ΠΑΝΕΠΙΣΤΗΜΙΟ
ΠΕΛΟΠΟΝΝΗΣΟΥ

POLYTECHNIC SCHOOL

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Feasibility study for the organization and operation of a Postgraduate Program (MSc) of the Department of Electrical and Computer Engineering of the School of Engineering of the University of Peloponnese, on **"Technologies and Services of Intelligent Information and Communication Systems"** and specializations in:

(a) Intelligent Cyber Systems and Services,

(b) Advanced Educational Technologies, and

(c) Business Analytics and Data Science.

1. BRIEF DESCRIPTION OF PHYSICAL OBJECT

The proposed MSc aims to provide a high level of postgraduate education in the field of **"Technologies and Services of Intelligent Information and Communication Systems"** to graduates:

- Polytechnics, Polytechnic Schools, Schools of Science, Schools of Management and Economics of Universities in Greece or corresponding Departments abroad
- Departments of T.E.I. whose subject is related to the subject of Computer Science, Informatics, Electronics, Networks, Telecommunications, Management and Economics,

The Postgraduate Program Its object is the development of technologies, models and methods that refer to the efficient management and processing of large volumes of data, the extraction of knowledge and the assistance of decision-making in critical national/regional sectors and in particular in modern cyber systems, education and businesses – organizations. Emphasis is also placed on the familiarization and application of entrepreneurship and open innovation.

More specifically, the Postgraduate Program aims to develop, produce and transmit knowledge, know-how, methodologies, operational tools and research results in the individual scientific fields of the specializations:

(a) Intelligent Cyber Systems and Services

This field of expertise concerns the development of technologies, models and methods for cybersystems, which are a dynamic new generation of systems, which has emerged in recent years with the emergence of the Internet of Things. Cybersystems combine the technologies of embedded systems, communication networks and decision-making systems to monitor and support operations and actions that cover a large part of the requirements and modern applications. The specialization combines the scientific fields of embedded hardware systems and accelerators, mobile communication systems and networks, decision-making systems for monitoring and supporting operations and actions, information theory and signal processing.

(b) Advanced Educational Technologies

This field of expertise concerns the study of advanced educational technologies, such as personalized learning environments, the Bring Your Own Device model, the blended learning model, cloud computing learning services, the reverse classroom, gamification, 3D-educational worlds and mass open online courses. In addition, special emphasis will be placed on the development of methodologies for the utilization of educational data to support reception decisions in school education as well as in didactic and educational analytics to support teacher research. The specialization combines the scientific fields of informatics, cloud computing systems and services, educational technologies, artificial intelligence, machine learning and modern and efficient methods of knowledge mining.

(c) Business Analytics and Data Science

This subject concerns the development of technologies, models and methods that refer to the efficient management and processing of big data and the extraction of knowledge in order to support business decision-making. The specialization combines the scientific fields of machine learning, modern distributed high-volume data management and processing systems, business intelligence and modern and efficient methods of knowledge mining.

2. PURPOSE OF THE POSTGRADUATE PROGRAM

Digital technology has created a shift in the global economy, opening up new markets and changing the way organizations produce products and services. Digital skills (e-Skills) are key to boosting competitiveness, productivity and innovation, as well as the professionalism and employability of the workforce. National education policies usually focus on the acquisition of

basic IT skills and not on **specialized** or **entrepreneurial skills**[1], such as Internet of Things, Cloud Computing, etc. This creates a serious contradiction at European Union level, according to which unprecedentedly high unemployment rates affect Europe's young people compared to other developed economies and at the same time many jobs remain vacant at the 'level of digital skills'[2].

Official statistics show that the demand for ICT professionals in the European Union is growing at a rate of 4% per year and outstripping supply, leaving almost 1,000,000 jobs vacant by 2020. This serious weakness is due to the lack of relevant digital skills and can only be addressed if the education of young people as well as the retraining of ICT graduates is improved. The quality and specialization of digital skills must be increased to meet the needs of the labor market for **new professional qualifications**, such as specialists in Cloud Computing, Big Data Analytics, Machine Learning, etc., instead of traditional ICT jobs[3].

