EIT Digital Master School

Cyber Security

What can I study at the entry and exit points?

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ENTRY - 1ST YEAR, COMMON COURSES 2

Babeș-Bolyai University (UBB), Romania **2**

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Entry - 1st year, common courses

Babeș-Bolyai University (UBB), Romania

Visit:

- University homepage
- Programme homepage

Contact: Dr. Darius Bufnea: darius.bufnea@ubbcluj.ro, cyber-master@cs.ubbcluj.ro

LIST OF COURSES

FIRST SEMESTER		
Compulsory courses	Cryptography	7 ECTS
	Security Audit and Risk Management	6 ECTS
	Computer Ethics and Academic Integrity	4 ECTS
I&E compulsory course	Digital Economy Principles - I&E basics	8 ECTS
I&E elective courses	Agile Project Management	5 ECTS
	Strategic Business Process Automation	5 ECTS
SECOND SEMESTER		
Compulsory courses	Web and Internet Security	6 ECTS
	Quality Aspects of Security in Software Testing	6 ECTS
I&E compulsory courses	Innovation Management - I&E Business Dev Lab	7 ECTS
	(Thematic Project with Innovation Challenge) EIT Summer School - Offered by EIT	4 ECTS
Elective courses	Network Security and Administration	7 ECTS
	Blockchain Security	7 ECTS
	Complex Networks in Security	7 ECTS

Eötvös Loránd University (ELTE), Hungary

Visit:

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- Visit programme homepage

Contact: Dr. Peter Burcsi; bupe@inf.elte.hu

FIRST SEMESTER

Compulsory courses

- Research methodology - 5 ECTS
- Introduction to Computer Security - 6 ECTS
- Cryptography - 5 ECTS

I&E

- I&E Basics - 6 ECTS
- Business Development Lab I. - 4 ECTS

SECOND SEMESTER

Compulsory courses

- Design and analysis of algorithms - 4 ECTS
- Network and system security - 6 ECTS
- Information security and privacy - 6 ECTS
- Advanced software technology - 4 ECTS

I&E

- Business Development Lab II. - 4 ECTS
- Innosocial aspects of the entrepreneurship - 6 ECTS

University of Rennes 1 (UR1), France

Visit:

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- Visit programme homepage

Contact: Pierre-Alain Fouque, pierre-alain.fouque@univ-rennes1.fr

LIST OF COURSES:

FIRST SEMESTER

Compulsory courses

- Introduction to Security (semester 1 - 5 ECTS)
- Software engineering and Security (semester 1 - 5 ECTS)
- Operating Systems and Security (semester 1 - 5 ECTS)
- Network Security (semester 1 - 5 ECTS)

Elective courses
I&E

- Introduction to Innovation and Business (semester 1 - 5 ECTS)
- Knowledge and intangible assets management (semester 2 - 5 ECTS)
- Business Development Laboratory 1 semester 1 - 5 ECTS)

SECOND SEMESTER

Compulsory courses

- Algorithmics for security (semester 2 - 5 ECTS)
- Privacy (semester 2 - 5 ECTS)
- System Security (semester 2 - 5 ECTS)
- Software Security (semester 2 - 5 ECTS)

Elective courses

I&E

- Business Development Laboratory 2 (semester 2 - 5 ECTS)
- (EIT Digital summer school, offered by EIT 4 ECTS)

University of Trento (UniTN), Italy

Visit:

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Contacts: Prof. Fabio Massacci; fabio.massacci@unitn.it, Bruno Crispo; bruno.crispo@unitn.it

LIST OF COURSES:

Compulsory courses:

- Introduction to Computer and Network Security - 6 ECTS
- Cryptography - 6 ECTS
- Software Security Testing - 6 ECTS
- Cyber Security Risk Assessment - 6 ECTS
- Network Security - 6 ECTS
- Privacy and IPR - 6 ECTS

Advanced and Eligible Courses:

- Machine Learning - 6 ECTS
- Data Hiding - 6 ECTS
- Formal Techniques for Crypto Protocol Analysis - 6 ECTS
- Laboratory on Offensive Technologies - 12 ECTS
- Finite Fields and Symmetric Cryptography - 6 ECTS
- Distributed Systems 2 - 6 ECTS

Innovation and Entrepreneurship Courses:

- Innovation and Entrepreneurship Basics (Economics and Management) - 6 ECTS
- Business Development Lab - 9 ECTS
- ICT Innovation - Product Design and Development - 6-9 ECTS
- I&E Studies - 6 ECTS

University of Turku (UTU), Finland

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Contact: **Dr Seppo Virtanen** (seppo.virtanen@utu.fi)

Compulsory courses

- System and Application Security - 5 ECTS
- Network Infrastructure Technologies and Security - 5 ECTS
- Human Element in Information Security - 5 ECTS
- Management of Information System Security and IT Service Continuity - 6 ECTS
- Foundations of Cryptography - 5 ECTS
- Cryptography I - 5 ECTS

I&E

- Introduction to Innovation and Business - 5 ECTS
- Business Development Laboratory - 7 ECTS
- Enterprise Architecture - 6 ECTS
- Business Management of Startups - 3 ECTS
- (EIT Digital summer school, offered by EIT) - (4 ECTS)

Elective courses

- Selected together with student from available courses during personal study planning.

University of Twente (UT), The Netherlands

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LIST OF COURSES:

FIRST SEMESTER

Compulsory major courses (15 ECTS)

Code	Course name	Quarter	ECTS
201500026	CRM: Cyber Risk Management	Q1	5
201500027	Crp: Security and Cryptography	Q1	5
201600051	SoS: Software Security	Q2	5

Compulsory I&E courses (15 ECTS)

Code	Course name	Quarter	ECTS
201700180	[I&E] Basics: Innovation and Entrepreneurial Finance for EIT	Q1	5
201700119	[I&E] Business Development Lab I	Q2	5
191612680	[I&E] Computer Ethics	Q2	5

Optional courses

Code	Course name	Quarter	ECTS
201500028	EoS: Economics of Security	Q1	5
192140122	SyV: System Validation [only in comb. w/ SeV, if needed]	Q1	5

201600070	MaL: Basic Machine Learning [only in comb. w/ CDA, if needed]	Q1	5
201700019	[I&E] Brand Management	Q1	5
201800077	[I&E] Bioresource Business Development & Management	Q1	5
201500040	Bio: Introduction to Biometrics	Q2	5
201500041	CSM: Cyber Security Management	Q2	5
192130112	DiS: Distributed Systems [only in comb. w/ BCT, if needed]	Q2	5
201800079	[I&E] Bioresource Supply Chain Management	Q2	5

SECOND SEMESTER

Compulsory major courses (15 ECTS)

Code	Course name	Quarter	ECTS
201700074	InS: Internet Security	Q3	5
201500042	PET: Privacy-Enhancing Technologies	Q4	5
201700086	SyS: System Security	Q4	5

Compulsory I&E courses (5 ECTS)

Code	Course name	Quarter	ECTS
201700120	[I&E] Business Development Lab II	Q3	5

Optional courses

Code	Course name	Quarter	ECTS
201500036	STR: Software Testing and Reverse Engineering	Q3	5
201700079	BCT: Blockchain & Distr. Ledger Tech. [check w/ teacher if DiS req.]	Q3	5

201500039	SeV: Security Verification [check w/ teacher if SyV req.]	Q3 or Q4	5
201100022	CCS: Cyber Crime Science	Q3-Q4	5
201600155	[I&E] Global Strategy and Business Development	Q3	5
201500037	CDA: Cyber Data Analytics [check w/ teacher if MaL req.]	Q4	5
201500038	ELa: E-Law	Q4	5
201700083	SSI: Security Services for the Internet of Things	Q4	5
194105070	[I&E] Information Systems for the Financial Services Industry	Q4	5
201500008	[I&E] Empirical Methods for Designers	Q4	5

