Module Descriptor

Title	Software Engineering for Autonomous Drones and Systems		
Session	2024/25	**Status**	Published
Code	COMP11132	**SCQF Level**	11
Credit Points	20	**ECTS (European Credit Transfer Scheme)**	10
School	**Computing, Engineering and Physical Sciences**		
Module Co-ordinator	J Riordan		

Summary of Module

This module explores the design and implementation of autonomous software systems for drones, focusing on drone hardware architectures, flight control systems, and programming frameworks. Students will gain hands-on experience through lab exercises, developing embedded systems, integrating sensors, and building autonomous solutions. The group project emphasises collaboration, where students will design and present a custom autonomous software solution. Through practical engagement and teamwork, students will develop critical skills in autonomous software engineering, advanced programming, system evaluation, and effective communication of technical concepts.

The module will cover:

- Autonomous drone systems and hardware architectures
- Flight control systems and stability algorithms
- Sensor integration with embedded systems (LiDAR, cameras, IMUs)
- Software frameworks for autonomous systems (ROS2)
- Real-Time Operating Systems (RTOS) and task management
- Communication protocols and data management in autonomous systems
- Software testing, debugging, and system reliability
- Cybersecurity in autonomous systems (secure communication protocols, encryption)
- Performance evaluation metrics for autonomous systems
- Software lifecycle management and version control
- Ethical considerations in autonomous systems

This module will work to develop a number of the key 'I am UWS' Graduate Attributes to make those who complete this module:

Universal

- Critical Thinker: Students will develop the ability to critically evaluate and synthesise complex information related to autonomous drone systems, enabling them to solve intricate engineering problems and innovate within the field.

- Collaborative: Given the nature of lab assignments and project work, students will work in teams, fostering collaboration and the sharing of diverse expertise to solve technical challenges.

Work-Ready

- Digitally Literate: The module heavily involves programming and the use of advanced software tools.
- Problem-Solver: The focus on real-world applications ensures that students enhance their problem-solving skills.

Successful

- Autonomous: Through independent lab assignments, students will demonstrate autonomy in managing their work.
- Innovative: The module encourages creativity and innovation in software engineering.

Module Delivery Method	**On-Campus**[1] ☒	**Hybrid**[2] ☒	**Online**[3] ☐	**Work -Based Learning**[4] ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☒ Lanarkshire ☐ London ☐ Paisley	☒ Online / Distance Learning ☐ Other (specify)	

Terms for Module Delivery	Term 1	☐	Term 2	☒	Term 3	☐
Long-thin Delivery over more than one Term	Term 1 – Term 2	☐	Term 2 – Term 3	☐	Term 3 – Term 1	☐

Learning Outcomes	
L1	Demonstrate a comprehensive understanding of the principles and practices of autonomous software engineering.
L2	Apply advanced programming skills to develop autonomous software systems
L3	Critically evaluate and improve autonomous software solutions based on performance metrics.
L4	Communicate technical information effectively, both in written and verbal formats.
L5	Independently design and implement autonomous software systems, demonstrating initiative and accountability.

[1] Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

[2] The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

[3] Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

[4] Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	**During completion of this module, there will be an opportunity to achieve core skills in:**
Knowledge and Understanding (K and U)	**SCQF 11** Demonstrate an in-depth understanding of the principles and theories underpinning autonomous systems, including robotics programming, software frameworks, and simulation techniques. Systems Integration and Architecture: Critically analyse the architecture of autonomous systems, including the integration of hardware and software components, communication protocols, and data management strategies.
Practice: Applied Knowledge and Understanding	**SCQF 11** Apply advanced robotics programming techniques to design and implement software for drone simulation and real-world application, ensuring reliable and efficient autonomous operations. Develop robust digital interfaces and interactions between various hardware and software units of drones, including sensors, controllers, and communication modules, ensuring seamless integration and operation. Create and deploy software solutions to manage autonomous drone flights and gather custom data, utilising techniques in data acquisition, processing, and real-time decision-making. Design and implement integrated embedded systems, ground control stations, and mobile applications to automate and control drone mission sequences, focusing on optimising system performance and reliability.
Generic Cognitive skills	**SCQF 11** Demonstrate the ability to solve complex engineering problems related to autonomous drone systems, including the design of algorithms for navigation, obstacle avoidance, and data fusion. Critically evaluate existing technologies and methodologies in autonomous software engineering, synthesising new approaches to enhance system capabilities and performance
Communication, ICT and Numeracy Skills	**SCQF 11** Effectively communicate technical information and project outcomes related to autonomous drone systems, including software architecture, design decisions, and testing results, using appropriate technical documentation and presentation formats. Demonstrate proficiency in using advanced programming languages and simulation tools for autonomous systems, including proficiency in languages like Python and platforms such as ROS (Robot Operating System).
Autonomy, Accountability	**SCQF 11** Manage and lead independent projects related to the development and deployment of autonomous software for drones, demonstrating

and Working with Others	initiative and accountability in all phases from planning to execution and evaluation.

