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International Master of Science on Cyber Physical Systems

Evaluation of existing courses and identification of needed courses D1.1

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Contact Person	Isam Ishaq	Organisation	AQU
Phone	+970 592 907 989	E-Mail	isam@itce.alquds.edu
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Contributors

Name	Organization
Isam Ishaq	AQU
Rashid Jayousi	AQU
Salah Odeh	AQU
Ala' Khalifeh	GJU
Dhiah Aboutair	GJU
Sahel Alouneh	GJU
Zaid Halhouli	TTU

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Table of Contents

1 Introduction

This deliverable reports on the systematic review of existing computer science master courses, along with information on the structure of the programs, possible standards and guidelines. Every partner analysed the status quo (existing materials, materials used in courses, existing environment, skills, but also development perspectives and expectations). A common analysis and requirements report for creation/adaptation of courses is presented.

1.1 Scope

The scope of this deliverable is the existing master programs curricula in partner countries. This deliverable explores these programs in order to find related modules to the Cyber Physical Systems Program (CPSP). The deliverable will also help the partners to identify the core course structure, capacity needed and modules of the intended program.

1.2 Relation to deliverables

This deliverable will act as the first milestone for WP1 that is concerned in outlining the framework for potential courses for the intended CPSP. This will serve as a starting point for identifying the courses to be used in conjunction with the finding of the next deliverable that identifies market needs for such program.

1.3 Relation to work packages

This deliverable will act as a milestone for WP2 that is concerned in the development of the program structure and modules. This deliverable will outline the initial requirements and the basis of the CPSP.

1.4 Terminology

CPSP: Cyber Physical System Program

IoT: Internet of Things

Modules/courses: These are used interchangeably to indicate a unit of the program to be implemented.

Partner Countries: Countries where the program to be implemented (Palestine, Tunisia, Jordan)

Program Countries: EU partners (Germany, Sweden, UK)

Program: The master program (CPSP) to be implemented

2 Methodology

In order to explore the existing computer science programs that are related to the CPSP, two surveys were designed (see Annex 1 and Annex 3). These surveys were analysed and compared with existing CPSP programs in different countries.

As a result of the analysis, main potential courses for the program to be proposed. Such list of courses will be refined after discussion and review by all partners. This will be concluded with a list of the core courses and structure of the intended program.

3 Survey Analysis

In this section we provide an overview of the survey that was conducted and present its findings and results.

3.1 Survey Overview

The purpose of the survey that can be seen in Annex 1 is to help to identify the potential courses and the program structure in every partner country where the program to be implemented. The survey contains four sections; Potential courses, market requirement, courses and staff expertise, and program structure and future prospective. The first section contains two parts; part one contains a list of courses that are related to CPSP, partners are asked to indicate if such courses exist in one of the programs offered in their perspective country and state whether expertise for such courses exist to teach such course; the second part contains a table to be filled by partners to add potential courses that do not exist in the first part.

The second section is intended for the market analysis; this will be used in deliverable D1.2. The third section is intended for the third deliverable D1.3.

All partners were asked to fill an additional table for similar programs around the world. This is to be used to learn more about CPSP that exists in other countries and be able to learn from such programs.

3.2 Survey Results

In this subsection we summarize the results of the survey filled by each partner country, actual filled surveys can be found in the subdirectory "Similar-Programmes-Survey" under documents of workpackage1 folder in the shared workspace for the MSCP project.

We also look at the similar programs and the courses taught for such programs and propose the list of commonly recommended courses.

3.2.1 Jordan

The two partner universities in Jordan filled the survey. Looking at the filled surveys, we found that the following courses exist in Jordan:

Topics in Embedded Software and Systems, Digital Systems Architecture, Advanced Real-Time Systems, Network Security, Microcontrollers, Control Systems I, Control Systems II, Linear Control Theory, Adaptive Control, Non-linear Control Theory, Intelligent Systems and Robotics Transportation System Design, Traffic Engineering, Computer Graphics, Digital Image Processing and Analysis, Advanced Computer Graphics, Computer Vision, Advanced Topics in Computer Science {Advanced Visual Computing}, Computer Systems Security, Topics in Computer Science {Advanced Computer Security}, Computer Networks, Computer Controlled Systems.

And the suggested extra courses are as follows:

The Internet of things, Wireless sensor networks, Cloud and fog computing, Big Data, Vehicular communications, mobile and ubiquitous computing.