Exit - 2nd year, specialisation

Babeș-Bolyai University (UBB), Romania

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Contact: Dr. Darius Bufnea: darius.bufnea@ubbcluj.ro, cyber-master@cs.ubbcluj.ro

Specialisation: Software Security
The courses in the 2nd year will have a strong focus on knowledge about "***Software Security***", which is also the specialization of the exit year. Students will be able to take courses like: *Advanced Software Security*, *Securing Mobile Applications*, *Program Analysis for Software Security*, and *Cloud Application and Infrastructure Security*. These courses will address advanced topics such as: software quality models, security as a quality factor in software, security analysis and verification of software, design of security checking tools, cloud and mobile application security. The overall goal of this specialization is for students to understand and assess different software security issues, in order to learn how to detect security vulnerabilities as soon as possible in the development cycle and to develop a more secure software from design to implementation.

This master's programme offers a multiple perspective on the field of cyber security, addressing issues related to its various components: operating system security, network security, organization and business process security, and, of course, security of the software itself.

LIST OF COURSES

THIRD SEMESTER		
Compulsory courses	Advanced Software Security	6 ECTS
	Securing Mobile Applications	6 ECTS
	Program Analysis for Software Security	6 ECTS
	Cloud Application and Infrastructure Security	6 ECTS
I&E compulsory course	Entrepreneurship in IT - I&E Study	6 ECTS

FOURTH SEMESTER		
	Internship in Specialization	20 ECTS
	Project in Cybersecurity	6 ECTS
	Elaboration of the Dissertation Thesis	4 ECTS

The programme also has a strong emphasis on practical knowledge in the field of cyber security, the curricula being discussed with a number of companies that offer services and solutions in this field. Some of the students' activities, such as the internship or the thematic projects, can be carried out in partnership with the partner companies / industry in the field. The latter have a strong local presence, the city of Cluj-Napoca, Romania, being known as a strong development hub in the field of IT&C.

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Eötvös Loránd University (ELTE), Hungary

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Contact: Dr. Peter Burcsi; bupe@inf.elte.hu

Specialisation: Advanced Cryptography at Eötvös Loránd University (ELTE), Budapest, Hungary.

The specialisation focuses on the general ideas, techniques and methods of applied cryptography as well as on the theoretical background and solid knowledge, putting security in a wider context. Security and privacy are considered both from the technological and from the economical point of view, which supports decisions in many practical cases. Applied cryptography serves as a base for most of the secure IT-systems (e.g. in Future Media and Content Delivery, Smart Spaces, Digital cities, Health and ICT-Mediated Human Activity, and Enabling the Internet of the Future).

List of courses:

Compulsory courses

- Cyber security Lab I. - 4 ECTS
- Advanced cryptography - 6 ECTS
- Cryptographic protocols - 6 ECTS
- Provably secure modular design of cryptographic protocols - 6 ECTS
- Preparation course for master studies and developing learning skills - 2 ECTS. (It can be substituted with any other technical CSE course)

I&E

- I&E Study - 6 ECTS

Peter Burcsi is an associate professor, head of the Department of Computer Algebra at the Faculty of Informatics, ELTE - Eötvös Loránd University, Budapest. His research areas are algorithms in elementary number theory and cryptography. He has participated in several security-related research and industrial projects at ELTE.

University of Trento (UniTN), Italy

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Contacts: Prof. Fabio Massacci; fabio.massacci@unitn.it, Bruno Crispo; bruno.crispo@unitn.it

Specialisation: Applied Security

In recent years, the most popular computing and communications platforms have changed dramatically from old desktops and personal computers to a myriad of new devices, often embedded and personal. New devices used not only to navigate the web, send email and write document but rather to support pervasively most of the activity users perform during their everyday life. This revolution has touched private, business and governmental domains (e.g., industry 4.0, Internet of Things, critical infrastructures, smartphones, smart cities, etc.). This in turn has created entire new ecosystems that include technical, social and economic factors.

