ERASMUS MUNDUS JOINT MSC IN ADVANCED SYSTEMS DEPENDABILITY (DEPEND)

THEMES & MODULES[i]

THEMES

- **Theme 1: Rigorous Software Development (RSD**)

  Learning outcomes: on completion of this theme, students will have gained skills and experience in the application of rigorous software development techniques to the production of highly dependable software systems. Students will be prepared to apply their learning to analyse, design, model, implement, and test software, applying domain-specific technologies in internet/web-based systems, databases, and cryptography, and based on an understanding of the fundamental principles of computation and object-orientation, in the research and development of highly dependable software systems.

- **Theme 2: Software Engineering (SE)**

  Learning outcomes: on completion of this theme, students will have gained skills and experience in the application of general software engineering principles and practice, software architecture, and critical systems engineering. Students will be prepared to apply their learning in the research and development of highly dependable software systems.

- **Theme 3: Artificial Intelligence (AI)**

  Learning outcomes: on completion of this theme, students will have gained skills and experience in the application of this key, state-of-the-art topic in the field of dependable software. Students will be prepared to apply their learning into artificial intelligence in the

research and development of software systems that use AI to achieve high levels of dependability in poorly specified or highly changeable environments.

- **Theme 4: Data Science (DS)**

  Learning outcomes: on completion of this theme, students will have gained skills and experience in data-intensive systems, data mining, knowledge discovery, machine learning and data ethics as applicable to dependable software systems. Students will be prepared to apply their learning in the research and development of highly dependable, data-intensive software systems.

- **Theme 5: Formal methods for dependability (FSD)**

  Learning outcomes: on completion of this theme, students will have gained skills and experience in the key, state-of-the-art fields of the application of formal methods to the analysis, design, development, and proof of software-based systems, with additional knowledge of the application of formal methods to data engineering, protocols, and cryptography along with supplementary skills in professional development.

- **Theme 6: Research and Experiential Learning (REL)**

  Learning outcomes: on completion of this theme, students will have gained skills and experience in planning and executing research projects, and in working in and industrial or professional research environment. Students will be prepared to apply their learning in a work environment: be it in academic research, in industrial research, or an industrial development environment, producing advances in dependability of products with a high degree of dependability.

COURSE STRUCTURE

- Maynooth University: RSD, REL
  - 1st Year (60 ECTS)
    - Students take 6 taught modules, and complete a project/dissertation, over two semesters.
  - 2nd Year (60 ECTS)
    - Option 1: Students take 4 taught modules in semester 1 including a Minor Dissertation, and complete a 6-month industrial work placement in semester 2. Students must have achieved a minimum of 70% (common grading scheme) in their first year of studies to avail of this option.
    - Option 2: Students take 6 taught modules, and complete a project/dissertation, over two semesters
- University of St. Andrews: SE, AI, DS, REL
  - 1st Year (60 ECTS)
    - Students take 5 taught modules, and complete a project/dissertation, over two semesters
  - 2nd Year (60 ECTS)
    - Option 1: Students take 4 taught modules in semester 1, and do a placement (research or industrial via the EngD placement programme) in semester 2. Students must have achieved a minimum of 70% (common grading scheme) in their first year of studies to avail of this option.
    - Option 2: Students take 5 taught modules, and a project/dissertation over two semesters
- Université de Lorraine: FSD, REL (*Note: all material taught through English)*
  - 1st Year (60 ECTS)
    - Students take 15 taught modules and participate in the UL research internship programme producing a research dissertation
  - 2nd Year (60 ECTS)
    - Students take 15 taught modules and participate in the UL research internship programme producing a research dissertation

MODULES

Maynooth University

Maynooth, Co. Kildare, IRELAND

Joint Module Code	Local Module Code	Short Title	60 ECTS
Core Modules (all must be taken)			
EMJM1	CS603	Rigorous Software Process	7.5 ECTS
EMJM2	CS607	Requirements & Design[1]	7.5 ECTS
EMJM3	CS608	Software Testing	7.5 ECTS
EMJM4	CS629	Directed Reading (not available in the 2nd year if CS631 the work placement is taken)	2.5 ECTS
Common Modules (only available if not previously taken, allocated by the consortium)			
EMJC1		Joint Programme Activities (new)	0 ECTS
EMJC2	CS613	Advanced Concepts in Object-Oriented Programming (compulsory)	7.5 ECTS
EMJC10	CS650	1st year summer school	0 ECTS
EMJC11	CS655	2nd year summer school	0 ECTS
Specialisation Modules (RSD)			
EMJM10	CS605	Mathematics of Computer Science	7.5 ECTS
EMJM11	CS616	Cryptography	7.5 ECTS
EMJM13	CS619	Program Comprehension	7.5 ECTS
EMJM14	CS615	Internet Solutions	7.5 ECTS
EMJM15	CS621B	Databases	7.5 ECTS
EMJM16	CS656	Minor Dissertation (new module)	7.5 ECTS
EMJM17	CS610	Interaction Design	7.5 ECTS
Research and Experiential Learning Modules (REL) all must be taken unless annotated otherwise			
EMJM50	CS631	Industrial Work Placement[2]	30 ECTS
EMJM51	CS646	Project & Dissertation	20 ECTS

[1] This module is not available in Year 2 if students did CS5030 at UStA in Year 1.