3.2.2 Palestine

The two partner universities in Palestine filled the survey. Looking at the filled surveys, we found that the following courses exist in Palestine:

Control Systems I, Control Systems II, Linear Control Theory, Adaptive Control, Non-linear Control Theory, Robotics, Intelligent Systems and Robotics, Introduction to Robotics, Project Management and Leadership, Computer Graphics, Digital Image Processing and Analysis, Computer Systems Security, Computer Networks, Introduction to Robotic Systems, Computer Controlled Systems, Nonlinear Control Systems, Introduction to Machine Learning and Applications, Modelling and Control of Power Electronics and Electric Vehicle Powertrains, Introduction to Machine Learning and Applications.

And the suggested extra courses are as follows:

Cloud Computing, Data Analytics, and Internet of Things.

3.2.3 Tunisia

The two partner universities in Tunisia filled the survey. Looking at the filled surveys, we found that the following courses exist in Tunisia:

Introduction to Cyber-Physical Systems, Discrete-Event Systems: Supervisory Control and Diagnosis, - Foundations of Hybrid and Embedded Systems, Topics in Embedded Software and Systems, Model-Integrated Computing, Systems Theory, Cyber-Physical Systems, Digital Systems Architecture, Advanced Real-Time Systems, Engineering Design of CPS, Data Analytics for Engineers, Probabilistic Methods in Engineering Design, Engineering Design Optimization, Uncertainty Quantification, Design of Electromechanical Systems, Dependable and Trustworthy CPS, Reliability and Risk Case Study, Risk and Decision Analysis, Network Security, Automated Verification, System-Level Fault Diagnosis, Embedded Systems, Microcontrollers, Embedded Systems, Control Engineering, Control Systems I, Control Systems II, Linear Control Theory, Adaptive Control, Non-linear Control Theory, Robotics, Intelligent Systems and Robotics, Introduction to Robotics, Robot Manipulators, Transportation Engineering, Transportation System Design, Traffic Engineering, Biomedical Engineering, Principles and Applications of BioMEMS, Therapeutic Bioengineering, Advanced Computational Modelling and Analysis, Smart Health Technology, Quantitative Methods, Project Management and Leadership, Engineering Leadership, Biomedical Instrumentation, Introduction to Machine Learning and Applications, Computer Graphics, Digital Image Processing and Analysis, Advanced Computer Graphics, Topcics in Computer Science {3D Graphical and Geometric Modelling}, Introduction to Micro and Nano Electromechanical Systems, Smart Sensor Technology I: Design, Machine Learning, Computer Vision, Advanced Topics in Computer Science {Advanced Visual Computing}, Smart Sensor Technology II: Characterization and Fabrication, Biomedical Microsystems, Computer Systems Security, Computational Modelling of Comple Systems, Special Topics in Computer Science {Cyber Security Practice}, Real-Time and Embedded Operating Systems, Topics in Computer Science {Embedded Networking}, Topics in Computer Science {Advanced Computer Security}, Embedded System Design, Computer Networks, Advanced Computer Security, Advanced Topics in Computer Science {Embedded Wireless Networking for Cyber-Physical Systems}, Real-Time Scheduling for Cyber-Physical Systems, Special

Topics in Electrical and Computer Engineering II {Information Theory and Reliable Communication}, :Special Topics in Electrical and Computer Engineering II {Microwave Engineering}, {Mied-Signal and RF Integrated Circuits}, Introduction to Robotic Systems, Computer Controlled Systems, Control systems II, Medical Robotics and Systems, Nonlinear Control Systems, Control of Discrete Event Systems, Dynamic Systems and Optimal Control, Special Topics in Civil Engineering/Special Topics in Civil Engineering II {Intelligent Transportation Systems}, duction to Machine Learning and Applications, Advanced Topics in Computer Science {Embedded Wireless Networking for Cyber-Physical Systems}, Introduction to Machine Learning and Applications, Modelling and Control of Power Electronics and Electric Vehicle Powertrains, Electrical Energy System Engineering, Machine Learning, Operation and Control of Modern Power Systems, Biomedical Instrumentation, Introduction to Machine Learning and Applications, Introduction to Micro and Nano Electromechanical Systems, Smart Sensor Technology I: Design, Smart Sensor Technology II: Characterization and Fabrication, Medical Robotics and Systems,

And the suggested extra courses are as follows:

Internet of Things, and Arduino Programming.