Prerequisites	**Module Code**	**Module Title**
	Other	
Co-requisites	**Module Code**	**Module Title**

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture / Core Content Delivery	24
Laboratory / Practical Demonstration / Workshop	24
Asynchronous Class Activity	24
Independent Study	128
Please select	
Please select	
TOTAL	200

Indicative Resources

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:

Study materials will be provided on AULA. Additional Online Resources and Tutorials

1. ROS Official Documentation
   - Website: http://wiki.ros.org/
2. PX4 Autopilot Documentation
   - Website: https://docs.px4.io/
3. Dronecode Foundation
   - Website: https://www.dronecode.org/
4. GitHub Repositories
   - PX4 Autopilot: https://github.com/PX4/PX4-Autopilot
   - ROS2 Examples: https://github.com/ros2/examples
   - MAVLink Protocol: https://github.com/mavlink/mavlink
5. Gazebo Simulator

o Website: http://gazebosim.org/

6. Arduino Documentation and Tutorials

o Website: https://www.arduino.cc/

7. DJI Developer Technologies

o Website: https://developer.dji.com/

Selected Texts:

Designing data-intensive applications : the big ideas behind reliable, scalable, and maintainable systems, Martin Kleppmann (2018)

Publisher: O'Reilly Media, ISBN-10. 1449373321 · ISBN-13. 978-1449373320

Pragmatic Programmer, The: Your journey to mastery, 20th Anniversary Edition.Publisher : Addison-Wesley Professional; 2nd edition (2 Dec. 2019)

ISBN-10 : 0135957052

ISBN-13 : 978-0135957059

Clean Architecture: A Craftsman's Guide to Software Structure and Design: A Craftsman's Guide to Software Structure and Design (Robert C. Martin Series), Addison-Wesley; 1st edition (17 Sept. 2017)

ISBN-10 : 0134494164

ISBN-13 : 978-0134494166

(N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the Student Attendance and Engagement Procedure, Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

For the purposes of this module, academic engagement equates to the following:

Attending all timetabled synchronous classes and engagement with asynchronous learning activities and resources.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.

Aligned with the overall commitment to equality and diversity stated in the Programme Specifications, the module supports equality of opportunity for students from all backgrounds and with different learning needs. Using our VLE, learning materials will be presented electronically in formats that allow flexible access and manipulation of content (part-time and distant learning students should check with their programme leader for any

queries). The module complies with University regulations and guidance on inclusive learning and teaching practice. Specialist assistive equipment, support provision and adjustments to assessment practice will be made in accordance with UWS policy and regulations.
(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	**Computing**
Overall Assessment Results	☐ **Pass / Fail** ☒ **Graded**
Module Eligible for Compensation	☐ **Yes** ☐ **No** **If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.**
School Assessment Board	Business and Applied Computing
Moderator	tbc
External Examiner	tbc
Accreditation Details	
Module Appears in CPD catalogue	☐ **Yes** ☐ **No**
Changes / Version Number	1.0

Assessment (also refer to Assessment Outcomes Grids below)
Assessment 1
Lab Assignments (30%) A series of lab exercises designed to give students hands-on experience with drone hardware architectures, flight control systems, and autonomous systems programming. Lab tasks will include building and deploying embedded systems, integrating sensors, and developing communication systems. Students will submit reports that document their work throughout the labs. Learning Outcomes Assessed: LO1: Demonstrate a comprehensive understanding of the principles and practices of autonomous software engineering. LO2: Apply advanced programming skills to develop autonomous software systems. LO3: Critically evaluate and improve autonomous software solutions based on performance metrics.
Assessment 2
Assessment 2: Group Project (70%) A group project where students collaboratively design and implement a custom software solution for autonomous drones. This could involve the development of a drone mission automation system or a data management application. Deliverables include a project report, source code, presentation, and demonstration of the system. Learning Outcomes Assessed:

LO1: Demonstrate a comprehensive understanding of the principles and practices of autonomous software engineering. LO3: Critically evaluate and improve autonomous software solutions based on performance metrics. LO4: Communicate technical information effectively both in written and verbal formats. LO5: Independently design and implement autonomous software systems demonstrating initiative and accountability.
Assessment 3
(N.B. (i) Assessment Outcomes Grids for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An indicative schedule listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Component 1							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Lab Assignments	☒	☒	☒	☐	☐	30	2

Component 2							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Group Project	☒	☐	☒	☒	☒	70	2

Component 3							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
	☐	☐	☐	☐	☐		
Combined total for all components						100%	4 hours

Change Control

What	**When**	**Who**