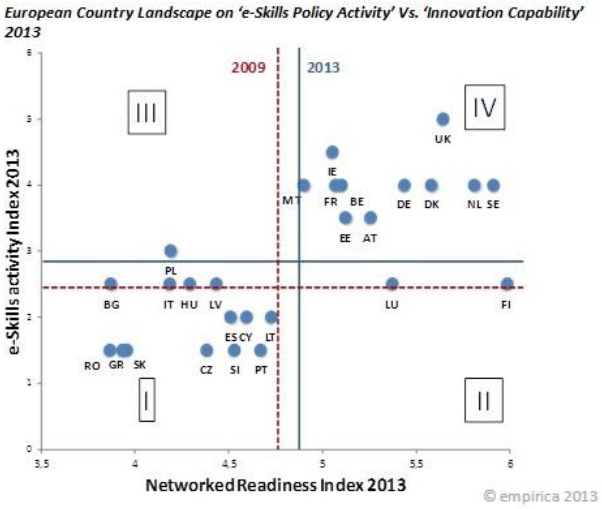

Figure 1. Digital as Skills and Innovation Integration Chart

Our country, in particular, lags significantly behind [4] the other members of the European Union in the field of digital skills and innovation (Figure 1) and at the same time has the lowest percentage of ICT professionals in terms of total employees, significantly lower than the EU-28 average (Figure

[1] M.Maryska, P.Doucek, R.Kunstova "The Importance of ICT Sector and ICT University Education for the Economic Development", in Proc. of International Conference on New Horizons in Education, 2012

[2] "The e-Skills Manifesto: With contributions from leading figures in government, education, policy, research and industry", European Schoolnet and DigitalEurope, part of the eSkills for Jobs 2016 campaign.

[3] "Information Technologies and Labour Market Disruptions: A Cross-Atlantic Dialogue" Background document from cross-sector roundtable, organized by the European Commission (DG Enterprise and Industry and DG Communication Networks, Content and Technology) in cooperation with TheConference Board and Cornell University ILR School, 03 Nov 2014.

[4] T. Hüsing, W. Korte, E Dashj "e-Skills in Europe: Trends and Forecasts for the European ICT Professional and Digital Leadership Labour Markets (2015-2020)", Working Paper, Nov 2015

2).

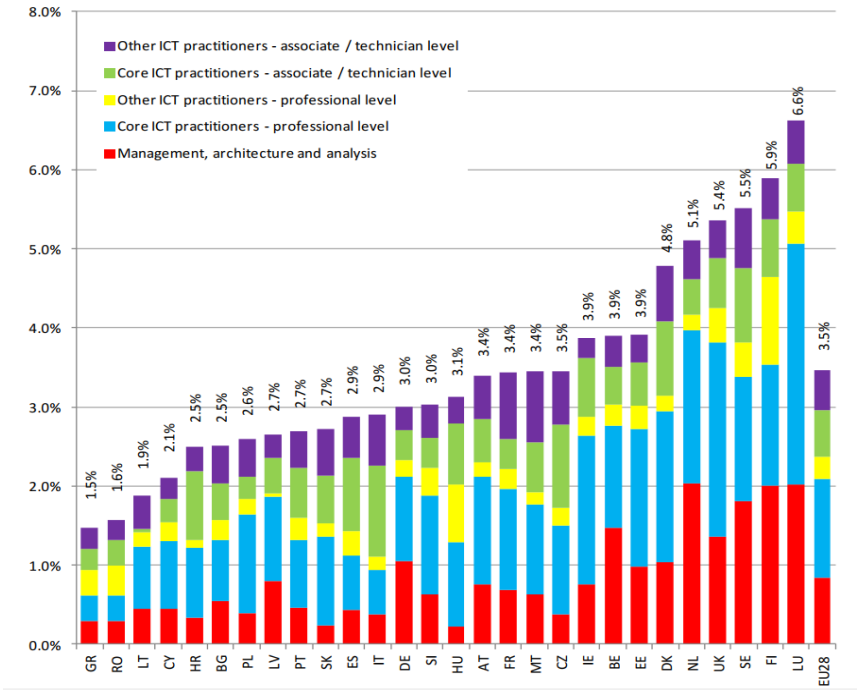

Figure 2. Percentage of ICT professionals in total employees

From the above analysis, it follows that both the European Union as a whole and our country in particular must ensure that the knowledge, skills, abilities and ingenuity of executives, professionals and ICT users meet the highest global standards and that they are constantly upgraded in the context of an effective educational process, based on Lifelong Learning.