3.2.4 International

The program countries partners pointed to a number of similar MSCP programs that are found internationally. The list of programs are shown in the following table:

University Name	Country	Program Title	Web Page
University of Oxford	UK	Cyber Physical Systems	https://www.cs.ox.ac.uk/research/cyberphysical/
MINES Saint- Étienne	France	Cyber-Physical and Social Systems	https://www.emse.fr/~picard/cours/cps2/
Deggendorf Institute of Technology	Germany	Mechatronic and Cyber-Physical Systems	https://www.th-deg.de/en/tc-cham- en/courses/master-mechatronic-and-cyber- physical-systems
Hochschule Emden/Leer - University of Applied Sciences	Germany	Industrial Informatics - Specialisation Industrial Cyber- Physical Systems	https://www.hs-emden- leer.de/studieren/studienangebot/alle- studiengaenge/industrial-informatics/
Università della Svizzera italiana	Switzerla nd	Cyber-Physical and Embedded Systems (MCPES)	https://www.usi.ch/en/mcpes
Vanderbilt School of Engineering	USA	Cyber-Physical Systems	https://engineering.vanderbilt.edu/academics/m _eng/CPS/index.php

Table 1: International MSCP programs

University of California	USA	Embedded And Cyber-physical Systems	https://mecps.uci.edu/
University Registrar	USA	EMBEDDED CYBER PHYSICAL SYSTEMS	https://www.reg.uci.edu/fees/2018- 2019/embeddedsystems.html
University of Warwick	UK	Cyber-Physical Systems	https://warwick.ac.uk/fac/sci/wmg/education/w mgmasters/structure/modules/cps
ITMO University	Russia	Control of Cyber- Physical Systems	http://en.itmo.ru/en/viewjep/2/69/Control_of_C yber-Physical_Systems.htm
HSE Tikhonov Moscow Institute of Electronics and Mathematics (MIEM HSE)	Russia	Internet of Things and Cyber- physical Systems	https://www.hse.ru/en/ma/internet/about/

4 Analysis and Conclusion

After reviewing the input of all partner countries and comparing it with the existing programmes world wide, the findings were summarised in table 2. In the first three columns, the courses taught at the international programmes, and the rest of the columns identify the existence of the courses in these programmes in partner countries seeking to implement similar programmes.

Table 2: Summary of serving existing international MCSP and existing courses at partner countries.

University	Vanderbilt University	University of Lyon	Università della Svizzera italiana	University	of Siegen	Al-Quds University	Jordan University of Science and Technology	Ger Jorda Univ		all univ	versities
Country	USA	France	Italy	Gerr	many	Palestine	Jordan	Jor	dan	Tu	nis
Program name	Master of Engineering Degree Program in Cyber-Physical	Master Program on Cyber-Physical and Social Systems (CPS2)	Master in Cyber- Physical and Embedded Systems			Electronics and Computer Engineering					
Program Level	MA	MA	MA	BA	MA	MA	BA	BA	MA	BA	MA
Required Credit Hours / ETCS	30 CH	Two years, 2 semesters each year (121 ECTS)	Two years, 2 semesters each year (120 ECTS)			36 CH					
Courses											
Cyber-Physical Systems	Required			x							
Embedded Systems	Elective		Required	x				х	x	x	
Embedded System Modeling and Design				x	x						<u> </u>
Foundations of Hybrid and Embedded Systems	Required			x							
Intelligent Systems and Robotics	Elective	M1 (Theoretical)			x	х		х		x	
Machine Learning			Elective		x	х					x
Engineering Leadership and Program Management	Elective	M1 (Intrnational project Management)	Required								
Advanced Real-Time Systems	Deguired		Deguired								
Sensors, Actuators and Sensor Networks	Required		Required	x	x x				х	х	
Cloud Computing		M2 (Cyber)		x	~						
Mobile Computing		M2 (Cyber and Physical)	Required	Â							
Internet of Things		M2 (Physical)									
Security & Privacy in CPS	Elective	Two courses (Security M1 Socail and Cyber, M2 Trust and Privacy)	Required	x	x						
System-Level Fault Diagnosis	Elective										х
Reliability and Risk Analysis	Elective			х							х
Probabilistic Methods in Engineering Design	Elective										
Uncertainty Quantification	Elective										
Discrete-Event Systems: Supervisory Control and Diagnosis	Required			x							x
Optimization and Operational Research		M1 (Theoretical)									
Advanced Modeling and Simulation		M1 (Theoretical)		х	x						
Data Analytics for Engineers	Elective	M1 (Theoretical)		х	x						
Advanced Computational Modeling and Analysis		M1 (Theoretical) (Complexity)		x	x						
Reprogrammable Systems			Elective								
Advanced Algorithmics and Programming		M1 (Theoretical)									
Multi-Agent Programming		M2 (Theoretical)									
Validation and Verification	Elective										
Software Engineering				x	x	х			L	L	<u> </u>
Specification Languages	<u> </u>			ļ	ļ						<u> </u>
Systems Theory	Required								ļ		x
Microcontrollers	Elective			x				x		x	
Control Systems for Cyber-physical Systems	Elective										
Control Theory	Elective			x	x	x	х	х	ļ		x
Smart Health Technology				x	ļ						┝───
Transportation System Design	Elective		Deer las d	x			x	х	ļ		<u> </u>
Nanosystems: Devices and Design	Poquinad		Required	x							├───
Digital Systems Architecture Virtual Reality/Augmented Reality	Required			x							┝───
Virtual Reality/Augmented Reality		M1 (Socail)				x			ł		├
		M2 (Cyber and									<u> </u>
Semantic Web		Physical)									

After analysing table 2, and comparing the different international programs with what is offered at the program and partner countries, the following list of courses is proposed, this list are divided into two lists: Core courses (Table 3) and elective courses (Table 4).