The specialisation Applied Security focuses on addressing security and privacy for these new ecosystems trying a holistic approach that does not focus only on technical issues. It covers the technological aspects such as investigating and experimenting new class of threats and vulnerabilities that apply to these new systems or designing user authentication mechanisms for devices were passwords cannot be an option. It also covers the economic aspects that are crucial to understand attackers, their motivations and the best defence strategy (i.e., When is worth patching a vulnerability? Which vulnerability is worth patching? Are economic-related questions rather than technical-related ones).

Specialisation courses:

- Multimedia Data Security (6 ECTS)
- Offensive Technologies (12 ECTS)
- Project course (6 ECTS)
- Research course (12 ECTS)
- Security Testing (6 ECTS)
- Distributed systems 2 (6 ECTS)

- Privacy and Intellectual Property Rights (6 ECTS)
- Machine Learning (6 ECTS)

Prof Dr Fabio Massacci received a M.Eng. in 1993 and PhD in Computer Science and Engineering at University of Rome La Sapienza in 1998. He visited Cambridge University in 1996-97 and was visiting researcher at IRIT Toulouse in 2000. He joined the University of Siena as assistant professor in 1999, and in 2001 he became a full professor at the University of Trento. His research interests are in security requirements engineering and verification and load-time security for mobile and embedded systems (Security-by-Contract). He co-founded the ESSOS with W. Jousen, Engineering Secure Software and Systems Symposium, which aims at bringing together requirements, software engineers and security experts. He was leading the Empirical Security Requirements and Risk Engineering Challenge (ERISE). He has been a scientific coordinator of multimillion-euro EU projects on security compliance, security engineering and secure evolution.

University of Twente (UT), The Netherlands

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Specialisation: High Tech, Human Touch

Although cryptography has been around for quite some time, emerging concepts such as "Bring Your Own Technology", the "Internet of Everything", or "Crypto Currencies", that increasingly exploit mobility and personalisation, put new requirements on security technologies; think about the e-cigarette USB-charger that infects a big corporation with malware. Today's high diversity of Internet-connected systems and services led to a substantial increase of (new) cyber-attacks in the past years.

Such Internet-connected systems can be found in almost every domain, including critical infrastructures (e.g., water supply), as well as in large-scale services (e.g., hospitals) and embedded systems (e.g., in-car control systems). Notably, many risks for such systems are not solely technical but use the human factor as a characteristic element (e.g., through social engineering).

Our specialisation looks at the many risks in the above-mentioned settings and provides mitigations that can be used at design time and at operation time, while taking into account the specific requirements of the various systems and the impact that risks might have. As a distinguishing element, we include the "human touch" in our attack analysis and mitigation techniques (e.g., replacing password-checks with biometric-verification or raising situational awareness to mitigate social engineering attacks).

Specialisation courses:

- Secure Data Management (5 EC)
- Secure Cloud Computing (5 EC)
- Cloud Networking (5 EC)
- Introduction to Biometrics (5 EC)
- Economics of Security (5 EC)

- Cyber Risk Management (5 EC)
- Cyber Security Management (5 EC)
- System Validation (5 EC)
- Basic Machine Learning (5 EC)
- Advanced Machine Learning (5 EC)
- Security Verification (5 EC)
- Governance of Cybersecurity (5 EC)
- Distributed Systems (5 EC)
- Internet of Things (5 EC)
- Fundamental of Quantum Information (4 EC)
- Quantum Cryptography (5 EC)
- Computer Ethics (5 EC)

The University of Twente (UT) holds the title of the most entrepreneurial university in Europe. As such, it has an extremely large network in industry that includes around 1000 university spin-offs (e.g., Booking.com was founded by a UT alumni). This provides excellent opportunities to connect to industry and access to a multitude of internship offers.

Contact

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EURECOM, France

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Specialisation: The specialisation Mobile and Cloud Security focuses on mobile systems and the security and privacy issues thereof, with a strong focus on android based smartphones and wireless protocols.