The proposed Postgraduate Program is part of the above mentioned framework and aims to create high-level professionals and executives for the public or private sector of our country, cultivating specialized digital skills in postgraduate students, which concern:

- Advanced Security Systems
- Distributed Systems
- Machine Learning Technologies
- Big Data management
- Internet of Things
- Next Generation Networks
- Cloud Technologies
- Intelligent Cyber-Physical Systems
- Designing User Interfaces for Intelligent Services

- Advanced Knowledge Mining Techniques
- Advanced Educational Technology Systems
- Digital Skills for STEM Sciences
- Operational Analysis
- Business Information Systems

In addition, it aims to cultivate the **horizontal skill** of Entrepreneurship through Technology.

3. FEASIBILITY – EXPECTED RESULTS – DIRECT BENEFICIARIES

The subject of the MSc is the development of technologies, models and methods that refer to the efficient management and processing of large amounts of data, the extraction of knowledge and the assistance of decision-making in critical national/regional sectors and in particular in modern cyber systems, education and businesses – organizations. Emphasis is also placed on the familiarization and application of entrepreneurship and open innovation.

The core of the Postgraduate Program consists of the courses of the first semester and the three basic (common) courses of the second semester. Specifically, during the first semester, students become familiar at an advanced level with the subjects – pillars of the master's degree: distributed systems, cloud technologies, security systems, machine learning technologies, and entrepreneurship in relation to technology and open innovation. Successful attendance of the first semester will allow further specialization in one of the three offered specializations in the second semester. The tightly structured design of the MSc allows the second semester to offer three common courses for all specializations. It's the internet of things, next-generation networks, and high-volume data management techniques. These courses further specify the courses – pillars of the first semester and constitute the adequate learning base on which the 3 specializations of the Postgraduate Program are based. The specialization by specialization is completed with the selection of two more courses (per specialization) from a pool of five courses in each specialization.

Specialization 1: Intelligent Cyber Systems and Services

Cybersystems are a dynamic new generation of systems, which has emerged in recent years with the emergence of the Internet of Things. Cyber systems combine the technologies of embedded systems, communication networks and decision-making systems to monitor and support functions and actions that cover a large part of the requirements and modern applications.

In the context of the MSc, postgraduate students will acquire knowledge and skills regarding the end-to-end design of cyber systems and their structural components. Particular emphasis will be

placed on technologies related to:

- Information Theory and Signal Processing
- Embedded systems and hardware accelerators
- Mobile systems and communication technologies
- Distributed systems and intelligent decision-making systems

Cybersystems are a modern trend of systems both commercially and in research. This is certified by the fact that a significant number of start-ups, small and medium-sized and large enterprises are developing technologies and systems in this category, creating a market that is expected to exceed 2 billion euros in turnover by 2030. Indicative examples of different thematic areas based on the use of cyber systems are:

- eHealth (eHeath & Wellbeing)
- Ambient Assisted Living
- Industrial IoT & Industry 4.0 (IIoT)
- Flight Control Systems Automation (Flight 4.0)
- Precision Farming
- Monitoring and management systems for natural resources (energy, water, etc.)

This area is also of significant research interest, as evidenced by the organization of international conferences by international organizations of recognized prestige such as IEEE and ACM. Indicatively, we mention the conferences:

- ACM/IEEE International Conference on Cyber-Physical Systems &
- IEEE International Conference on Industrial Cyber-Physical Systems

Also indicative of the growing dynamics of this region is that in recent years the European Commission has had a special unit concerning intelligent cyber systems with a budget for research and development of more than 100 million. by 2020 (Horizon 2020 Financial Framework).

From the above, it is clear that the graduates of the Postgraduate Program will have acquired the necessary knowledge and skills to enter a labor and research market with excellent prospects for their next steps, whether they concern their professional rehabilitation or the continuation of their academic career.

At the same time, this direction creates a new generation of adequately trained executives and researchers with skills related to the design of cyber systems. Due to the size of this market, at European and global level, there is an increased demand for professionals and researchers with skills to design and develop intelligent systems. The specific direction of the Postgraduate

Program aims to meet this exact need.