Core Courses				
1	Internet of Things			
2	Embedded Systems			
3	Intelligent Systems and Robotics			
4	Real-Time Systems			
5	Cloud Computing and Semantic Web			
6	Security & Privacy in CPS			
7	Data Analytics for Engineers			
8	Multiagent Systems			
9	Ubiquitous Computing			
10	Knowledge Management			
11	Image Processing			
12	Optimization			

Table 3: Initial list of proposed core courses

Table 4: Initial list of proposed elective courses

	Elective Courses					
1	Sensors, Actuators and Sensor Networks					
2	Mobile Computing					
3	Reliability and Risk Analysis					
4	Advanced Computational Modelling and Analysis					
5	Systems Theory					
6	Microelectronics					
7	Microcontrollers					
8	Control Systems for Cyber-physical Systems					
9	Control Theory					
10	Smart Health Technology					
11	Transportation System Design					
12	Nano Systems: Devices and Design					
13	Heterogeneous Multicore Architectures					
14	Digital Systems Architecture					
15	Virtual Reality/Augmented Reality					

The above proposed courses is an initial list of courses that will be reviewed by partners and will be tuned and adjusted to the context of each partner country where the program to be implemented.

It is suggested that the elective courses can be parcelled into groups that form a track of specialisation if needed.

Annex 1: Survey

This survey is intended to guide us in the program design, it contains four sections:

- 1- Potential courses
- 2- Market requirement
- 3- Courses and Staff Expertise
- 4- Programme Structure and Future Prospective

Please fill these parts of the survey according to you knowledge and experience.

Thank you for your help and cooperation.

A- Potential Courses

Please cite if any of this courses taught in your univ	Leve	l of ses	Academic staff expertise existence		
	Yes	NO	BA	MA	Yes NO
Introduction to Cyber-Physical Systems					
Discrete-Event Systems: Supervisory Control and					
Diagnosis					
- Foundations of Hybrid and Embedded Systems					
Topics in Embedded Software and Systems					
Model-Integrated Computing					
Systems Theory					
Cyber-Physical Systems					
Digital Systems Architecture					
Advanced Real-Time Systems					
Engineering Design of CPS					
Data Analytics for Engineers					
Probabilistic Methods in Engineering Design					
Engineering Design Optimization					
Uncertainty Quantification					
Design of Electromechanical Systems					
Dependable and Trustworthy CPS					
Reliability and Risk Case Study					
Risk and Decision Analysis					
Network Security					
Automated Verification					
System-Level Fault Diagnosis					
Embedded Systems					
Microcontrollers					
Embedded Systems					
Control Engineering					
Control Systems I					
Control Systems II					
Linear Control Theory					
Adaptive Control					
Non-linear Control Theory					
Robotics					
Intelligent Systems and Robotics					
Introduction to Robotics					
Robot Manipulators					

Transportation Engineering		
Transportation System Design Traffic Engineering		
Biomedical Engineering		
Principles and Applications of BioMEMS		
Therapeutic Bioengineering Advanced Computational Modeling and Analysis		
Smart Health Technology		
Quantitative Methods		
Project Management and Leadership		
Engineering Leadership		
Biomedical Instrumentation		
Introduction to Machine Learning and Applications		
Computer Graphics		
Digital Image Processing and Analysis		
Advanced Computer Graphics		
Topcics in Computer Science {3D Graphical and Geometric Modeling}		
Introduction to Micro and Nano Electromechanical Systems		
Smart Sensor Technology I: Design		
Machine Learning		
Computer Vision		
Advanced Topics in Computer Science {Advanced Visual Computing}		
Smart Sensor Technology II: Characterization and Fabrication		
Biomedical Microsystems		
Computer Systems Security		
Computational Modeling of Complex Systems		
Special Topics in Computer Science {Cyber Security Practice}		
Real-Time and Embedded Operating Systems		
Topics in Computer Science {Embedded Networking}		
Topics in Computer Science {Advanced Computer Security}		
Embedded System Design		
Computer Networks		
Advanced Computer Security		

Please suggest other curses that are not mention add rows if needed.	Level of courses		Academic staff expertise existence		
	Yes	NO	BA	MA	Yes NO

A-2 : Please write non mentioned courses that can be related to the proposed Master:

B: Market Requirement:

1- Based on the program description in your opinion how attractive would the MA Degree program be to prospective students?