[2] Optional. Available in Year 2 (Semester 4) only. Assessment does not count towards final mark: students must submit a satisfactory report.

University of St. Andrews

St. Andrews, Scotland, UNITED KINGDOM

Joint Module Code	Local Module Code	MU Registration Code	Short Title	60 ECTS
Core Modules (all must be taken)				
None.				
Common Modules (only available if not previously taken, allocated by the consortium)				
EMJC1		CS6001X	Joint Programme Activities (new)	0 ECTS
EMJC2	CS5001	CS6002X	Object-Oriented Modelling, Design and Implementation (compulsory)	7.5 ECTS
EMJC10		CS6003X	1st year summer school	0 ECTS
EMJC11		CS6004X	2nd year summer school	0 ECTS
Specialisation Modules (SE) (at least 2 must be taken)				
EMJS10	CS5030	CS6005X	Software Engineering Principles[3]	7.5 ECTS
EMJS11	CS5031	CS6006X	Software Engineering Practice	7.5 ECTS
EMJS12	CS5033	CS6007X	Software Architecture	7.5 ECTS
EMJS13	CS5032	CS6008X	Critical Systems Engineering	7.5 ECTS
Specialisation Modules (AI) (at least 2 must be taken)				
EMJS21	CS5010	CS6009X	Artificial Intelligence Principles	7.5 ECTS
EMJS22	CS5011	CS6010X	Artificial Intelligence Practice	7.5 ECTS
EMJS23	CS5012	CS6011X	Language and Computation	7.5 ECTS
Specialisation Modules (DS) (at least 2 and never both ID5059 & CS5014)				
EMJS31	CS5052	CS6012X	Data-Intensive Systems	7.5 ECTS
EMJS32	ID5059 OR CS5014	CS6013X CS6022X	Knowledge Discovery and Data Mining Machine Learning	7.5 ECTS
	CS5055	CS6023X	Data Ethics and Privacy	7.5 ECTS
Optional Modules (remaining credits from)				
EMJS1	CS4052	CS6014X	Logic and Software Verification	7.5 ECTS
	CS4402	CS6024X	Constraint Programming	7.5 ECTS

[3] This module is not available in Year 2 if students did CS607 at MU in Year 1.

EMJS3	CS5041	CS6015X	Interactive Software and Hardware	7.5 ECTS
EMJS4	CS5044	CS6016X	Information Visualisation and Visual Analytics	7.5 ECTS
EMJS5	CS5020	CS6017X	Principles in Computer Communication Systems	7.5 ECTS
EMJS6	CS5022	CS6018X	Practice in Computer Communication Systems	7.5 ECTS
EMJS7	CS4204	CS6019X	Concurrency and Multi-Core Architecture	7.5 ECTS
Research and Experiential Learning Modules (REL)(at most one of the following)				
EMJS50	CS5899	CS6020X	Project & Dissertation	22.5 ECTS
EMJS51	CS5898	CS6021X	Special Project[4]	30 ECTS

[4] Optional. Year 2 only. Research placement or industrial placement.

Université de Lorraine

Nancy, Lorraine, FRANCE

Joint Module Code	Local Module Code	MU Registration Code	Short Title	60 ECTS
Core Modules (all must be taken)				
EMJL1		CS6030X	Advanced Software Engineering	2 ECTS
EMJL2		CS6031X	Non-classical Logics and Proofs	2 ECTS
EMJL3		CS6032X	Software Modelling	2 ECTS
EMJL4		CS6033X	Proofs of Programs	2 ECTS
EMJL5		CS6034X	Algorithmic Verification	2 ECTS
EMJL6		CS6035X	Project Management	2 ECTS
EMJL7		CS6036X	Integration of methods and tools (Project)	2 ECTS
Common Modules (only available if not previously taken, allocated by the consortium)				
EMJC1		CS6037X	Joint Programme Activities (new)	0 ECTS
EMJC10		CS6038X	1st year summer school	0 ECTS
EMJC11		CS6039X	2nd year summer school	0 ECTS
Specialisation Modules (FSD) - six must be chosen				
EMJL20		CS6040X	Proofs of Programs - Advanced Methods	2 ECTS
EMJL21		CS6041X	Semantics, Proofs and Types	2 ECTS
EMJL22		CS6042X	Decision Procedures for Program Verification	2 ECTS
EMJL23		CS6043X	Rewriting for Programming and Proving	2 ECTS
EMJL24		CS6O44X	Data Engineering and Knowledge extraction	2 ECTS
EMJL5		CS6045X	Security of Protocols	2 ECTS
EMJL26		CS6046X	Advanced Cryptography	2 ECTS
EMJL27		CS6047X	Models of Computation	2 ECTS
EMJL28		CS6048X	Option (from another Master programme)	2 ECTS
EMJL29		CS6049X	Professional module	2 ECTS
EMJL30		CS6050X	Language Module: French	2 ECTS
Research and Experiential Learning Modules (REL) all must be taken unless annotated otherwise				
EMJL51		CS6051X	Internship - Research project (Semester 2)	30 ECTS

[i] We have done our best to ensure the accuracy of the information shown here, but we accept no responsibility or liability for any incorrect material.