date</td><td colspan="3">September 2021</td></tr>
<tr><td>Micro-credential frequency, duration and term</td><td>Frequency of delivery during the academic year:

Once per academic year</td><td>Duration of the MC (e.g. 6 weeks). If block delivery applies provide details:

Semester 1 – 12 weeks</td><td>Indicate term(s):

Michaelmas ☒

Hilary ☐

Trinity ☐</td></tr>
<tr><td>Contact and independent study hours (include total)</td><td colspan="3">(1 ECTS = 25 hrs) Note: contact hours also relate to online delivery.

Contact hours: 66

Independent study hours: 120

Continuous assessment hours: 44 hours

Summative assessment hours: 20</td></tr>
<tr><td>Micro-credential aims</td><td colspan="3">The key objectives are as follows:
• To introduce students to the design concepts in CPS
• To review fundamentals of discrete and continuous systems
• To give students experience in frameworks for CPS including actuators and software systems
To allow students to understand the ethical dimension including safety and reliability in the design of CPS.</td></tr>
<tr><td>Micro-credential learning outcomes (approx. 5)</td><td colspan="3">Resources: Academic Practice and QQI

Note: Learning outcomes should stem from and align with the MC aims and start with an explicit and assessable verb.

On successful completion of this micro-credential, learners will be able to:

MLO14.1 Formally describe and design cyber-physical systems
MLO14.2 Make appropriate sensory, actuatory and computational choices for cyber-physical systems in a given context</td></tr>
</table>

	MLO14.3 Write specifications of cyber-physical systems and required tests for them **MLO14.4** Verify a cyber-physical system's performance **MLO14.5** Design distributed and networked control schemes for cyber-physical systems and write software for their implementation **MLO14.6** Apply machine learning techniques to problems of sensing and control **MLO14.7** Coordinate heterogeneous teams of cyber-physical systems **MLO14.8** Critically assess cyber-physical systems in terms of security and ethics
MC content areas. *(Bullet points can be used)* If the MC (or components) will be delivered in a blended format, identify the content that will be delivered online.	A cyber physical system expresses the synergy between physical components (mechanisms) and software that controls them. They adapt to changes in their mission and environment, aim to be autonomous, and are designed as networks of interacting elements. This MC on cyber-physical systems and control brings together the knowledge of communications networks and self-organisation on one side, and control, robotics, and computing on the other. Alongside technical aspects of CPS, attention is given to questions of safety, economy, and ethics. In the MC, students learn to write software and select hardware for mobile autonomous CPS: as a platform of choice we use a light-weight, simple unmanned aerial vehicle (UAV). Design of such a system brings together multiple disciplines relevant to engineering: software architecture from computer science, dynamics and mechanics from physics, as well as control-theoretic and communications engineering knowledge. The power of autonomy in cyber-physical systems is harnessed by cooperative, networked, distributed systems with many agents: Students will learn how to build these systems to be robust and reliable. Through formal models and theory of verification and validation, we make sure the individual agents perform their duty, and observe them in performing a joint mission.
Teaching and Learning Methods (state pedagogical approach). Include the online environment (s) to deliver the MC e.g. Blackboard/Zoom, if appropriate.	Resources: Academic Practice 66 contact hours : Scheduled hybrid lectures (synchronous online and in-situ f/f) 22 hours, Tutorials/Labs (f/f in-situ as appropriate) 44 hours. Please note that at Level 9 Tutorials and Labs are interchangeable since students exercise theory by actually doing design. Independent student reading/Reflection using asynchronous materials in VLE 120 hours, Continuous assessment 44 hours, Summative assessment 20 hours
MC assessment components *Please include the following…* *How will the module/MC be assessed?*	This MC is assessed through 60 % Continuous Assessment and 40% Final Examination. There will be assignments to be assessed every 2 weeks in the semester. Assignments are varied and guidance on word count is not used. The teaching strategy includes elements of Mastery Learning, mixed with Flipped Classroom. The security and ethics topics will be the main focus of the flipped classroom.

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<tr>
<td>Indicate the LO assessed for each assessment (e.g. LO1 etc.)

Indicate the % of overall mark each assessment is worth.

Indicate if summative/formative (e.g. essay/research paper)</td>
<td>
<table>
<tr><td>Assessment mode</td><td>Assessment</td><td>LOs addressed</td><td>% weight</td><td>Due Date</td></tr>
<tr><td>CA</td><td>Labs + assignments</td><td>2,4,7,3,5,6</td><td>60</td><td>-</td></tr>
<tr><td>Exam</td><td>examination</td><td>1,2,3,8,6</td><td>40</td><td>End of Michaelmas term</td></tr>
</table>
</td>
</tr>
<tr><td>State how the MC will be reassessed if failed</td><td>100% examination</td></tr>
<tr><td>Pass standard & any special requirements for passing the MC</td><td>Resources: Calendar II and Calendar III

50% pass mark</td></tr>
<tr><td>Penalties for late submission</td><td>We do not have formal regulations on this. No marks are awarded if deadlines are not met.</td></tr>
<tr><td>Core reading (if applicable)</td><td>Students are expected to refer to current literature.</td></tr>
<tr><td>Are there subject experts in other Schools/disciplines?</td><td>No

If yes, name of School and discipline Click or tap here to enter text.

Has the MC been discussed with the School/discipline and DUTL/DTLP? Choose Yes/No</td></tr>
<tr><td>Proposed student fee</td><td>External student fee €2,000</td></tr>
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Faculty Dean and School Executive Approval:

Date of approval of the proposed micro-credential by the School Executive: 13th April 2021

Date of approval of financial information by Faculty Dean: 12th May 2021

Signed by Head of School: Henry Rice Faculty Dean

Date: 13/04/2021 Date: 12/05/2021