2- In your opinion how many students do you expect that will attend CPS MA program?

3- Do you think there is a demand to CPS MA at national level or region?

4- What industries in your country for CPS and related skills?

- 5- Please write top titles of jobs required CPS and related skills in your region:
- 6- What Possible/ present day specialized skills for CPS program graduates?

C- Courses and Staff Expertise

1- In your opinion which courses in your university needs to develop to align the requirement of MA CPS program?

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2- What capacity building skills your staff needs to meet the requirements of the CPS MA program.(Training needs of existing staff in the organizations towards MA CPS)

3-Training needs of existing staff in the organizations towards M.Sc in CPS.

D- Programme Structure and Future Prospective

if you are specialist in the proposed domain please answer these questions

1. Need for and Job requirements of new M.Sc. of CPS

2. Experience of hiring Staff with M.Sc. of CPS

3. Training needs of existing staff in the organizations towards M.Sc. of CPS

4. Requirement of M.Sc. of CPS graduates for employment in the coming five years.

5. Major skills the graduates are expected to have when they complete the M.Sc. of CPS

6. Program structure for M.Sc. of CPS

7. Courses requirements for the M.Sc. of CPS program

8. Requirements of additional managerial and technical skill

9. Length (Duration) of the M.Sc. degree program in CPS

10. Option and justification for online learning mode

11. Emerging or new topics to be addressed at the M.Sc. of CPS.

12. Problem areas/challenges that need to be addressed through research endeavors at M.Sc. CPS

13. Interpersonal/community engagement skills training may be required by the graduates.

14. Additional training to be introduced in the training to produce graduates that are desired by Employers.

15. Professionals/industries that should be involved in the design and future revision of courses in the proposed M.Sc. of CPS

16. Ways in which organizations might support employees registered for the M.Sc. of CPS.

17. Additional remark forwarded in relation to the proposed M.Sc. of CP

Annex 2: Detailed Results

These can be found in the subdirectory of Similar-Programs under the document folder in workpackage1 folder in the shared workspace for the MSCP project

A2.1 Jordan

TTU Survey

This survey is intended to guide us in the program design, it contains four sections:

- 1- Potential courses
- 2- Market requirement
- 3- Courses and Staff Expertise
- 4- Programme Structure and Future Prospective

Please fill these parts of the survey according to you knowledge and experience. Thank you for your help and cooperation.

A- Potential Courses

Please cite if any of this courses taught in your university			Level of courses		Academic staff expertise existence	
	Yes	NO	BA	MA	Yes NO	
Introduction to Cyber-Physical Systems		х				
Discrete-Event Systems: Supervisory Control and		x				
Diagnosis						
- Foundations of Hybrid and Embedded Systems		x				
Topics in Embedded Software and Systems		х				
Model-Integrated Computing		x			Yes	
Systems Theory		x				
Cyber-Physical Systems		х				
Digital Systems Architecture		х				
Advanced Real-Time Systems		x				
Engineering Design of CPS						
Data Analytics for Engineers	1	x	l —			
Probabilistic Methods in Engineering Design	1	x	<u> </u>			
Engineering Design Optimization		X	<u> </u>			
Uncertainty Quantification		x	<u> </u>			
Design of Electromechanical Systems		x				
Dependable and Trustworthy CPS		~				
A V						
Reliability and Risk Case Study		x				
Risk and Decision Analysis	x	x				
Network Security			х		Yes	
Automated Verification		х				
System-Level Fault Diagnosis		x				
Embedded Systems						
Microcontrollers		x				
Embedded Systems		x				
Control Engineering		~				
		<u> </u>				
Control Systems I	х		х			
Control Systems II	x		x			
Linear Control Theory	х		x		Yes	
Adaptive Control	х		х		Yes	
Non-linear Control Theory Robotics	х		х		Yes	
KODOUCS						
Intelligent Systems and Robotics		x				
Introduction to Robotics	1	x				
Robot Manipulators	1	x				
Transportation Engineering	1	1				
Transportation System Decim					Vas	
Transportation System Design	x x	L	x		Yes	
Traffic Engineering Biomedical Engineering		I	х		Yes	
0 0	1	I				
Principles and Applications of BioMEMS	1	x				
Therapeutic Bioengineering	1	x				
Advanced Computational Modeling and Analysis	1	x				
Smart Health Technology	1	x				
Smart Health Teenhology						

GJU Survey

This survey is intended to guide us in the program design, it contains four sections:

- 1- Potential courses
- 2- Market requirement
- **3-** Courses and Staff Expertise
- 4- Programme Structure and Future Prospective

Please fill these parts of the survey according to you knowledge and experience. Thank you for your help and cooperation.