Semester 9 (30 ECTS)

UE Fundamentals EIT Digital Security [5 ECTS]

- BigSec - Security and privacy for Big Data and Cloud (2.5)
- MPC - Multipary Computation and Blockchains (2.5)
- MobiSec - Mobile Systems and Smartphone Security (5)

UE Electives EIT Digital Security [10 ECTS]

- Malis - Machine Learning and Intelligent System (5)
- Clouds - Distributed Systems and Cloud Computing (5)
- MobSys - Mobile communication systems (5)
- MobServ - Mobile application and services (5)

UE I & E [6 ECTS]

- Innovation and entrepreneurship EIT (external course)

UE Project [8 ECTS]

UE Languages [1 ECTS]

Master thesis (30 ECTS)

Prof. Philippe Benassi, bio: http://www.eurecom.fr/en/people/benassi-philippe
Dr. Antonio Faonio, bio: www.eurecom.fr/en/people/faonio-antonio

University of Turku, Finland

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Contact: **Dr Seppo Virtanen** (seppo.virtanen@utu.fi)

Specialisation: Security of Networked Systems

The specialisation Security of Networked Systems focuses on researching cyber security technologies for networked systems and applications of the communication-intensive future. The technological topics covered include system and network security, security of communication systems and applications, and designing secure systems.

The goal of this specialisation is to give its students profound and substantial education and expertise in the field.

Optional studies selected personally for each student build a special individual information security expertise profile. The curriculum consists of both theoretical and hands-on study modules. Also a large group project module called "Capstone project" can be included in the studies.

The graduates of this specialisation will have strong technological, theoretical and practical understanding in security of networked systems. With their new knowledge and skills the graduates can proceed to building a successful career in securing the information and communication technology in the industry.

List of courses:

Compulsory courses (15 ECTS):

- Firewall and IPS Technology (5 ECTS)
- Security Engineering (5 ECTS)
- Protocol Processing and Security (5 ECTS)

I&E:

- I & E Study (6 ECTS)

Elective courses:

- Communication Technologies and Security in IoT (5 ECTS)
- Capstone Project (10 ECTS)
- Cryptography 2 (5 ECTS)
- Algebraic Structures in Cryptography (5 ECTS)
- Privacy and Security for Software Systems (5 ECTS)
- Ethical Hacking (5 ECTS)
- Seminar 1 (TurkuSec meetings) (1-5 ECTS)
- In addition to the courses listed above, a variety of courses qualifying as elective studies are available annually. Electives are chosen individually for each student when their personal study plan is made.

Dr Seppo Virtanen is associate professor of cyber security engineering at University of Turku, Finland. He is the vice head of the Department of Computing. Dr Virtanen received his MSc degree in electronics and information technology in 1998 and DSc (Tech.) degree in Communication Systems in 2004 from the University of Turku. He serves regularly as a programme committee member and referee for international journals and conferences. Currently the focus in his research is on information security issues in the communication and network technology domain, specifically focusing on design and methodological aspects of reliable and secure communication systems and secure communication for IoT. He has acted as the supervisor or the examiner of 10 PhD theses, 135 Master's theses and 35 Bachelor's theses.

EIT Digital

We believe in making and shaping a competitive digital Europe that is inclusive, fair and sustainable and aim at global impact through European innovation fueled by entrepreneurial talent and digital technology.

We embody the future of innovation by mobilizing a pan-European multi-stakeholder open-innovation ecosystem of top European corporations, SMEs, startups, universities and research institutes, where students, researchers, engineers, business developers and investors address the technology, talent, skills, business and capital needs of digital entrepreneurship.

We build the next generation of digital ventures, digital products and services, and breed digital entrepreneurial talent, helping business We build the next generation of digital ventures, digital products and services, and breed digital entrepreneurial talent, helping business and entrepreneurs to be at the frontier of digital innovation by providing them with technology, talent, and growth support:

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