Specialization 2: Advanced Educational Technologies

To close the digital skills gap in the labour market, the European Union is implementing a number of important actions[5]. A common factor of these actions is the interventions that must be made at all levels of education. Especially for primary and secondary education, measures such as:

- To provide incentives to teachers in order to upgrade their knowledge of ICT and to modernize their pedagogical methods, so that digital teaching complements the traditional one.
- The orientation of the curricula not to basic skills, but to more demanding ones, which are necessary in high-tech industries.
- The improvement of education in the field of STEM (Science, Technology, Engineering, Mathematics) and STEAM (Science, Technology, Engineering, Mathematics, Arts).
- The cultivation of digital skills should start from the lower levels of education and reach Lifelong Learning.
- The cultivation of computational thinking from an early age because it equips students with skills of categorizing and analyzing everyday problems, which can be solved with the help of a computational system.
- The use of flexible and focused educational approaches, such as Massive Open Online Courses (MOOCs).

The area of educational technologies is showing an international boom and new advanced services such as personalized learning environments, the Bring Your Own Device model, mobile learning services, gamification environments, 3D-educational worlds, etc., are constantly being created and evolving. In addition, the utilization in recent years of cloud computing systems and services, artificial intelligence, machine learning and modern and efficient methods of knowledge mining, has given new dimensions to educational technologies. The spread of the use of advanced educational technologies has led to the production of a large amount of educational data related to learning and its processes. The need to develop methodologies that will utilize educational data, extract knowledge from them and support decision-making processes in school education

[5] (a) "Redesign of Education" http://ec.europa.eu/education/policy/multilingualism/rethinking-education_el
(b) "Action Plan for Entrepreneurship 2020" https://ec.europa.eu/growth/smes/promoting-entrepreneurship/action-plan_el
(c) "Grand Coalition for Digital Employment" https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition

as well as in didactic and educational analytics, is now critical.

Based on the above, this specialization aims to:

- To further develop teachers' digital skills and make them capable solvers of real problems
- To expand interdisciplinary knowledge of the subject of teachers in order to enhance the quality of their teaching.
- To bring teachers into contact with experts and specialists from the field of educational technologies.
- To empower teachers in the process of creating innovative educational proposals and modern teaching approaches based on educational technologies.
- To help teachers understand the range of critical problems they can face in their teaching through STEM
- To put into practice the results of research and innovations related to the use of technology in teaching.
- To monitor research results and trends in educational technology.
- Take the lead in improving existing or introducing new processes, using educational technologies and ICT in general.
- Apply digital skills to address everyday problems, e.g. student and programme assessment, administration and decision-making, mentoring, training and professional development.
- To act as agents of change and innovation in their professional environment.

Specialization 3: Business Analytics and Data Science

The object of the specialization is to provide specialized postgraduate level knowledge in the field of Business Analytics and Data Science to graduates of universities and TEIs, executives of companies and organizations of the public and private sector.

This field of expertise concerns the development of technologies, models and methods that refer to the efficient management and processing of large volume business data (bit data) and the extraction of knowledge in order to support business decision-making.

In this context, the specialization of Business Analytics and Data Science has as its learning purpose to develop the quantitative and analytical skills of students in order to be able to extract value from large volume multidimensional data in order to shape business decisions and for

research purposes. To this end, emphasis is placed on the acquisition of practical experience at the postgraduate level and the familiarization with advanced technologies related to machine learning, modern distributed systems for the management and processing of large volumes of data, data visualization and modeling, decision-making and the corresponding modern methods of knowledge mining. Emphasis is also placed on the familiarization and application of entrepreneurship and open innovation.

Business data analytics will have tremendous growth in the next decade due to the existence of a huge amount of data in the business environment and the ever-increasing need to make decisions in a very short period of time for businesses to continue to be competitive. The use of the internet expands to a particularly high degree the dimension of business data (e.g. social media / sentiment analysis, Internet of Things) and imposes the need to acquire advanced knowledge and skills in distributed file management systems, new databases, modern business intelligence methods and data mining. The graduates of the specialization will staff businesses and organizations, expand entrepreneurship, promote the upgrading of the quality of the products and services provided, contributing to sustainable development, both in the economic, social and environmental sectors at regional and national level.