A- Potential Courses

YesNOBAMAYesNOIntroduction to Cyber-Physical SystemsxxxxDiscrete-Event Systems: Supervisory Control and Dignosisxxxx-Foundations of Hybrid and Embedded SystemsxxxxTopics in Embedded Software and SystemsxxxxModel-Integrated ComputingxxxxxSystems TheoryxxxxxxCyber-Physical SystemsxxxxxxAdvanced Real-Time SystemsxxxxxxEngineering Design of CPSxxxxxxData Analytics for EngineersxxxxxxProbabilistic Methods in Engineering DesignxxxxxDegendable and Trustworthy CPSxxxxxReliability and Risk Case StudyxxxxxRisk and Decision AnalysisxxxxxSystem-Level Fault DiagnosisxxxxxEmbedded SystemsxxxxxControl Systems IIxxxxxIntenzerontrollersxxxxxEmbedded Systems IIxxxxxControl Systems IIxxxyesNon-linear Control Theo	Please cite if any of this courses taught in your univ	Leve	ses	Academic staff expertise existence		
Discrete-Event Systems: Supervisory Control and Diagnosis x x - Foundations of Hybrid and Embedded Systems x x Model-Integrated Computing x Yes Systems Theory x Yes Cyber-Physical Systems x Yes Digital Systems Architecture x X Advanced Real-Time Systems x X Engineering Design of CPS X X Data Analytics for Engineers x X Probabilistic Methods in Engineering Design x X Engineering Design of CPS X X Uncertainty Quantification x X X Uncertainty Quantification x X X Reliability and Risk Case Study x X X Risk and Decision Analysis x X X System-Level Fault Diagnosis x X X Embedded Systems X X X Control Systems I X X X Control Systems II X X X Intelligent System Architectin </td <td></td> <td>Yes</td> <td>NO</td> <td>BA</td> <td>MA</td> <td>Yes NO</td>		Yes	NO	BA	MA	Yes NO
Diagnosisvv- Foundations of Hybrid and Embedded Systemsx			х			
- Foundations of Hybrid and Embedded Systems x x Topics in Embedded Software and Systems x x Model-Integrated Computing x Yes Systems Theory x x x Digital Systems Architecture x x x Advanced Real-Time Systems x x x Probabilistic Methods in Engineering Design of CPS x x x Data Analytics for Engineering Design of Design Optimization x x x Design of Electromechanical Systems x x x x Dependable and Trustworthy CPS x x x x x Reliability and Risk Case Study x x x Yes Automated Verification x x x Yes Automated Verification x x x x System-Level Fault Diagnosis x x x x Embedded Systems x x x x Control Systems I x x x x Control Systems II x			х			
Topics in Embedded Software and SystemsxYesModel-Integrated ComputingxYesSystems TheoryxYesCyber-Physical SystemsxImage: Comparison of CPSDigital Systems ArchitecturexImage: Comparison of CPSAdvanced Real-Time SystemsxImage: Comparison of CPSData Analytics for EngineersxImage: Comparison of CPSData Analytics for EngineersxImage: Comparison of CPSData Analytics for Engineering DesignxImage: Comparison of CPSData Analytics for Engineering DesignxImage: Comparison of CPSData Analytics for Engineering DesignxImage: Comparison of CPSDesign of Electromechanical SystemsxImage: Comparison of CPSDesign of Electromechanical SystemsxImage: Comparison of CPSReliability and Risk Case StudyxXImage: Comparison of CPSReliability and Risk Case StudyxXImage: Comparison of CPSRetwork SecurityxxXImage: Comparison of CPSAutomated VerificationxxImage: Comparison of CPSSystems IxXImage: Comparison of CPSControl Systems IxxImage: Comparison of CPSIntelligent Systems and RoboticsxImage: Comparison of CPSIntelligent Systems and RoboticsxImage: Comparison of CPSIntelligent Systems and RoboticsxImage: Comparison of CPSTransportation EngineeringxXTra	- Foundations of Hybrid and Embedded Systems		x			
Model-Integrated ComputingxYesSystems TheoryxxCyber-Physical SystemsxxDigital Systems ArchitecturexxAdvanced Real-Time SystemsxxEngineering Design of CPSxxData Analytics for EngineersxxProbabilistic Methods in Engineering DesignxxIngineering Design OptimizationxxDesign of Electromechanical SystemsxxDependable and Trustworthy CPSxxReliability and Risk Case StudyxxNetwork SecurityxxAutomated VerificationxxSystem-Level Fault DiagnosisxxEmbedded SystemsxxMicrocontrollersxxEmbedded Systems IxxControl Systems IxxControl Systems IIxxInteract Control TheoryxxRoboticsxxIntelligent Systems and RoboticsxxIntelligent System Sate MobilesxxIntelligent System Control TheoryxxXYesMobilesxxIntelligent System Sate MobilesxIntelligent System Sate Mobilesx <td>Topics in Embedded Software and Systems</td> <td></td> <td>х</td> <td></td> <td></td> <td></td>	Topics in Embedded Software and Systems		х			
Systems TheoryxxCyber-Physical Systemsx	Model-Integrated Computing		х			Yes
Digital Systems Architecture x x Advanced Real-Time Systems x x Engineering Design of CPS x x Data Analytics for Engineers x x Probabilistic Methods in Engineering Design x x Engineering Design Optimization x x Uncertainty Quantification x x Design of Electromechanical Systems x x Dependable and Trustworthy CPS x x Reliability and Risk Case Study x x Network Security x x Yes Automated Verification x x Yes Microcontrollers x x X Embedded Systems x x Yes Control Systems I x x X Linear Control Theory x x Yes Non-linear Control Theory x x Yes Robotics x X Yes Non-linear Control Theory x x Yes Robotics x X X	Systems Theory		x			
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Data Analytics for EngineersxxProbabilistic Methods in Engineering Designx	Advanced Real-Time Systems		x			
Probabilistic Methods in Engineering DesignxxEngineering Design Optimizationx	Engineering Design of CPS					
Engineering Design OptimizationxxUncertainty Quantificationx						
Uncertainty QuantificationxxDesign of Electromechanical Systemsx	Probabilistic Methods in Engineering Design					
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Therapeutic Bioengineering x Advanced Computational Modeling and Analysis x Smart Health Technology x			v			
Advanced Computational Modeling and Analysis x Smart Health Technology x						
Smart Health Technology x						
	Ouantitative Methods		x			

A2.2 Palestine

This survey is intended to guide us in the program design, it contains four sections:

- 1- Potential courses
- 2- Market requirement
- 3- Courses and Staff Expertise
- 4- Programme Structure and Future Prospective

Please fill these parts of the survey according to you knowledge and experience. Thank you for your help and cooperation.

A- Potential Courses

Please cite if any of this courses taught in your uni	Leve		Academic staff expertise existence		
	Yes	NO	BA	MA	Yes NO
Introduction to Cyber-Physical Systems		х			
Discrete-Event Systems: Supervisory Control and		x			
Diagnosis					
- Foundations of Hybrid and Embedded Systems		х			
Topics in Embedded Software and Systems		х			
Model-Integrated Computing		x			Yes
Systems Theory Cyber-Physical Systems		x			
Cyber-Physical Systems		х			
Digital Systems Architecture		х			
Advanced Real-Time Systems		x			
Engineering Design of CPS					
Data Analytics for Engineers	+	x	<u> </u>	<u> </u>	
Probabilistic Methods in Engineering Design	+	X	<u> </u>		
Engineering Design Optimization	+	X			
Uncertainty Quantification	-	x			
Design of Electromechanical Systems	+	x			
Dependable and Trustworthy CPS		Α			
Reliability and Risk Case Study		x			
Risk and Decision Analysis		x			
Network Security	х		х		Yes
Automated Verification		x			
System-Level Fault Diagnosis		x			
Émbedded Systems					
Microcontrollers		х			
Embedded Systems		х			
Control Engineering					
Control Systems I	x		x		
Control Systems II	х		х		
Linear Control Theory	х		х		Yes
Adaptive Control	х		х		Yes
Non-linear Control Theory	х		х		Yes
Robotics					
Intelligent Systems and Robotics		х			
Introduction to Robotics		х			
Robot Manipulators		х			
Transportation Engineering					
Transportation System Design	х		х		Yes
Traffic Engineering	х		х		Yes
Biomedical Engineering					
Principles and Applications of BioMEMS		х			
Therapeutic Bioengineering		х			
Advanced Computational Modeling and Analysis		х			
Smart Health Technology		х			
Quantitative Methods		х			

A2.3 Tunisia

This survey is intended to guide us in the program design, it contains four sections:

- 1- Potential courses
- 2- Market requirement
- 3- Courses and Staff Expertise
- 4- Programme Structure and Future Prospective

Please fill these parts of the survey according to you knowledge and experience. Thank you for your help and cooperation.