4. INDIRECT BENEFICIARIES FROM THE REALIZATION OF THE POSTGRADUATE PROGRAM.

Indirect beneficiaries of the implementation of the Postgraduate Program will be organizations and businesses that need specialized high-level staff to successfully carry out their activities both within the country and abroad. These businesses can belong to all sectors of the economy, not just the ICT sector. Accordingly, the executives that will be produced by the Postgraduate Program will be able to fill positions in the public administration and the public sector in general, improving the level of services that public bodies provide to citizens. Finally, the Postgraduate Program will contribute to the cultivation of an academic and research profile among its graduates and will contribute to the development of research in the specific disciplines.

5. SCIENTIFIC COMPETENCE OF TEACHERS AND LINKING TEACHING WITH RESEARCH

The Department of Electrical and Computer Engineering has the research staff and the required research infrastructure to adequately support the Postgraduate Program and its individual specializations. These infrastructures have been used with great success in the last six (6) years for the implementation of the Master's Program "Technologies and Systems of Broadband Applications and Services" implemented by the Department of Electrical and Computer Engineering, the evolution of which is the new Postgraduate Program proposed.

The faculty members of the Department have subjects and rich research and development work

in the individual disciplines, which are relevant to the subject of the Postgraduate Program:

- Development of algorithms for searching and filtering information
- Modeling and forecasting in e-commerce systems
- Data security and data analysis by businesses and organizations
- Mining information from data on the web
- eGovernment services
- E-learning services
- Design and implementation of educational games
- Customizing commercial video games for use in teaching
- Educational robotics
- Interaction design and usability assessment
- Computer Network Technologies
- Internet and web application technologies and protocols
- Advanced digital communication systems
- Basic and advanced digital signal processing techniques
- Mobile networks
- Wireless communications and sensor networks
- Network multimedia systems
- Distributed/Parallel Systems and Distributed/Parallel Computing
- Distributed Computing and Information Management Algorithms
- Distributed Decision Support and Resource Management Environments
- Parallel and distributed object-oriented approach to the design and implementation of complex applications
- Cloud Technologies
- Mobile Algorithmic Issues
- Network-centric information systems
- Web Application Modeling
- Large-scale data analysis
- Knowledge mining with machine learning methods

- Knowledge mining from distributed data
- Manage business processes and workflows
- Diffuse Computing Systems
- Applications and techniques of knowledge mining and visualization in biomedical data
- Scheduling algorithms and applications
- Modeling large problems with constraints
- Combined and integral optimization
- Designing Digital Integrated Circuits for Security Systems
- Efficient implementations in integrated circuits of cryptography algorithms
- Development of methods for detecting viral material
- Efficient implementations in signal processing system integrated circuits
- Design of architectures in digital integrated circuits (FPGAs and ASICs)

The connection of education with research is achieved mainly through the preparation of the Diploma Thesis, which is an original research project under the supervision of an experienced academic researcher.

6. EVALUATION CRITERIA OF THE POSTGRADUATE PROGRAM

The aim of the criteria is to evaluate the quality of the education provided, the extent of the research activity and the administrative services provided, in order to make modifications and improvements in the above fields if necessary.

The sources of the evaluation information will be the electronic evaluation questionnaires of the postgraduate students (at the end of each semester in accordance with article 20 of the Regulation), the investigation of the requirements of the labor market, the prepared Diploma Theses and the research publications that will result from them.

The general evaluation criteria of the Postgraduate Program include the following:

1. The academic physiognomy and the orientation of the curriculum.
2. The learning outcomes and the desired qualifications.
3. The structure and organization of the curriculum.
4. The quality and effectiveness of the teaching work.
5. The suitability of the qualifications of the teaching staff.

6. The quality and extent of the research work.
7. The degree of connection between teaching and research.
8. The demand in the labor market for the acquired qualifications.
9. The evaluation of the examination system.
10. The international dimension of the MSc.
11. The selection process of postgraduate students.
12. The ratio of teachers/learners and the cooperation between them.
13. The degree of participation of the regular staff of the Department.
14. The quality of support services, such as administrative services, libraries and student welfare services.

7. SYNERGY AND COMPLEMENTARITY WITH EXISTING STRUCTURES

The implementation of this Master's Program will be in collaboration with the other Postgraduate Programs of the Foundation. Its implementation will be contributed by the Foundation's structures related to the upgrading of the material and technical or other infrastructure, such as the network connection of the Foundation, the modernization of the Libraries of the Department and the Foundation. Also, cooperation will be carried out by the Liaison Office through which information will be disseminated for the preparation of the Postgraduate Program as well as for possible jobs.