A- Potential Courses

Please cite if any of this courses taught in your university				l of ses	Academic staff expertise existence	
	Yes	NO	BA	MA	Yes NO	
Introduction to Cyber-Physical Systems		x				
Discrete-Event Systems: Supervisory Control and		x				
Diagnosis						
- Foundations of Hybrid and Embedded Systems		x				
Topics in Embedded Software and Systems		x				
Model-Integrated Computing		x			Yes	
Systems Theory		x				
Cyber-Physical Systems		x				
Digital Systems Architecture		x				
Advanced Real-Time Systems		х				
Engineering Design of CPS						
Data Analytics for Engineers		x				
Probabilistic Methods in Engineering Design		х				
Engineering Design Optimization		х				
Uncertainty Quantification		х				
Design of Electromechanical Systems		х				
Dependable and Trustworthy CPS						
Reliability and Risk Case Study		х				
Risk and Decision Analysis		x				
Network Security	х		х		Yes	
Automated Verification		х				
System-Level Fault Diagnosis		х				
Embedded Systems						
Microcontrollers		х				
Embedded Systems		х				
Control Engineering						
Control Systems I	x		х			
Control Systems II	х		х			
Linear Control Theory	х		х		Yes	
Adaptive Control	х		х		Yes	
Non-linear Control Theory	x		х		Yes	
Robotics						
Intelligent Systems and Robotics		х				
Introduction to Robotics		х				
Robot Manipulators		х				
Transportation Engineering						
Transportation System Design	х		х		Yes	
Traffic Engineering	x		х		Yes	
Biomedical Engineering						
Principles and Applications of BioMEMS		х				
Therapeutic Bioengineering		х				
Advanced Computational Modeling and Analysis		х				
Smart Health Technology		х				
Ouantitative Methods		x				

Annex 3: Similar Programmes

This is a screen shot for similar programmes in Jordan, the actual list for all partners can be found in the subdirectory of Similar-Programs under the document folder in workpackage1 folder in the shared workspace for the MSCP project.

Wor	kpackage	1		Similar-Pro	grams		🖋 Edit Workbook 🔻	🖨 Print	🗙 Exit	Shar
	А	В	С	D	E	F		G		
1	ID 👻	University name	Responsible Part	City 🖵	Country -	Title of the similar program	Webpage			~
2	JO001	Balqa Applied University- Ajloun College	πυ	Ajloun	Jordan	n.a.				
3	JO002	Ajloun National University	πυ	Ajloun	Jordan	n.a.				
4	JO003	Al-Ahliyya Amman University	ττυ	Amman	Jordan	n.a.				
5	JO004	Al-Isra University	πυ	Amman	Jordan	n.a.				
6	JO005	Al-Zaytoonah University of Jordan	TTU	Amman	Jordan	n.a.				
7	JO006	Amman Arab University	ττυ	Amman	Jordan	n.a.				
8	JO007	Applied Science Private University	TTU	Amman	Jordan	n.a.				
9	JO008	Arab Academy for Banking and Financial Sciences	ττυ	Amman	Jordan	Closed				
10	JO009	Arab Open University	TTU	Amman	Jordan	n.a.				
11	JO010	Columbia University: Amman Branch	ττυ	Amman	Jordan	n.a.				
12	JO011	German-Jordanian University: Jabal-Amman Branch	ττυ	Amman	Jordan	n.a.				
13		German-Jordanian University: Almushaqar campus/Main Campus	ττυ	Madaba		n.a.				
14	JO013	Jordan Academy for Maritime Studies	TTU	Amman		n.a.				
15		Jordan Academy of Music	πυ	Amman		n.a.				
16		Jordan Institute of Banking Studies	πυ	Amman	Jordan	n.a.	-			
17	JO016	Jordan Media Institute	ττυ	Amman	Jordan	n.a.				
18	JO017	Middle East University	πυ	Amman		n.a.				
19	JO018	Petra University	ττυ	Amman		n.a.				
20	JO019	Philadelphia University	ττυ	Amman		n.a.				
21	JO020	Princess Sumaya University for Technology	πυ	Amman		n.a.				
22	JO021	Queen Noor Civil Aviation Technical College	πυ	Amman		n.a.				
23	JO022	Tafila Technical University	πυ		Jordan	n.a.				
24	JO023	The World Islamic Science & Education University (W.I.S.E)	πυ	Amman		n.a.				
25	JO024	University of Jordan	ττυ	Amman		n.a.				
26	JO025	Aqaba University of Technology (2011)	πυ	Aqaba		n.a.				
27	JO026	Institute of Banking Studies: Aqaba Branch	ττυ	Aqaba		n.a.				
28	JO027	Aqaba Campus of the University of Jordan	πυ		Jordan	n.a.				
20	0028	Ralna Annlied I Iniversity (Salt)	тти	Anaha	lordan	na				

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